Radio Trade Annual

RADIOTRON

1936

RADIO TRADE ANNUAL OF AUSTRALIA 1936

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We of the Radio Industry must live in the future, if we wish to live at all.

In radio's ever-changing world, research must be continuous: looking, planning, seeking new worlds to conquer — for radio can never stand still.

Smaller units of the industry may perhaps narrow their vision to weeks or months, but the leaders of radio, those great concerns whose field of activity and research is almost infinite, can stop short only when the whole world comes under their survey, and when for years ahead they have planned to take care of radio's advance and improvements.

With such a mighty concern the Mullard Radio Co. (Aust.) Ltd. is linked. In every department of the field of radio endeavour in Australia, Mullard will bring the knowledge of progress which is borne to this mighty Company overseas from the wisdom of the past and from its continual expeditions into the future.

Every member of the radio industry is free to take his share of what this continuous research can bring, both in a material and in an abstract way for the progress of the industry.

Your co-operation is invited both now and in the future.

On every type of valve, the past, present and future, accepted in Australia, you can see this sign of a Master Valve . . .

Mullard

Advertisement of MULLARD RADIO CO. (AUST.) LTD., Geelong House, 26-30 Clarence Street, Sydney, N.S.W. Victorian Distributors: HOWARD RADIO PTY. LTD., Osborne House, Little Collins Street, Melbourne, C.1.

This *is the* MAN . . .

who made a very nice shoe

HE wanted to sell his shoe, so he put some lovely ads. in some magazines telling smart women about the very nice shoe.

This is the LADY *who read his ad.*

SHE wanted a shoe, and this was a very nice shoe, so she put on her hat and went to her LOCAL SHOE DEALER.

This is the DEALER

who had NEVER HEARD of the very nice shoe that the very nice lady wanted to buy.

BUT HE wanted a SALE

and she wanted a shoe—so they got together and compromised on another brand of very nice shoes that he had learned all about in an advertisement in the latest issue of his Trade Journal.

MORAL

DON'T NEGLECT

the people who sell your goods. On no other item does the customer take the dealers' word for quality, performance and tone as much as on a radio receiver.

You've GOT to sell the DEALER Before you can sell the consumer

Which is why so many manufacturers are finding it wise to display their goods persistently in the show windows of the . . .

Radio Retailer
OF AUSTRALIA

"Trade News While It's News"
Published by
AUSTRALIAN RADIO PUBLICATIONS LTD.
'Phone: B 7188 (3 lines)

Head Office:
6th Floor
Lisgar House
Carrington Street
Sydney

Victorian Branch:
422 Little Collins St.
Melbourne
'Phone: M 5438

THE P.5

This is Australia's most Dependable Dry Battery

The Diamond P.5 Radio Battery is everywhere regarded as Australia's most dependable Radio Battery. This has been proved time and time again under all circumstances, Diamond always emerging triumphant from any test. Therefore, stress Diamond dependability and their lasting power. You'll find that your customers already know Diamond P.5 very favourably and that sales will be easy and regular.

WIDDIS DIAMOND DRY CELLS PTY. LTD.

Cr. Dalgety Road and Millers Point, Sydney, N.S.W.

119 Hawke Street, West Melbourne, C.3. F 1175.

CONQUERING SPACE!

History tells of the dauntless explorers, Raleigh, Columbus, Cook and many others, who CONQUERED SPACE and opened up new worlds. To-day, radio waves flashing through the skies are CONQUERING SPACE at the almost incredible speed of 186,000 miles per second.

By supplying the necessary power to the radio receiver and enabling amplification of radio waves, Ever Ready is daily performing a service to thousands of radio listeners in homes in near and distant parts of the Commonwealth. A wealth of music, entertainment and information breaks down all barriers of isolation.

Users specify EVER READY because they know that full reliance can be placed on EVER READY products which carry a guarantee of satisfactory service. For strength, durability and steady Power, EVER READY BATTERIES hold their own.

THERE IS A BATTERY FOR EVERY TYPE OF SET

AUSTRALIA'S BEST BATTERIES

EVER READY

TORCHES, REFILLS & RADIO BATTERIES

STILL PIONEERING *in an aggressive and Competitive Field!*

SINCE 1894 and the earliest days of the telephone, when it was still a thing to wonder at, Stromberg-Carlson has led in the development of voice transmission and reception. It is natural, therefore, that when the younger science of Radio was evolved, the name "Stromberg-Carlson" should become synonymous with Quality in Radio, and to-day this organisation is world-renowned.

Stromberg-Carlson reproduction is the standard by which all other Radio Receivers are judged, and Stromberg-Carlson developments and refinements lead the way in the design of Australian Radio Receivers.

To-day, more than ever, Stromberg-Carlson are forging ahead on a solid foundation of well established success, with a background of over 40 years of leadership and scientific pioneering.

There is nothing finer than a Stromberg-Carlson

Stromberg-Carlson

Chromo-phonic RADIO

Wholesale Distributors in Australia and New Zealand:

N.S.W.: Bennett & Wood Ltd., 284 Pitt street, Sydney. Wagga Wireless Distributors, Box 93, Wagga. Heiron & Smith (Salonola), 91 Hunter Street, Newcastle.

Queensland: Noyes Bros. (Sydney) Ltd., Burton House, Elizabeth Street, Brisbane. Lawrence & Hanson Electrical Co. Ltd., 87 Elizabeth Street, Brisbane.

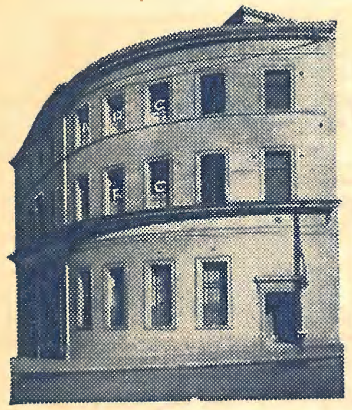
S.A.: Savery's Pianos Ltd., 29 Rundle Street, Adelaide. Radio Wholesalers, James Place, Adelaide.

Victoria: Warburton Franki (Melb.) Ltd., 380-382 Bourke Street, Melbourne. M. Brash & Co. Pty. Ltd., Elizabeth Street, Melbourne; Vealls Pty. Ltd., 243-249 Swanston Street, Melbourne.

Tasmania: Findlays Pty. Ltd., 80 Elizabeth Street, Hobart; George Street, Launceston. Wills & Co. Pty. Ltd., 7 The Quadrant, Launceston. Findlay & Wills Pty. Ltd., Devonport.

W.A.: Musgroves Limited, Lyric House, Murray Street, Perth.

N.Z.: Gough, Gough & Hamer Ltd., Christchurch.



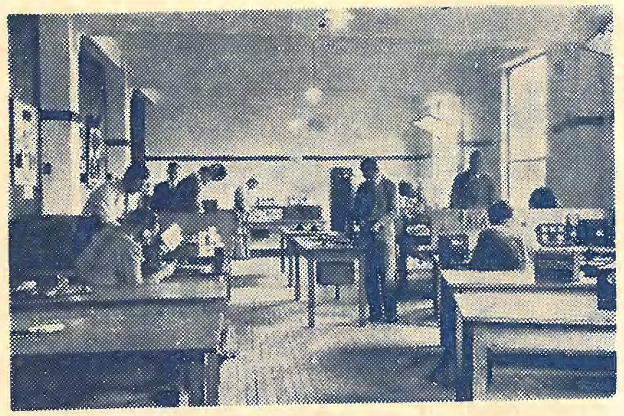
Above you see the College premises.

To the right is the modernly equipped practical laboratory.

Below, the splendid lecture hall with lecture in progress is shown.

A.R.C. Students perform full practical work on modern equipment in conjunction with their lessons.

"Moulding Radio's character . . ."



A JOB worth doing is worth doing well. The Australian Radio College is doing this every day—every minute. It's an important job, this moulding the character of Radio.

Each student's success is assured by the thorough training and personal attention given.

Glance below at the services and facilities which make this possible.

RADIO . . . TELEVISION . . . REFRIGERATION . . .

SPECIALISED TRAINING IN ELECTRONIC ARTS

- RADIO ENGINEERING
- SERVICE ENGINEERING
- TELEVISION ENGINEERING
- SOUND PROJECTION
- REFRIGERATION SERVICE ENGINEERING

A.R.C. facilities and free services spell "Success" for A.R.C. students

- DAY CLASS TRAINING
- NIGHT CLASS TRAINING
- CORRESPONDENCE TRAINING
- PRACTICAL INSTRUCTION
- PRACTICAL LECTURES
- UP-TO-DATE LESSONS
- EMPLOYMENT SERVICE
- BUYING SERVICE
- BUSINESS ADVICE SERVICE
- TECHNICAL CONSULTATION SERVICE

A free illustrated prospectus may be obtained upon application to

AUSTRALIAN RADIO COLLEGE LTD.

(Principal, L. B. Graham)

CNR. BROADWAY and CITY ROAD, SYDNEY

Type 6CR7

Type 2VC11

Type 4SR7

Type 2VS7

THE POWER BEHIND BATTERY-OPERATED RADIO PERFECTION

Famous for their sturdy strength and for their proved efficiency, Clyde Radio Batteries are the first choice of Battery-set owners everywhere. Special thick plates of exceptionally high capacity and life. Enclosed in Hard Rubber Containers, leak-proof, and practically indestructible.

SPECIFICATIONS.

TYPE.	VOLTS.	Amp. Hour Capacity at 100 Hr. Rate.	PRICE. £	s.	d.	CODE WORD.
2VS5	2	25	0	16	0	Voyage
2VS7	2	40	0	17	0	Zone
2VS9	2	55	1	8	6	Caper
2VC11	2	100	1	9	6	Ogre
2VC15	2	130	1	17	0	Mask
4SR5	4	25	1	14	0	Pagan
4SR7	4	40	2	1	9	Pearl
4CR7	4	60	2	6	6	Ransom
4CR9	4	80	2	12	0	Slave
6CR7	6	60	3	1	0	Renew
6CR9	6	80	3	6	8	Ocean

Freight, Packing and Sales Tax Extra.

CLYDE
RADIO BATTERIES

The Batteries with a background of great achievements

PRODUCT OF

THE CLYDE ENGINEERING CO., LTD.

Manufacturers of all types of Car and Home-Lighting Batteries

GRANVILLE - - - N.S.W.

Main Sales and Service Division: 61-65 Wentworth Avenue, Sydney

Branches at Brisbane, Melbourne and Adelaide

Distributors: Dalgety & Co. Ltd., Perth; H. C. Heathorn & Co. Ltd., Hobart and Launceston.

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BY APPOINTMENT

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BY APPOINTMENT

"His Master's Voice" *true-to-life* RADIO and RADIOGRAMS

Designed and built specially for Australian conditions, by the Australian branch of the greatest radio factory in the British Empire. Backed by a Trade Mark that is a guarantee of quality throughout the world.

Any instrument bearing this Trade Mark is already half sold.

The Gramophone Company Ltd., Homebush, N.S.W.

THAT THIS WILL BE ONE OF THE BIGGEST YEARS RADIO HAS SEEN.

WE KNOW IT WILL BE FOR TASMA

ARE YOUR RADIO SALES RISING — OR STAGNANT? It is an inspiration to us to hear the enthusiastic reports of TASMA dealers. It more than compensates for the extra hard work involved in producing receivers which will honestly live up to the word "exceptional." To see Tasma maintaining its records as a best-seller, building profits and an enviable reputation for manufacturer and retailer alike, is the greatest compliment two sincere men can ever receive. Are you coming in with Tasma — or staying with the rank and file?

Opportunities are available for new Tasma dealers in a limited number of unallotted territories. Write to us.

Tasma DETAIL-BUILT RADIO

TASMA ·· A PRODUCT OF THOM AND SMITH LTD.

55 Dowling Street . . . East Sydney

ARISTOCRAT RADIO

PRE-EMINENT IN DESIGN AND PERFORMANCE

"SUPERBE" CABINET

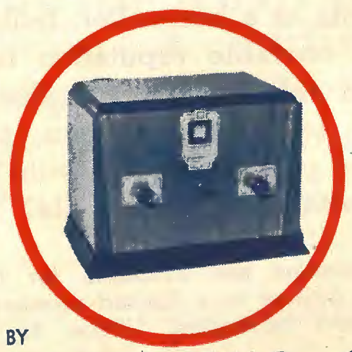
"DE LUXE" CABINET

"CONSOLE" CABINET

Aristocrat Radio for 1936 features a complete and comprehensive range of receivers . . . models for every purpose and for every purse.

Whatever type of receiver may be desired, whether it be A.C., A.C./D.C. or Battery-operated; Mantel, Console, or Radio-Phonograph combination; Broadcast or Dual-Wave . . . there is an "Aristocrat" that will give satisfaction—in appearance, operation and performance.

Aristocrat Receivers range from 16 gns. to 75 gns.



Above—Radio-Phonograph Combination.

At Left—Mantel Cabinet

At Left—S.W. Converter

MANUFACTURED BY

ELECTRICAL SPECIALTY MANUFACTURING CO. LTD.

17-19 GLEBE STREET, GLEBE, SYDNEY — 'PHONES: MW 2608-9 — TELEGRAPHIC ADDRESS: "ESSEMCO"

DISTRIBUTORS:

Electrical Service Co. Newcastle — Trackson Bros. Pty. Ltd. Brisbane — Carlyle & Co. Perth — McCann Bros. Hobart — Nicholson & Co. Ltd. Sydney

1935

JANUARY

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JUNE

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SEPTEMBER

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OCTOBER

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1937

JANUARY

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FEBRUARY

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MARCH

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JUNE

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AUGUST

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SEPTEMBER

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OCTOBER

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NOVEMBER

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DECEMBER

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26	27	28	29	30	31	

Trade Discount Ready Reckoner

DISCOUNT RATE %.

Amount	2½	3⅓	3¾	5	6	7½	10	12½
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
£100	2 10 0	3 6 8	3 15 0	5 0 0	6 0 0	7 10 0	10 0 0	12 10 0
90	2 5 0	3 0 0	3 7 6	4 10 0	5 8 0	6 15 0	9 0 0	11 5 0
80	2 0 0	2 13 4	3 0 0	4 0 0	4 16 0	6 0 0	8 0 0	10 0 0
70	1 15 0	2 6 8	2 12 6	3 10 0	4 4 0	5 5 0	7 0 0	8 15 0
60	1 10 0	2 0 0	2 5 0	3 0 0	3 12 0	4 10 0	6 0 0	7 10 0
50	1 5 0	1 13 4	1 17 6	2 10 0	3 0 0	3 15 0	5 0 0	6 5 0
40	1 0 0	1 6 8	1 10 0	2 0 0	2 8 0	3 0 0	4 0 0	5 0 0
30	15 0	1 0 0	1 2 6	1 10 0	1 16 0	2 5 0	3 0 0	3 15 0
20	10 0	13 4	15 0	1 0 0	1 4 0	1 10 0	2 0 0	2 10 0
10	5 0	6 8	7 6	10 0	12 0	15 0	1 0 0	1 5 0
9	4 6	6 0	6 9	9 0	10 10	13 6	18 0	1 2 6
8	4 0	5 4	6 0	8 0	9 7	12 0	16 0	1 0 0
7	3 6	4 8	5 3	7 0	8 5	10 6	14 0	17 6
6	3 0	4 0	4 6	6 0	7 3	9 0	12 0	15 0
5	2 6	3 4	3 9	5 0	6 0	7 6	10 0	12 6
4	2 0	2 8	3 0	4 0	4 10	6 0	8 0	10 0
3	1 6	2 0	2 3	3 0	3 7	4 6	6 0	7 6
2	1 0	1 4	1 6	2 0	2 5	3 0	4 0	5 0
1	6	8	9	1 0	1 3	1 6	2 0	2 6
19/-	6	8	9	11	1 2	1 5	1 11	2 5
18/-	5	7	8	11	1 1	1 4	1 10	2 3
17/-	5	7	8	10	1 0	1 3	1 8	2 2
16/-	5	6	7	10	11	1 3	1 7	2 0
15/-	5	6	7	9	11	1 2	1 6	1 11
14/-	4	6	6	8	10	1 1	1 5	1 9
13/-	4	5	6	8	9	1 0	1 4	1 8
12/-	4	5	5	7	9	11	1 2	1 6
11/-	3	4	5	7	8	10	1 1	1 5
10/-	3	4	5	6	7	9	1 0	1 3
9/-	3	4	4	5	7	8	11	1 2
8/-	2	3	4	5	6	7	10	1 0
7/-	2	3	3	4	5	6	8	11
6/-	2	2	3	4	4	5	7	9
5/-	2	2	2	3	4	5	6	8
4/-	1	2	2	2	3	4	5	6
3/-	1	1	1	2	2	3	4	5
2/-	1	1	1	1	1	2	2	3
1/-	–	–	–	1	1	1	1	2
11d.	–	–	–	1	1	1	1	1
10d.	–	–	–	1	1	1	1	1
9d.	–	–	–	–	1	1	1	1
8d.	–	–	–	–	–	1	1	1
7d.	–	–	–	–	–	1	1	1
6d.	–	–	–	–	–	–	1	1
5d.	–	–	–	–	–	–	1	1
4d.	–	–	–	–	–	–	–	1
3d.	–	–	–	–	–	–	–	–
2d.	–	–	–	–	–	–	–	–

DISCOUNT RATE %.

Amount	15	17½	20	25	27½	33⅓
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
£100	15 0 0	17 10 0	20 0 0	25 0 0	27 10 0	33 6 8
90	13 10 0	15 15 0	18 0 0	22 10 0	24 15 0	30 0 0
80	12 0 0	14 0 0	16 0 0	20 0 0	22 0 0	26 13 4
70	10 10 0	12 5 0	14 0 0	17 10 0	19 5 0	23 6 8
60	9 0 0	10 10 0	12 0 0	15 0 0	16 10 0	20 0 0
50	7 10 0	8 15 0	10 0 0	12 10 0	13 15 0	16 13 4
40	6 0 0	7 0 0	8 0 0	10 0 0	11 0 0	13 6 8
30	4 10 0	5 5 0	6 0 0	7 10 0	8 5 0	10 0 0
20	3 0 0	3 10 0	4 0 0	5 0 0	5 10 0	6 13 4
10	1 10 0	1 15 0	2 0 0	2 10 0	2 15 0	3 6 8
9	1 7 0	1 11 0	1 16 0	2 5 0	2 9 6	3 0 0
8	1 4 0	1 8 0	1 12 0	2 0 0	2 4 0	2 13 4
7	1 1 0	1 4 0	1 8 0	1 15 0	1 18 6	2 6 8
6	18 0	1 1 0	1 4 0	1 10 0	1 13 0	2 0 0
5	15 0	17 6	1 0 0	1 5 0	1 7 6	1 13 4
4	12 0	14 0	16 0	1 0 0	1 2 0	1 6 8
3	9 0	10 6	12 0	15 0	16 6	1 0 0
2	6 0	7 0	8 0	10 0	11 0	13 4
1	3 0	3 6	4 0	5 0	5 6	6 8
19/-	2 10	3 4	3 10	4 9	5 3	6 4
18/-	2 8	3 2	3 7	4 6	4 11	6 0
17/-	2 7	3 0	3 5	4 3	4 8	5 8
16/-	2 5	2 10	3 2	4 0	4 5	5 4
15/-	2 3	2 8	3 0	3 9	4 2	5 0
14/-	2 1	2 5	2 10	3 6	3 10	4 8
13/-	1 11	2 3	2 7	3 3	3 7	4 4
12/-	1 10	2 1	2 5	3 0	3 4	4 0
11/-	1 8	1 11	2 2	2 9	3 0	3 8
10/-	1 6	1 9	2 0	2 6	2 9	3 4
9/-	1 4	1 7	1 10	2 3	2 6	3 0
8/-	1 2	1 5	1 7	2 0	2 2	2 8
7/-	1 1	1 3	1 5	1 9	1 11	2 4
6/-	11	1 1	1 2	1 6	1 8	2 0
5/-	9	11	1 0	1 3	1 5	1 8
4/-	7	8	10	1 0	1 1	1 4
3/-	5	6	7	9	10	1 0
2/-	4	4	5	6	7	8
1/-	2	2	2	3	3	4
11d.	2	2	2	3	3	4
10d.	2	2	2	3	3	3
9d.	1	2	2	2	2	3
8d.	1	1	2	2	2	3
7d.	1	1	1	2	2	2
6d.	1	1	1	2	2	2
5d.	1	1	1	1	1	2
4d.	1	1	1	1	1	1
3d.	–	1	1	1	1	1
2d.	–	–	–	1	1	1

N.L.

... The ...

RADIO TRADE ANNUAL OF AUSTRALIA

FOURTH EDITION

1936

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Preface . . .

THIS is the fourth edition of the "Radio Trade Annual of Australia," which is now accepted as the reference book of the radio industry in Australia.

This Annual has earned for itself a place on the bookshelf, in the library or on the table of every executive or person who wants to know many things about radio.

The contents this year have been considerably revised, particularly the technical section, and also the broadcasting section. In previous years we included all reference data concerning commercial broadcasting stations, but in view of the growth of commercial broadcasting in Australia it has been found necessary to publish a separate book, and we are therefore issuing the "Broadcasting Business Year Book" very shortly after this Annual appears.

The "Radio Trade Annual" therefore deals with the broadcasting situation in general, including the Federal Government service operated by the Australian Broadcasting Commission, while the commercial stations (operated by private enterprise and commonly referred to as "B" stations) are treated in detail in the Year Book.

This Annual deals with the radio manufacturing industry, which has progressed in a remarkable manner during the past twelve months.

Australia, on account of its vast area (nearly 3,000,000 square miles) and sparse population (less than 7,000,000 people) has a great need for an up-to-date and effective broadcasting service, and it is pleasing to record the growth of more country stations, both by the Government and commercial interests.

The radio industry is assisting to meet that need very effectively by cheaper and better receiving sets.

The publishers extend their appreciation to all those who have again made the publication of this Radio Trade Annual possible.

O. F. MINGAY
Editor.

Reviewing 1935 in the Australian Radio Industry

THE change made in radio in Australia during 1935 was one not only of substantial improvement, but of consolidation on the part of both the manufacturing and broadcasting industries.

The most authentic indication of substantial improvement is reflected in the continued growth of the listeners' license figures. Keeping in mind that the Federal Government issues a listener's license, and every person possessing a wireless set is required by law to possess such a license at a cost of 21/-, procurable at all post offices, there were 169,621 of these new licenses issued throughout the Commonwealth during 1935. It can safely be claimed that every new license means a new set, but in addition the replacement question is an ever-growing one. After careful analysis it is believed that at least 50 per cent. of total sales is made to owners of sets who invariably trade-in or otherwise dispose of their old set; but to be on the conservative side, say that one in every three sales is a replacement, and therefore would not call for a new license. This would mean that at least another 84,000 sets were made and sold during 1935. That brings the estimated total quantity of wireless sets sold during 1935 in Australia to over a quarter of a million (250,000) which is not quite as good as 1934, but that was the cricket year when the Australians visited England and play descriptions were broadcast from about 8 p.m. to 2 a.m.—the time when the men of the household are at home.

The next big cricket year will be 1938.

As to value it is estimated by the writer that at least £5,000,000 was spent by the public on radio sets alone, not including renewals, repairs and service, on the basis of £20 average retail price.

During 1935 the licenses increased by 88,518 after allowing for 81,103 cancellations and making the total at December 31 last, 770,152 as compared to 681,634 at December 31, 1934. Unfortunately the months of May, June, July and August still continued the peak months, and for that period new licenses issued were equal to 40 per cent. of the total, whilst renewals equalled 46 per cent.

Manufacturing Activities

THE consolidation of the radio manufacturing industry was most marked during 1935 by the fact that the substantial factories continued to grow and do a more profitable business, holding the confidence of the retailers and public alike, getting a better price for their receivers, while on the other hand several lesser factories who could not stay the distance in either reputation, finance or ability, simply faded out. Losses in that direction must have been nearly £80,000, which should be a lesson to those who extend credit somewhat promiscuously. The better-class factory with a better product has succeeded and will always do so.

Several manufacturers planned the building of new factories or extensions to existing premises, all of which is a good sign and proof of the consolidation of radio in Australia.

The radio industry is most active in N.S.W., where about 65 per cent. of the total Commonwealth production originates. Victoria produces about 25 per cent. and the balance is spread over the rest of the States. Figures in respect to employees in radio are not available, and due to the variation at different times of the year, even an estimate would be difficult.

Overseas Broadcast

DURING 1935 the outstanding overseas broadcast was that of the Jubilee Celebrations of our late King George and his subsequent Christmas broadcast. He was undoubtedly the world's most popular broadcaster. His correct and yet natural English voice made him most readily appreciated by all. Unfortunately, he has now passed to the "beyond," and the world is much the poorer.

Speaking of the Jubilee Year reminds one that during 1935 a record number of radio industry personalities visited overseas, for, no doubt, both pleasure and business.

Broadcasting Industry

READERS (particularly overseas) are reminded that there are two systems of broadcasting stations in Australia; the National Government service conducted on the programme side by the Australian Broadcasting Commission, and on the technical side by the Postmaster-General's Department. The P.M.G.'s Department also issues the listeners' licenses and collects 21/- per annum from every licensed listener, of which 12/- goes to the Australian Broadcasting Commission for programmes, and the balance is retained by the P.M.G. for erection of new stations and maintenance of existing equipment.

The other stations, privately owned and referred to as Commercial Stations, do not participate at all in the license revenue, but depend entirely for their income upon revenue for advertising over the air.

During the year of 1935 two new regional relay stations were added to the National Service, one in Tasmania and one in Victoria.

(Continued on next page)

REVIEW OF AUSTRALIAN RADIO INDUSTRY—
(Continued)

In the commercial field about 10 new stations went on the air, the highest power being 2,000 watts and others down to 50 watts. Commercial stations are making rapid progress in programme presentation, listener response, advertising support and increased technical efficiency. They claim as a whole to hold at least 75 per cent. of the public appreciation.

The outstanding event in commercial broadcasting circles was the introduction in February, 1935, of the first continuous 24-hour service of any known broadcasting station in the world, by 2UW Sydney, which operates all through the year and is never off the air, using two transmitters alternately on the same wavelength (1110 k.c. 270 metres).

Many other stations operate from 6 a.m. to about midnight.

The National stations are being added to by relay stations located in country areas and every endeavour is being made by the Commission to improve programmes, while the P.M.G.'s Department is pushing ahead with more new stations and the improvement of existing stations.

Wavelengths were reallocated in many instances on September 1, 1935, to provide for the continual increase in new stations.

During 1935 new regulations were issued by the Postmaster-General restricting the ownership of commercial stations by any one person or group. Considerable agitation ensued against the drastic proposals, which were subsequently modified and limited to eight stations in the Commonwealth.

It is generally considered that the Postmaster-General should not control the broadcasting situation, particularly in respect to the commercial stations, as he is responsible for the Government's National service. Government by regulation is not popular, nor desirable. Considerable discussion took place in Federal Parliament on the subject, which no doubt will be revived this year.

The validity of the Wireless Act was challenged during 1935 as being ultra vires the Commonwealth Constitution, but ultimately the High Court decided that the Act was valid. The full decision is published in this Annual.

Patents

THE past year of 1935 was a record in respect to the number of radio patents taken out, many of which concerned television, which, as yet, has not made its appearance in Australia.

Details of patent registration are also to be found in this Annual.

The main event during the year was the acquisition by Australian Radio Manufacturers' Patents Association Ltd. (a group of radio manufacturers) of the British Baird Television patents in Australia.

Importations

A VERY useful barometer of the progress of radio in Australia is to be found in the importation figures of valves. There is only one valve factory in Australia and the balance is imported. During the year under review, 1,195,482 valves were imported as compared to 1,672,918 for 1934, a drop of about 500,000, but it is estimated that there was a big carry over of stocks at the beginning of 1935 on account of an American shipping strike during the latter end of 1934, and therefore not so many valves were imported during 1935. Then again, the latter end of 1935 saw the introduction of the metal valves in the U.S.A., which must have curtailed the imports of glass valves. The average overseas invoice price on the imported valves from all countries was 4/6.4d. during 1935, while in 1934 it was only 3/5.2d.

Of the 1935 importations 19.4 per cent. of the total quantity and 37.2 per cent. of the value of valves came from Great Britain at an average price of 8/8d. From Canada the quantity was 1.2 per cent., and the value 0.8 per cent. of the total with an average price of 3/1d. Holland showed a big increase and sent to Australia 14.1 per cent. of the quantity and 28 per cent. of the value averaging 9/- each; while U.S.A. contributed 65.3 per cent. of the quantity and 33.5 per cent. of the value, with an average cost of only 2/3.9d. each.

Tariff Report

During 1935 the Federal Tariff Board issued their report on the wireless industry and substantially reduced the then existing tariff, full particulars of which are included herewith. Nevertheless, the radio industry continues to thrive in Australia, and while prices have a tendency to rise with the passing of the world-wide depression, the public is getting cheaper and better value in radio than ever before.

Amended Customs Tariff

Following the above report the Federal Government introduced on November 29, 1935, an amended Customs Tariff on Wireless Apparatus, substantially reducing duties on imported radio material. Valves were not altered, except that an Excise duty on Australian-made valves of 2/- per valve was imposed as from November 29.

The general situation in Australia is that radio sets and many parts cannot be imported into this country at an economical figure. The Australian sets under existing tariffs satisfy the market and general conditions. Valves are made in only one factory but some of these are merchandised under well known brands. Resistors and condensers are imported as well as being made in Australia.

The Australian radio industry is making great progress and the public are getting good radio sets at prices more than comparable with what might pertain if there was no protective duty.

(Continued on next page)

REVIEW OF AUSTRALIAN RADIO INDUSTRY—
(Continued)

TECHNICAL TRENDS DURING 1935—

IT cannot be said that 1935 was distinguished by any outstanding trend in receiver circuit design in Australia. Superheterodynes became standardised fairly well in 1934, and the same year saw dual and all-wave receivers fairly well established as factors to be reckoned in planning the production schedules of the majority of factories.

What 1935 did see, however, was a pronounced trend in favour of better engineering. Circuits remained much as before, but much greater attention was paid to the layout and wiring while components received due attention as the governing factor in the performance of a receiver instead of being regarded as mere accessories, to be bought at the cheapest price possible.

This must not be interpreted as meaning that the industry stood still, as the enormous amount of work which has been put into perfecting coil, intermediate and transformer design has had its effect in receivers being produced which, valve for valve, are far more efficient and serviceable than similar receivers, using almost identical circuit arrangements, were twelve months or more ago.

Outstanding examples of component developments are instanced in "pie-winding" for broadcast and intermediate frequency coils, the almost universal use of multi-strand "Litz" for these coils, the growing acceptance of ceramics for radio frequency insulation, proper dehydration and impregnation of parts likely to be affected by atmospheric conditions and a general tightening up of tolerances all around.

The trend towards better engineering did not stop at components alone, as closer tolerances called for greater precision in testing, with the result that sales of test equipment reached a new "high," further resulting in the firm establishment of a healthy branch of the local radio industry, that of test equipment and meter manufacturing. Further details of this section of the industry will be found elsewhere in this edition of the "Radio Trade Annual."

It is not difficult to determine the causes of this trend towards greater precision in manufacture, as, not only did the almost universal production of multi-band receivers call for better engineering methods if the public were to be satisfied that short-wave listening was worth-while, even as an interlude, but the steady increase, both in numbers and power, of the Australian broadcast stations forced the manufacturers to produce better receivers.

Wave-length Re-allocation

How well standardisation had been achieved by the adoption of better engineering methods was amply demonstrated in September, 1935, when the reshuffle of wavelengths took effect. Although some complaints were received of interference, these were in part due to the faulty frequency allocations of several stations, which have since been changed. In the vast majority of cases, manufacturers already had their dial scales prepared for the new station positions, and no recorded instance is to hand where any trouble was caused by faulty calibration, and even though the reshuffle undoubtedly intensified the difficulties attendant upon "interstate" reception in many districts, the receivers marketed prior to September as being "suitable for the new conditions" did their job with credit to the engineers responsible for their design.

Quite a number of refinements found their way into receivers during the past twelve months, prominent among these being the almost universal use of A.V.C. (applied in some cases to the audio as well as the R.F. and I.F. stages) noise suppression or muting, both manual and automatic, and a pronounced trend towards better fidelity of reproduction. Variable selectivity has been introduced as standard in several instances, and, during the latter part of 1935, the introduction of ferro-magnetic cores opened up still further possibilities for the improvement of tuned circuit efficiency.

Multi-band receivers were improved enormously, both from a production and a performance point of view, with the result that to-day consistent reception of overseas stations is the rule rather than the exception. Improvement in this field has been due, as mentioned before, to increased attention to engineering details, and this has had a reflex action in that improved performance has led to greater public demand with consequent still greater attention to the production of really efficient receivers. The increasing number of overseas stations operating on regular schedules has also had its effect in fostering public demand, but it is fairly safe to say that improved engineering on the part of Australian receiver manufacturers has been mainly responsible.

Battery Sets

Battery receivers came in for far more than their usual share of attention during 1935, and development reached a state where country listeners could be assured of as much entertainment value from their receivers as their city cousins. Components were again responsible for the majority of the improvement, and, in addition to the factors which helped so much in all-electric power receivers, battery set designers were assisted by the fact that 1935 saw a really worthwhile improvement in permagnetic speaker technique, made possible by the introduction of aluminium-nickel alloys as magnet materials. Speaker designers were not slow to take advantage of the improvement in flux densities made possible by the use of these new alloys and produced speakers for battery sets which were practically as efficient as their power-energised brethren. Low-consumption battery valve technique advanced by leaps and bounds, and resulted in improved efficiency in every department for not only was the power consumption, especially from the high-tension supply, decreased considerably, but the actual characteristics of the tubes were improved beyond all expectations. Australian valve engineers, were responsible for some of the improvements effected in battery valve design, and two tube types, developed by them, received the seal of approval from the radio trade by their almost universal adoption as standard equipment for the stages designed for.

(Continued on next page)

REVIEW OF AUSTRALIAN RADIO INDUSTRY—
(Continued)

Valve Technique

Valve technique was responsible for the most outstanding radio event during 1935, namely, the introduction of the metal valve. While stocks of these tubes arrived in Australia too late to be applied to any very great extent, during 1935, sufficient was seen of them to convey the impression that they were here to stay. Early advice on the metal range of tubes indicated that they were to be standardised in about ten types, all single purpose, and, with the exception of one type, fairly close replicas of commonly used glass types insofar as their characteristics were concerned. The new tube was a mixer, intended for use in the "first detector" socket of all-wave superheterodyne receivers and its development was no doubt brought about as a result of the inclusion of an ultra high frequency receiving band in the coverage of the better makes of American all-wave receivers.

Several more tubes have been added to the metal range, however, since the first release and as a dual purpose tube (a duo-diode triode) has been included, one of the major objections to metal tubes, that of the necessity of using more tubes per set, has been removed. A feature of these new metal tubes, apart from their metal envelopes, is the fact that they are equipped with a universal eight position type base and so fit a standard socket. The arrangement of the possible pin positions is such that each pin position is separated by 45 degrees around the circumference of a circle, and, as each pin is of the same diameter, precautions were necessary to ensure correct replacement of the tubes in their sockets. The difficulty was overcome by the provision of a locating pin and key on the base, which fitted into a corresponding keyway in the socket.

Some difficulties attended the mass-production of the metal tubes and these led to the introduction of "octal-based" glass tubes, known as "G" tubes, and octal-based metal-clad glass tubes known as "MG" tubes. The characteristics of these "intermediate" tubes were designed so as to be as close as possible to those of the all-metal tubes, one of the reasons being that manufacturers wishing to prepare receivers to use the new range could go straight ahead with their designs and use the intermediate tubes until such time as full stocks of the all-metal tubes became available. At such time the metal tubes could be used without any serious structural and very little electrical alteration being necessary.

Hard on the heels of the metal tubes came the release, by a Continental manufacturer, of a range of improved glass tubes. These tubes, with one exception, were also fitted with a universal base using special side-type, strip contacts. The entire range of tubes suitable for R.F. use in this series was sprayed with a metal compound which was earthed to a base pin and thus reduced the amount of external tube shielding required to a minimum.

One tube in this particular range was new to tube practice in Australia and deserves special mention. It took the form of a "high-mu" output pentode which had a mutual conductance and, consequently, an effective amplification, nearly four times as high as any other type of output pentode available. Simplification of the audio channels of the less elaborate types of radio receivers was thus made possible and it will be interesting to note just what effect this tube (and others of the same type which may be introduced) will have on receiver design technique in this country.

A feature of both the metal and Continental ranges of tubes was a separate duo-diode intended for use in the demodulator—A.V.C. rectifier stage of a receiver. While this type of tube was not new to tube practice, it was the first time that a separate duo-diode had been released which was suitable for operation in standard A.C. receivers. Local designers were not slow to take advantage of the advantages offered by such a tube and several improved demodulator—A.V.C.—first A.F. amplifier circuits made their appearance wherein the duo-diode was used in conjunction with either a triode or a pentode in order to provide more effective A.V.C. and greater freedom from distortion in the A.F. channel.

Towards the latter end of 1935, a radically new tube made its appearance in the form of a miniature "cathode-ray" tuning indicator combined with a triode amplifier and intended to act as an extremely sensitive means of obtaining resonance indications in the highly selective receivers required to cope with modern conditions. This tube found immediate application in several well known manufacturers' products, thus demonstrating once again that Australian designers do not lag far, if at all, behind the rest of the world.

Technical Trends in Australian Broadcasting

NO review of technical trends in Australia during 1935 would be complete without some mention of the enormous strides forward which have been made in transmission technique by the various stations which comprise Australia's Commercial Broadcasting System.

Perhaps the most outstanding event of the year, even from a purely technical viewpoint, was the inauguration by 2UW, Sydney, of a 24 hour a day service. This meant the installation of two transmitters, and, also, to avoid any break in the programme, the provision of means whereby a changeover could be effected from one to the other while **both** were operating. This has been to such good effect that only a very momentary period of distortion is noticed whilst the changeover is being effected. Some idea of the careful engineering entailed in instituting such a service (incidentally, the first of its kind in the world) may be gained from the fact that the aerial equipment, to cite only one portion of the apparatus, is never "dead." All of the equipment used at 2UW is Australian made, and no finer tribute to Australian skill and enterprise in radio engineering can be paid than the bare statement of fact

(Continued on next page)

REVIEW OF AUSTRALIAN RADIO INDUSTRY—
(Continued)

that, during the nine thousand odd hours which have elapsed since the "24 hour" service was inaugurated, 2UW have only been "off the air," through breakdowns, for periods **totalling** under two hours.

The installation of a half-wave vertical radiator for use by 2SM, Sydney, in conjunction with a new "series-modulated" transmitter, designed and built by Amalgamated Wireless (A/sia) Ltd., also opened up new trends in Australian broadcasting practice. Several other vertical self-radiating antennae are being constructed for use in various parts of Australia, one in particular, that at Wagin, Western Australia, being of the recently developed "capacity top" type.

Sixty K.W. for N.Z.

Quite a considerable amount of work has been carried out by the developmental engineers of Amalgamated Wireless (A/sia) Ltd., in connection with "series modulation," and the efficiency of several transmitters equipped with this system and installed by A.W.A indicates that Australian engineers do not lag far, if at all, behind overseas engineers when it comes to the appreciation and application of new developments. In this connection it is of interest to note that the 60 K.W. station designed and built for the New Zealand Government by A.W.A. uses this modulation system.

"High Fidelity" and "series modulation" almost go hand-in-hand, and it is of interest to note that every station equipped with this system by Amalgamated Wireless is capable of linear modulation up to 10,000 cycles, at any percentage up to one hundred. As these transmitters are all equipped with velocity and/or dynamic microphones and speech amplifying gear which corresponds in fidelity, it may be seen that they may be truly classed as "High Fidelity" stations. Unfortunately, ether conditions at the present time do not allow the full "band-width," of which these stations are capable, to be radiated all the time, but it is gratifying to realise that, even though the average aerial power is lower, Australia has broadcasting stations which are the equal of any others overseas.

On short-waves, too, Australian engineers have not been idle and 1935 saw VK2ME, VK3ME and VK3LR still further established as disseminators of Australian goodwill overseas. In addition, 1935 closed with the construction of a further addition to the "ME" chain well advanced, this time in Perth. The new station will be known as VK6ME and should be in regular operation by the time this edition of the "Radio Trade Annual" is available.

Even ultra-short waves came in for their share of attention and a seven metre service was commenced by A.W.A. in Sydney during the early part of 1935. This service is purely experimental and re-radiates VK2ME programmes during all sessions of that station. Here again we see that Australian engineers are right in step with developments overseas, and are fully aware of the growing importance of wavelengths below ten metres. Much valuable data has been collated on U-S-W propagation and reception problems since the inception of this service, and many independent research engineers have expressed their appreciation of the work being done, both as an aid to receiver design and as a guide to probable field strength contours, when television comes along.

Special Services

Quite a large amount of research has been devoted to special problems, such as atmospherics, radio-inductive interference and direction finding equipment as an aid to aerial navigation during 1935.

In the first of these fields, the Radio Research Board of Australia, working in conjunction with the University of Sydney, has been particularly active, and much valuable work has been carried out, particularly with regard to the application of the cathode-ray tube to "static" direction finding.

Radio-inductive interference has been largely a particular problem reserved for attack by the engineers of the Postmaster-General's Department. An enormous amount of work has been done and a considerable alleviation of the problem has been accomplished. The efforts of the P.M.G. department in this direction were admirably summed up in a paper delivered before the Institution of Radio Engineers by an officer of the Department, and which is reprinted in another section of this Annual.

The attention to D-F equipment as an aid to aerial navigation was necessitated by the increasing number of aerial services being established in Australia. Several permanent D.F. stations have been established in various parts of Australia, and at the time of writing, the construction of an aerial beacon for use in conjunction with Mascot (Sydney, N.S.W.) aerodrome, is well under way.

The Commonwealth Wireless Telegraphy Act

No. 8 of 1905

An Act relating to Wireless Telegraphy. Assented to 18th October, 1905.

BE it enacted by the King's Most Excellent Majesty, the Senate, and the House of Representatives of the Commonwealth of Australia, as follows:—

1. This Act may be cited as the **Wireless Telegraphy Act,** 1905.

2. In this Act,—

"Australia" includes the territorial waters of the Commonwealth and any territory of the Commonwealth.

"Wireless Telegraphy" includes all systems of transmitting and receiving telegraphic messages by means of electricity without a continuous metallic connexion between the transmitter and the receiver.

3. This Act shall not apply to ships belonging to the King's Navy.

4. The Postmaster-General shall have the exclusive privilege of establishing, erecting, maintaining, and using stations and appliances for the purpose of—

(a) transmitting messages by wireless telegraphy within Australia, and receiving messages so transmitted, and

(b) transmitting messages by wireless telegraphy from Australia to any place or ship outside Australia, and

(c) receiving in Australia messages transmitted by wireless telegraphy from any place or ship outside Australia.

5. Licenses to establish, erect, maintain, or use stations and appliances for the purpose of transmitting or receiving messages by means of wireless telegraphy may be granted by the Postmaster-General for such terms and on such conditions and on payment of such fees as are prescribed.

6. (1) Except as authorised by or under this Act, no person shall—

(a) establish, erect, maintain or use any station or appliance for the purpose of transmitting or receiving messages by means of wireless telegraphy; or

(b) transmit or receive messages by wireless telegraphy.

Penalty: Five hundred pounds, or imprisonment with or without hard labour for a term not exceeding Five years.

(2) Sub-section (1) of this section shall not, except as prescribed extend to appliances maintained on any ship, arriving from any place beyond Australia, for the purpose of enabling messages to be transmitted from or received on that ship by means of wireless telegraphy but all such appliances shall, while the ship is within Australia—

(a) be subject to the control of the Postmaster-General; and

(b) only be used by his authority or as authorised by the regulations.

Penalty: Five hundred pounds.

7. All appliances erected, maintained, or used in contravention of this Act or the regulations, for the purpose of transmitting or receiving messages by means of wireless telegraphy, shall be forfeited to the King for the use of the Commonwealth.

8. (1) If a justice of the peace is satisfied by information on oath that there is reasonable ground for supposing that any appliance is established, erected, maintained, or used in contravention of this Act or the regulations, for the purpose of transmitting or receiving messages by means of wireless telegraphy he may grant a search warrant to any person.

(2) A search warrant under this section shall authorise the person to whom it is addressed to break and enter any place or ship, where the appliance is or is supposed to be, either by day or by night, and to seize all appliances which appear to him to be used or intended to be used for transmitting or receiving messages by means of wireless telegraphy.

9. (1) Proceedings for any offence against this Act may be instituted in any Court of Summary Jurisdiction, and any person proceeded against under this section may be dealt with summarily or may be committed for trial.

(2) The Court in dealing summarily with any accused person under this section may, if he is found guilty of any offence against this Act, punish him by imprisonment with or without hard labour for any period not exceeding six months or by a penalty not exceeding Fifty pounds.

10. The Governor-General may make regulations, not inconsistent with this Act, prescribing all matters which by this Act are required or permitted to be prescribed or which are necessary or convenient to be prescribed for carrying out or giving effect to this Act.

AMENDMENT No. 33 OF 1915

An Act to amend the Wireless Telegraphy Act, 1905. (Assented to 6th September, 1915.)

BE it enacted by the King's Most Excellent Majesty, the Senate, and the House of Representatives of the Commonwealth of Australia, as follows:—

1. (1) This Act may be cited as the **Wireless Telegraphy Act,** 1915.

(2) The **Wireless Telegraphy Act,** 1905, as amended by this Act, may be cited as the **Wireless Telegraphy Act,** 1905-1915.

2. Sections four, five and six of the **Wireless Telegraphy Act,** 1905, are amended by omitting the words "The Postmaster-General" and inserting in their stead the words "the Minister for the time being administering the Act."

AMENDMENT No. 4 OF 1919

An Act to amend Section Two of the Wireless Telegraphy Act, 1905-1915

BE it enacted by the King's Most Excellent Majesty, the Senate, and the House of Representatives of the Commonwealth of Australia, as follows:—

1. (1) This Act may be cited as the **Wireless Telegraphy Act,** 1919.

(2) The **Wireless Telegraphy Act,** 1905-1915 as amended by this Act, may be cited as the **Wireless Telegraphy Act,** 1905-1919.

2. Section two of the **Wireless Telegraphy Act,** 1905-1915, is amended by inserting in the definition of "Wireless telegraphy," after the word "telegraphic," the words, "or telephonic."

Commonwealth Wireless Regulations

Under the Wireless Telegraphy Act, 1905-1919

Statutory Rules No. 101 of 1924 have been amended from time to time by No. 123 of 1925, No. 114 of 1926, Nos. 3-24-63-153 of 1927, Nos. 79-129 of 1928, No. 81 of 1929, No. 113 of 1930 and No. 120 of 1935, and the following are the existing regulations as applicable to Broadcasting in Australia. Details of regulations governing other wireless stations are available from Government Printer, Canberra, F.C.T., or from the Radio Inspector in any capital city.

Part III.—Broadcasting

Division I.—Broadcasting Stations

45. (1) The Postmaster-General may grant to any applicant a Broadcasting Station License.

(2) A License shall not be transferred without the approval of the Postmaster-General.

(3) The Postmaster-General shall not recognise any vested interest in the License, and compensation shall not be payable to the Licensee on the termination of the License.

46. An applicant for a Broadcasting Station License shall state in his application the following particulars:—

(a) Name and address of applicant (in the case of a company; (1) the name of the company and the address of the head office thereof; (2) the name and address of the secretary or other person authorised to act on behalf of the company);

(b) Technical qualifications of the applicant or of the persons whom it is proposed will operate the licensed installation (where the applicant does not possess the necessary qualifications and proposes to engage an expert to control the station after the issue of the License, this should be stated);

(c) Location of the proposed station;

(d) Type of transmitter and character of modulation proposed;

(e) Proposed normal operating power of transmitter;

(f) Hours of service; and

(g) Class of service to be broadcasted and particulars of average programme.

47. (1) A Broadcasting Station License shall be prepared in duplicate, one copy of which shall be retained by the Department and the other shall be issued to the Licensee.

(2) A Licensee shall make his License available for inspection by any authorised officer as and when required.

48. (1) A Broadcasting Station License may be granted for any period not exceeding three years as the Postmaster-General determines.

(2) The Postmaster-General if he deems it desirable may from time to time renew a License for a period not exceeding one year from the date of expiration of the current License.

(3) A Licensee who desires a renewal of his License shall make application for the renewal thereof at least six months before the date of the expiration of his current license, except in cases where a license has been granted or renewed for a period of less than one year, when the application for a renewal shall be made at least one month before the date of expiration of the current license.

(Statutory Rules No. 120 of 1935 repealed, Statutory Rules No. 104 of 1935, 23/10/35 and new regulation 48a reads as follows:—)

48a. (1) Any person making application for the grant or renewal of a Broadcasting Station License shall supply such information as is required by the Postmaster-General, and shall lodge with the application a Statutory Declaration that the grant or renewal of the license will not result in the ownership by any person of more than—

(a) one metropolitan broadcasting station in any State;

(b) four metropolitan broadcasting stations in the Commonwealth;

(c) four broadcasting stations in any one State; or

(d) eight broadcasting stations in the Commonwealth, and will not result in any person being in a position to exercise control, either directly or indirectly, of more than that number of stations.

(2) Where the applicant is a company, the Statutory Declaration referred to in the last preceding sub-regulation shall be made by a majority of the directors of the company and the manager or secretary of the company.

(3) Where the applicant is neither an individual or a company, the Statutory Declaration referred to in sub-regulation (1) of this regulation shall be made by such persons as the Postmaster-General determines.

(4) In this regulation—

'metropolitan broadcasting stations' means a broadcasting station situated within a radius of 30 miles from the General Post Office in the capital city of a State;

'person' includes a firm, body corporate or association."

49. A Broadcasting Station Licensee shall commence a satisfactory service in accordance with these regulations within three months from the date of the issue of the License or within such further period as the Postmaster-General approves.

50. The licensed installation of a Broadcasting Station shall be equipped, designed and controlled to the satisfaction of the Postmaster-General and shall not be altered without his consent.

51. The power of a Broadcasting Station shall be as approved by the Postmaster-General and shall not be altered without his consent.

52. (1) The frequency (wave length) on which each Broadcasting Station shall operate shall be determined by the Postmaster-General.

(2) The operating frequency shall be maintained to a constancy to the satisfaction of the Postmaster-General.

(3) For the purpose of the last preceding sub-regulation, the transmitting apparatus shall include such equipment for indicating the accuracy of the operating frequency as the Postmaster-General approves.

53. The location of a Broadcasting Station and the periods of operation thereof shall be subject to the approval of the Postmaster-General.

54. (1) The Postmaster-General reserves the right, during the currency of a Broadcasting Station License, to vary the conditions upon which the License is granted, especially in regard to the power, location, frequency (wave length) and periods of operation of the licensed installation.

(2) The Licensee shall, at his own expense and to the satisfaction of the Postmaster-General, give effect to any such variation.

55. The licensed installation of any Broadcasting Station shall only be operated by such persons as, in the opinion of the Postmaster-General, are competent to operate the installation.

COMMONWEALTH WIRELESS REGULATIONS— (Continued)

56. The licensed installation of any Broadcasting Station shall, at all reasonable times, be open to inspection by any authorised officer, and every facility shall be given by the Licensee for ascertaining the conditions of the Station.

57. (1) A Broadcasting Station shall be connected by telephone with the public telephone exchange system of the area in which the Station is located.

(2) The Broadcasting Station Licensee shall enter into the usual telephone subscribers' agreement for the establishment of a service.

58. The Postmaster-General may require the licensee of a Broadcasting Station to include, without charge, such items of general interest or utility as the Postmaster-General, from time to time, determines.

Provided however that the requirements of the Postmaster-General shall not be such as to entail a period of occupation of the Station in excess of thirty minutes in each consecutive period of twelve hours.

59. (1) All matter including advertisements to be broadcasted shall be subject to such censorship as the Postmaster-General determines.

(2) The Broadcasting Station Licensee shall, before broadcasting any such matter which is of a controversial nature or likely to cause offence to any section of the community, direct the attention of the Postmaster-General or an authorised officer, to such matter.

60. (1) A Broadcasting Station Licensee may broadcast advertisements.

(2) A Licensee desiring to broadcast advertisements shall publish a tariff of advertising charges, and shall make his advertising service available without discrimination to any person or firm.

61. The Licensee of any Broadcasting Station may, to such extent as the Postmaster-General approves, by agreement with the Licensees of other Stations, relay or broadcast. the programmes broadcast by these stations.

62. A Broadcasting Station Licensee shall:—

(a) compile and maintain in a recognised business or commercial form, separate accounts in respect of his broadcasting activities;

(b) make such accounts available for inspection by the Postmaster-General as required;

(c) supply to the Postmaster-General as required duly audited annual balance sheets in detail for the year ending on the thirtieth day of June in each year or on some other date approved by the Postmaster-General; and

(d) keep such records relating to the broadcasting service, as the Postmaster-General, from time to time, directs. and supply copies thereof to the Postmaster-General as required.

63. (1) The programme transmitted from a Broadcasting Station shall, both in rendition and transmission, be to the satisfaction of the Postmaster-General.

(2) The general terms of any announcement, whether complete in themselves or referring to items to be transmitted, shall be to the satisfaction of the Postmaster-General.

(3) Every announcer employed by the Licensee shall be of good education, style and personality, and possessed of clear enunciation, as far as possible free from any characteristic dialect.

64. (1) The license fee for a Broadcasting Station License or any renewal thereof shall be £25 per year or part of a year payable in advance.

(2) This regulation shall be deemed to have come into operation on the first day of November, One thousand nine hundred and twenty-nine.

65. A Broadcasting Station Licensee shall at all times keep the Postmaster-General indemnified against any claim for royalties in respect of any equipment operated under his license. or against any claims whatsoever arising out of the Licensee's operations.

66. A Broadcasting Station Licensee shall not—

(a) transmit any work or part of a work in which copyright subsists except with the consent of the owner of the copyright; or

(b) send out news or information of any kind published in any newspaper or obtained, collected, collated or co-ordinated by any newspaper, or association of newspapers or any news agency or service except with the full consent in writing, first obtained, of, and upon such payment and conditions as are agreed upon by the licensee and, the newspaper, association of newspapers, news agency or service.

67. (1) A Broadcasting Station Licensee who supplies in advance to the proprietor of any registered newspaper programmes of the items to be broadcasted by his Station shall, on application in writing, supply in advance such programmes on equal terms to the proprietor of any other registered newspaper.

(2) The proprietor of such other newspaper may publish such programmes in any registered newspaper owned by him.

(3) In this regulation "registered newspaper" means a newspaper registered under the Post and Telegraph Act 1901-1923.

68. A person shall not publish any portion of the text of a broadcasted item without the consent of the Broadcasting Station Licensee and the approval of the Postmaster-General.

69. A Broadcasting Station Licensee shall not, without the permission of the Postmaster-General, transmit any message or other communication, the transmission of which would be in contravention of the provisions of the Post and Telegraph Act, 1901-1923 if the licensed installation were a telegraph within the meaning of that Act.

70. Except where any inconsistency exists, nothing in this Part shall affect the generality of the provisions of any other Part of these Regulations.

71. The decision of the Postmaster-General with regard to the interpretation or application of any of the provisions of this Division shall be final.

72. The Postmaster-General may, on such terms and conditions as he thinks fit—

(a) make contracts for the establishment, erection maintenance or use of wireless broadcasting stations or appliances on his behalf; and

(b) for the purpose of using any wireless broadcasting stations or appliances established, erected or maintained by him or on his behalf, make contracts for the provision of programmes by such stations or by such appliances.

73. Any License for a Class B Station in force immediately prior to the commencement of this regulation shall be deemed to have been granted under and subject to the provisions of these Regulations.

74. Notwithstanding anything contained in this Division, any License for a Class A Station granted under the Regulations in force immediately prior to the commencement of this regulation shall not, on and from the commencement of this regulation, be renewed and those Regulations shall be deemed to apply to such License so long as it remains in force.

Division II.—Broadcast Listeners' License

75. A Broadcast Listener's License in accordance with Form 5 in the Schedule to these Regulations may be granted at any Money Order Office on payment of the prescribed fees.

76. (1) For the purpose of the granting of Broadcast Listeners' Licenses and the payment of fees therefor, the Commonwealth and the Territories thereof shall be divided into two zones as follows:—

(i) Zone 1 shall include all the territory within an approximate radius of 250 miles from such Broadcasting Stations as the Postmaster-General determines; and

(ii) Zone 2 shall include all the territory of the Commonwealth and the Territories outside Zone 1.

(2) The Postmaster-General may determine the zone within which any Broadcast Listeners' Station is situated.

(3) The Postmaster-General may modify the boundaries of the Zones specified in sub-regulation (1) of this regulation, or establish additional Zones.

(Continued on next page)

COMMONWEALTH WIRELESS REGULATIONS— (Continued)

77. (1) The fees payable in respect of any Broadcast Listeners' License or any renewal thereof shall be as follows:—

(a) For Zone 1, 21/- per annum; and

(b) For Zone 2, 15/- per annum (from 6/8/34).

(2) License fees shall be paid in advance.

78. Where a Broadcast Listeners' License is being granted in respect of receiving equipment which has been used prior to the grant of the License, the License may be given the date and shall be deemed to have been effective from the date the receiving equipment was first used without a current License.

79. A Broadcast Listeners' License shall not be transferable from one person to another.

80. (1) The user of receiving equipment, capable of being utilised for the reception of broadcast programmes or other wireless signals, shall be in possession of a current Broadcast Listeners' License.

(2) Where a current Broadcast Listeners' License is not held in respect of equipment installed or connected up or capable of being connected up for the purpose of receiving broadcast programmes or other wireless signals in any dwelling house, office, shop, premises or place, the occupier of any such dwelling house, office, shop, premises or place shall be guilty of an offence.

(3) It shall be a defence to a prosecution for an offence against the last preceding sub-regulation, if the occupier proves that he was not aware, or could not with reasonable diligence have become aware, of the existence in the dwelling house, office, shop, premises or place of the receiving equipment in question.

81. (1) Receiving equipment shall not, without the consent of the Postmaster-General, or an authorised officer, be used at a place other than that specified in the Broadcast Listeners' License.

(2) The Licensee shall notify the Department of any permanent change of address within two weeks of the change.

82. A Broadcast Listeners' License shall, at all reasonable times, be available at the address given thereon for inspection by an authorised officer.

83. A Licensee of a Broadcast Listeners' Station shall not divulge, except to an authorised officer or a legal tribunal, the contents of any commercial or defence wireless communications, other than those transmitted by a Broadcasting Station.

84. Any Licensee of a Broadcast Listeners' Station using reaction (back coupling) in such a manner as to cause interference to the reception at any other Station shall be guilty of an offence against these Regulations.

85. A person or firm shall not operate receiving equipment for the purpose of demonstration or test of receivers with the object of promoting the sale of receiving equipment without being in possession of a Broadcast Listeners' License.

Regulation 109 of the Wireless Telegraphy Regulations is repealed as from 2/10/30 and the following regulation inserted in its stead:—

"109. The fee for an Experimental License shall be £1 10s. 0d. per annum."

AMENDING REGULATION

Free License to Blind

(Statutory Rules 1933, No. 136).

Regulation 12 of the Wireless Telegraphy Regulations is amended by adding at the end of sub-regulation (1) the following proviso:—

1. (1) Provided also that a Broadcast Listeners' License or any renewal thereof may be granted free of charge to any blind person over the age of sixteen years.

(2) This regulation shall come into operation on the first day of January, 1934.

STATUTORY RULES

REGULATION UNDER THE WIRELESS TELEGRAPHY ACT, 1905-1919.*

I, The Governor-General in and over the Commonwealth of Australia, acting with the advice of the Federal Executive Council, hereby make the following Regulation under the **Wireless Telegraphy Act,** 1905-1919.

Dated this twenty-seventh day of November, 1935.

ISAAC A. ISAACS.
Governor-General.

By His Excellency's Command,

A. J. McLACHLAN,
Postmaster-General.

Amendment of the Wireless Telegraphy Regulations †

Regulation 48a of the Wireless Telegraphy Regulations is repealed, and the following regulation inserted in its stead:—

"48a.—(1) Any person making application for the grant or renewal of a Broadcasting Station License shall supply such information as is required by the Postmaster-General, and shall lodge with the application a Statutory Declaration that the grant or renewal of the license will not result in the ownership by any person of more than—

(a) One metropolitan broadcasting station in any State;

(b) four metropolitan broadcasting stations in the Commonwealth;

(c) four broadcasting stations in any one State; or

(d) eight broadcasting stations in the Commonwealth.

and will not result in any person being in a position to exercise control, either directly or indirectly, of more than that number of stations.

(2) Where the applicant is a company, the Statutory Declaration referred to in the last preceding sub-regulation shall be made by a majority of the directors of the company and the manager or secretary of the company.

(3) Where the applicant is neither an individual or a company, the Statutory Declaration referred to in sub-regulation (1) of this regulation shall be made by such persons as the Postmaster-General determines.

(4) In this regulation—

'metropolitan broadcasting station' means a broadcasting station situated within a radius of 30 miles from the General Post Office in the capital city of a State;

'person' includes a firm, body corporate or association."

* Notified in the "Commonwealth Gazette" on 28th November, 1935.

‡ Statutory Rules 1924, No. 101, as amended by Statutory Rules 1925, No. 123; 1926, No. 114; 1927, Nos. 3, 24 and 63; 1928, Nos. 79 and 129; 1929, No. 81; 1930, No. 113; 1933, No. 136; 1934, No. 99, and 1935, No. 104.

Australian Broadcasting Commission

An Act relating to Broadcasting. No. 14 of 1932. (Assented to 17th May, 1932.)

BE it enacted by the King's Most Excellent Majesty, the Senate and the House of Representatives of the Commonwealth of Australia, as follows:—

Part 1.—Preliminary

1. This Act may be cited as the **Australian Broadcasting Commission Act, 1932.**

2. This Act shall commence on a date to be fixed by Proclamation.

3. This Act is divided into Parts, as follows:—
Part I.—Preliminary.
Part II.—Establishment and Constitution of Commission.
Part III.—Powers and Functions of the Commission.
Part IV.—Finance.
Part V.—Issue of Debentures by the Commission.
Part VI.—Miscellaneous.

4. In this Act, unless the contrary intention appears—
"Commission" means a member of the Commission;
"National broadcasting stations" means stations made available by the minister for the purpose of the transmission of the National Broadcasting Programmes;
"the Commission" means the Australian Broadcasting Commission appointed under this Act; and
"the Fund" means the Australian Broadcasting Commission Fund established under this Act.

Part 2.—Establishment and Constitution of the Commission

5. (1) For the purposes of this Act, there shall be a Commission, to be known as the Australian Broadcasting Commission, which shall be charged with the general administration of this Act.

(2) The Commission shall be a body corporate with perpetual succession and a common seal, and may acquire, hold, and dispose of real and personal property and shall be capable of suing and being sued in its corporate name.

(3) All Courts, Judges and persons acting judicially shall take judicial notice of the seal of the Commission affixed to any document or notice and shall deem that it was duly fixed.

6. (1) The Commission shall consist of five Commissioners, one of whom shall be a Chairman, and one of whom shall be a Vice-Chairman.

(2) The Commissioners shall be appointed by the Governor-General, and shall hold office, during good behaviour, for the period for which they were appointed.

7. (1) Subject to this Act, the period for which the Commissioners first appointed under this Act shall hold office shall be, in the case of the Chairman, not exceeding five years, in the case of the Vice-Chairman, not exceeding four years, and in the case of each of the remaining Commissioners not exceeding three years.

(2) After the appointment of the five Commissioners first appointed under this Act, each further appointment shall be for a period not exceeding three years.

(3) Each person who is appointed a Commissioner shall, upon the expiration of the term for which he was appointed, be eligible for re-appointment.

8. (1) Subject to this section, the Commissioners shall receive such salaries and allowances as the Governor-General determines.

(2) The salaries of the Commissioners shall not exceed the following:—

in the case of the Chairman	Five hundred pounds per annum;
in the case of the Vice-Chairman	Four hundred pounds per annum; and
In the case of each other Commissioner	Three hundred pounds per annum.

9. (1) In case of the illness or absence of the Chairman, the Vice-Chairman, if present, shall act as Chairman.

(2) In case of the illness or absence of both the Chairman and the Vice-Chairman, the Commissioners present may appoint one of their number to act as Chairman:

Provided that the Governor-General may, if he thinks fit, appoint a person to act as Chairman for such period as the Governor-General specifies.

(3) If the Governor-General appoints a person to act as Chairman the appointment shall be at such salary as is determined by the Governor-General, not exceeding the maximum salary fixed bv section eight of this Act.

10. (1) In case of the illness or absence of any other Commissioner, the Governor-General may, if he thinks fit, appoint a person to perform the functions of the Commissioner during such illness or absence.

(2) The salary of any person so appointed shall be determined by the Governor-General but shall not exceed the maximum salary fixed by section eight of this Act in respect of that office.

11. In the event of the absence of any Commissioner, the Governor-General may determine the conditions as to remuneration or otherwise upon which leave may be granted.

12. The Governor-General may terminate the services of a Commissioner or an acting Commissioner for inability, inefficiency or misbehaviour, or for neglect or failure to carry out any of the provisions of this Act.

13. A Commissioner shall be deemed to have vacated his office—
(a) If his appointment is terminated by the Governor-General in pursuance of this Act;
(b) if he becomes bankrupt or compounds with his creditors or makes any assignment of his salary for their benefit or takes advantage of any provision of any Act relating to bankruptcy;
(c) if he becomes of unsound mind;
(d) if he resigns his office by writing under his hand addressed to the Governor-General and the resignation is accepted by the Governor-General;
(e) if he absents himself (except on leave granted by the Governor-General) from all meetings of the Commission held during two consecutive months; or
(f) if he, in any way, otherwise than as a member, and in common with the other members, of an incorporated company consisting of more than twenty-five persons—
(i) becomes concerned or interested in any contract or agreement made by or on behalf of the Commission; or
(ii) participates, or claims to participate, in the profits of any such contract or agreement or in any benefit or emolument arising therefrom.

14. (1) The Commission shall hold such meetings as, in the opinion of the Chairman or at least three other Commissioners, are necessary for the efficient conduct of its affairs.

(Continued on next page)

AUSTRALIAN BROADCASTING COMMISSION ACT—(Continued)

(2) At meetings of the Commission three Commissioners shall form a quorum, and the Chairman shall have a deliberative vote, and, in the event of an equality of votes, a second or casting vote.

15. (1) The Commission shall appoint a general manager and such other officers and such servants as it thinks necessary.

(2) The salaries payable to the general manager and the next six most highly paid executive officers of the Commission shall be subject to the approval of the Governor-General.

(3) Officers and servants appointed by the Commission shall not be subject to the provisions of the **Commonwealth Public Service Act,** 1922-1931, but shall be subject to such conditions (including tenure of office) as are determined by the Commission.

Part 3.—Powers and Function of the Commission

16. The Commission shall provide and shall broadcast from the national broadcasting stations adequate and comprehensive programmes and shall take in the interest of the community all such measures as, in the opinion of the Commission, are conducive to the full development of suitable broadcasting programmes.

17. For the purpose of the exercise of its powers and functions under this Act, the Commission may compile, prepare, issue, circulate and distribute, whether gratis or otherwise in such manner as it thinks fit, such papers, magazines, periodicals, books, pamphlets, circulars and other literary matter as it thinks fit (including the programmes of national broadcasting stations and other stations).

Provided that, prior to the publication of any programme in pursuance of this section, a copy of the programme shall be made available at an office of the Commission on equal terms to the publishers of any newspaper, magazine, or journal published in the Commonwealth.

18. (1) Subject to this Act, the Commission may—
(a) acquire by lease or purchase any land, buildings, easements or other property, rights or privileges which it thinks necessary for the purposes of this Act; and
(b) sell, exchange, lease, dispose of, turn to account or otherwise deal with any property, rights or privileges of the Commission.

(2) The Commission shall not, without the approval of the Minister—
(a) acquire any property, the cost of acquisition of which exceeds the sum of Five thousand pounds, or in any manner dispose of any property having an original or book value exceeding the sum of Five thousand pounds; or
(b) enter into any lease for a period exceeding five years.

19. (1) The Commission shall provide such studios, offices and other accommodation as it thinks necessary for the purposes of this Act, and such accommodation in relation to the studios as the Minister requires for the proper carrying out of the technical services to be provided by the Minister, and shall take over, as arranged by the Minister and at the valuation determined by him, any existing studios, buildings, sites, fittings, furniture or other assets controlled by the Minister which are used for broadcasting purposes, and shall accept an assignment of any leases relating thereto, and of the rights and liabilities of the Minister under any agreements relating thereto.

(2) The location of any studios to be provided by the Commission in pursuance of this section shall be subject to the approval of the Minister.

20. (1) The Commission shall transmit free of charge from all of the national broadcasting stations, or from such of them as are specified by the Minister, any matter the transmission of which is directed by the Minister as being in the public interest.

(2) The Commission shall not, without the permission of the Minister, transmit or receive for transmission any message the transmission of which would, without the authority of, or license granted by, the Minister administering the **Post and Telegraph Act,** 1901-1923, or the **Wireless Telegraphy Act,** 1905-1919, contravene the provisions of either of those Acts.

21. (1) The Commission shall not broadcast advertisements.

(2) Nothing in this section shall be construed as preventing the Commission from broadcasting, if it thinks fit—
(a) any announcements of its own future programmes;
(b) a programme supplied by any organisation, firm or person engaged in artistic, literary, musical or theatrical production or in educational pursuits; or
(c) a programme supplied by any organisation, firm or person, provided the programme is not, in the opinion of the Commission, being used as an advertisement.

22. The Commission may collect in such manner as it thinks fit news and information relating to current events in any part of the world and may subscribe to news agencies.

23. The Commission shall, as far as possible, give encouragement to the development of local talent and endeavour to obviate restriction of the utilisation of the services of persons who, in the opinion of the Commission are competent to make useful contributions to broadcasting programmes.

24. The Commission shall endeavour to establish and utilise, in such manner as it thinks desirable in order to confer the greatest benefit on broadcasting, groups of musicians for the rendition of orchestral, choral and band music of high quality.

25. The Commission may, if it thinks fit, appoint Committees to advise it in relation to all or any matters connected with the provision or rendition of broadcasting programmes, or the exercise of any powers, duties or functions conferred or imposed upon it by this Act.

Part 4.—Finance

26. (1) There shall be an Australian Broadcasting Commission Fund into which shall be paid from time to time out of the Consolidated Revenue Fund, which is hereby appropriated accordingly, an amount which represents such portion of the fees received from broadcast listeners' licenses as is fixed by or under this Act.

(2) For the year commencing on the first day of July, One thousand nine hundred and thirty-two, the amount referred to in the last preceding sub-section shall be twelve shillings in respect of each broadcast listener's license fee received, and this amount shall continue to be paid in each subsequent year unless some other amount is fixed by the Minister.

(3) The payments provided for by the preceding provisions of this section shall be made monthly, and as soon as possible after the last day of each calendar month, and shall in each case represent an amount approximating the appropriate sum relating to the licenses in force during the previous month.

(4) The final adjustments shall be made as soon as conveniently possible after the end of each quarter.

(5) Any account certified by such officer of his Department as is designated for that purpose by the Minister and forwarded by the Minister to the Commission purporting to set out the sum payable to the Commission in pursuance of the foregoing provisions of this section shall be final and conclusive for all purposes.

(6) There shall also be paid into the Fund any other revenue or money received by the Commission.

(7) Income derived from the investment of any portion of the Fund shall form part thereof.

27. The moneys paid into the Fund shall be applied by the Commission as follows:—
(a) In payment of the expenses, charges and other obligations incurred or undertaken by the Commission in the exercise of its powers, duties and functions under this Act;
(b) In payment of the salaries, wages and allowances of Commissioners and of officers and servants of the Commission; and
(c) In investment in any securities of, or guaranteed by, the Government of the Commonwealth or of any State.

28. Moneys held in the Fund, uninvested by the Commission, may be lodged either in an account at call or on fixed deposit, or partly in an account at call and partly in an account at fixed deposit, with the Commonwealth Bank, and while in such Bank shall be held to be moneys of the Crown.

(Continued on next page)

AUSTRALIAN BROADCASTING COMMISSION ACT—(Continued)

29. Cheques drawn on any account referred to in the last preceding section shall be signed in such manner as the Commission directs.

30. (1) For the purpose of enabling the Commission to defray any expenses incidental to its establishment and operation, the Treasurer may advance, out of the Consolidated Revenue Fund, which is hereby appropriated accordingly, such amounts not exceeding in all the sum of Thirty thousand pounds as are, in the opinion of the Minister, required by the Commission.

(2) In addition to the moneys advanced in pursuance of the last preceding sub-section, the Treasurer may advance to the Commission such sums, if any, as are from time to time appropriated by the Parliament for the purpose.

(3) The terms and conditions of any advances made in pursuance of this section, including the security and basis of repayment shall be as determined by the Treasurer.

31. (1) The accounts of the Commission shall be subject to inspection and audit, at least once yearly, by the Auditor-General of the Commonwealth.

(2) The Auditor-General shall report to the Minister the result of each inspection and audit.

32. The Commission shall, as soon as possible after the expiration of each financial year, prepare a profit and loss statement and balance-sheet in the form prescribed, and shall forward them, together with a report on the operations of the Commission during that year, to the Minister, for presentation to both Houses of the Parliament.

33. The payment by the Commission of compensation exceeding in any individual case, One hundred pounds to members of the Commission, its officers or servants, or other bodies or persons, shall not be made without the approval of the Minister.

34. The income, property, and operations of the Commission shall not be subject to any rates, taxes or charges, under any law of the Commonwealth or a State, to which the Commonwealth is not subject.

35. (1) The Commission shall exercise the powers and functions conferred and imposed upon it by this Act, in such a manner that its operations will be financially self-supporting.

(2) The Commission shall establish such sinking funds as are in the opinion of the Treasurer, necessary to enable the Commission to meet repayment of loans and other obligations and to meet losses and depreciation in assets, and may set aside out of its revenue such sums as it thinks proper as a reserve fund for such purposes as the Commission deems desirable (not being purposes for which any sinking fund has been established).

Part 5.—Issue of Debentures by the Commission

36. (1) Subject to this section, the Commission may, from time to time, issue debentures to such amount, bearing such rate of interest and subject to such conditions, as the Treasurer and the Minister approve.

(2) The total amount of debentures so issued, and current at any one time, shall not exceed Fifty thousand pounds.

37. Debentures shall be in accordance with the form approved by the Treasurer, and shall be under the seal of the Commission and shall be signed and countersigned in such manner as the Treasurer directs.

38. The Commonwealth by this Act guarantees the payment by the Commission of the principal and interest due in respect of any debenture issued by the Commission in pursuance of this Act, and the Consolidated Revenue Fund is hereby appropriated for the purpose of this section.

39. (1) Every debenture issued in pursuance of this Act shall be payable to the bearer thereof, and shall pass by delivery only without any assignment or indorsement, and the bearer of a debenture shall have the same rights and remedies as if he were expressly named therein.

(2) At the request of the bearer of a debenture, the Commission may in lieu thereof issue to him inscribed stock of the same currency, and bearing the same interest, and transferable only in manner prescribed.

(3) At the request of the holder of any inscribed stock of the Commission, the Commission may in lieu thereof issue to him debentures of the same currency and bearing the same interest.

40. The Commission may sell debentures, or cause them to be sold, at such times and at such places and in such sums and on such conditions as the Treasurer approves.

41. A trustee, executor or administrator may invest any trust moneys in his hands in the purchase of debentures issued by the Commission.

42. (1) Any person who, with intent to defraud—
- (a) forges any security of the Commission, or
- (b) utters any forged security of the Commission, or
- (c) makes any instrument for forging any security of the Commission, or
- (d) has in his possession any such instrument, or
- (e) has in his possession any forged security of the Commission, shall be guilty of an indictable offence.

Penalty: Imprisonment for ten years.

(2) Any person who, without authority, proof whereof shall lie upon him—
- (a) makes any form of security of the Commission,
- (b) has in his possession any form of security of the Commission, or
- (c) makes or has in his possession any instrument or thing by which any distinctive mark or signature on any security of the Commission may be made or imitated,

shall be guilty of an offence.

Penalty: Imprisonment for two years.

(3) In this Part "security of the Commission" means any Commission debenture, Commission inscribed stock, or any coupon, warrant or document for the payment of interest thereon, and includes any transfer of any Commission inscribed stock, and any indorsement on any coupon, warrant or document for the payment of interest on any security of the Commission.

43. All forged securities of the Commission, and all unauthorised forms of security of the Commission, and all unauthoriesd instruments and things by which any distinctive mark or signature on any security of the Commission, may be unlawfully made or imitated, shall be forfeited to the King and may be seized by any member of the police force of the Commonwealth or of a State.

Part 6.—Miscellaneous

44. The Postmaster-General shall undertake the provision and operation of all technical services associated with the transmission of programmes, including any transmission and reception for the interchange of programmes with other broadcasting administrations which is mutually agreed upon between the Commission and the Postmaster-General.

45. (1) For the purpose of providing and operating the technical services referred to in this Act, the Postmaster-General, or any person acting under the authority of the Postmaster-General, may—
- (a) erect, place and maintain any electric line which is, in the opinion of the Postmaster-General, necessary for conveying electric current to a Broadcasting station, and in respect of the erection, placing and maintenance of any electric line, the Postmaster-General and any person acting under his authority shall have the same powers, and be subject to the the same obligations, as are conferred or imposed under Part IV. of the **Post and Telegraph Act**, 1901-1923, in relation to the erection, placing and maintenance of telegraph lines; and
- (b) arrange for and obtain from any person the supply of any electric current which, in the opinion of the Postmaster-General, is necessary or advisable for the working of any broadcasting station or the operation of any apparatus for the transmission or reception of programmes.

(2) In this section "electric line" includes all means used for the purpose of conveying, transmitting, transforming or distributing electricity and any casing, coating, covering, tube, tunnel, pipe, pillar, pole, post, frame, bracket or insulator enclosing, surrounding, or supporting the same or any part thereof or any apparatus connected therewith.

(Continued on next page)

AUSTRALIAN BROADCASTING COMMISSION ACT—(Continued)

46. The Postmaster-General shall provide free of cost to the Commission—
- (a) the transmissions emanating from recognised National Broadcasting Service studios which are to be radiated from the national broadcasting stations, including such simultaneous transmissions from two or more stations as are mutually agreed upon; and
- (b) microphones, pick-up equipment and all other necessary portable apparatus for occasional or periodical transmission from various places within the Commonwealth.

47. The Postmaster-General shall provide, at the expense of the Commission—
- (a) for the installation and operation of the apparatus referred to in paragraph (b) of the last preceding section;
- (b) the circuits required to connect the various pick-up points with the recognised relevant studios; and
- (c) apparatus required permanently for pick-up purposes or for other purposes affecting the rendering of programmes where such apparatus is to be installed at any place other than a recognised National Broadcasting Service studio.

48. Notwithstanding anything contained in this Act, the Commission shall not be empowered to enter into any agreement involving any expenditure in excess of Five thousand pounds, or extending over a period of more than five years, unless the approval of the Minister thereto has first been obtained.

49. The Commission shall at all times indemnify and keep indemnified the Postmaster-General against any action claim or demand brought or made by any person against the Postmaster-General or against any officer of the Postmaster-General's Department in respect of any act done by the Postmaster-General or by such officer on behalf, at the request, or in the interests, of the Commission.

50. The control of the provision and rendition of broadcasting programmes by the Commission shall commence on the first day of July one thousand nine hundred and thirty-two, but the Commission may exercise, prior to that date, any powers or functions conferred on it by this Act for the purpose of enabling it to assume full control on that date.

51. (1) The Minister may from time to time, by notice in writing, prohibit the Commission from broadcasting any matter, or matter of any class or character, specified in the notice, or may require the Commission to refrain from broadcasting any such matter.

(2) The Minister may at any time revoke or vary any requirement made in pursuance of the last preceding sub-section.

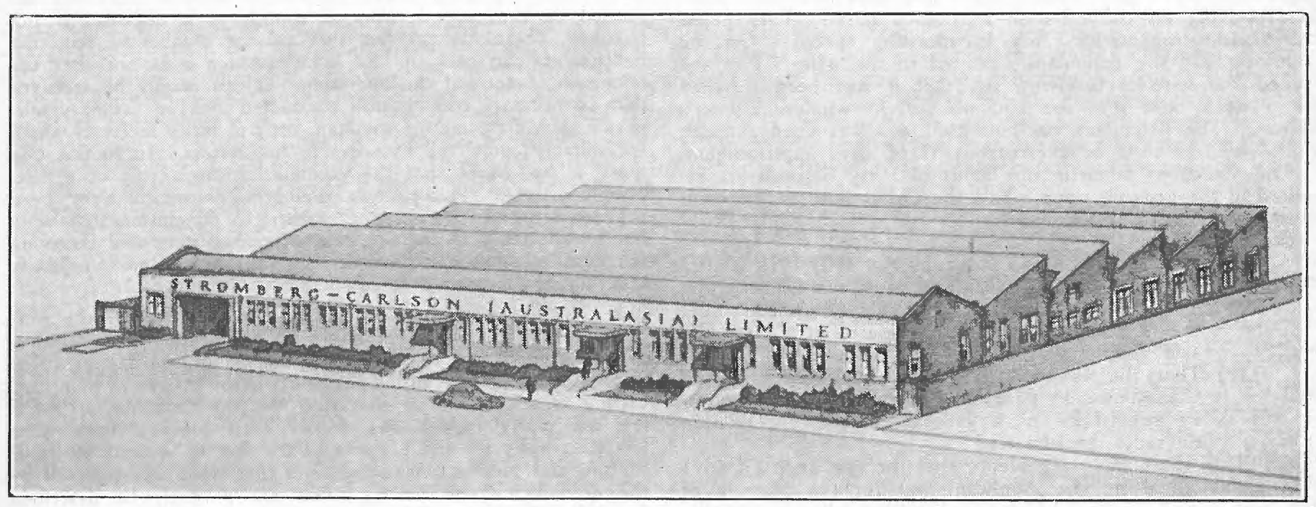
52. The Commission shall have the power to determine to what extent and in what manner political speeches may be broadcast.

53. The Governor-General may, whenever any emergency has arisen, which, in his opinion, renders it desirable in the public interest so to do, authorise the Minister to exercise during the emergency complete control over the matter to be broadcast from the national broadcasting stations, and, thereupon and so long as the emergency continues such persons as are thereto authorised in writing by the Minister shall have access at all times to any premises controlled by the Commission and may exercise full authority over all rights and privileges possessed by the Commission.

54. Nothing in this Act shall be deemed to diminish or affect the rights of any person under any contract or agreement made prior to the commencement of this Act to which the Commonwealth is a party.

55. The Governor-General may make regulations, not inconsistent with this Act, prescribing all matters required or permitted to be prescribed, or which are necessary or convenient to be prescribed, for carrying out or giving effect to this Act and in particular for providing for the issue, inscription, transfer, transmission, and redemption of inscribed stock of the Commission, and all matters in relation thereto.

A MODERN AUSTRALIAN RADIO FACTORY



The factory illustrated above was completed during April of this year by Stromberg-Carlson A/sia Ltd., which is affiliated with Stromberg-Carlson Inc., of Rochester, U.S.A. The Australian factory is of the most modern type and is built on land comprising 3 acres. The frontage of the factory is 300 ft. to Bourke Rd., Botany, N.S.W., and the depth in April was 460 ft., with further additions to be made as required. Provision exists for over 400 employees, and is the outcome of the successful operations by Stromberg-Carlson in Australia, under the Managing-Directorship of Mr. L. P. R. Bean.

Australian High Court Judgment on Validity of Wireless Act and Regulations

Delivered by the High Court of Australia in Sydney, Tuesday, December 17, 1935.

THE KING v. BRISLAN

ex parte Williams

REASONS FOR JUDGMENT. BY THE CHIEF JUSTICE

THE question raised upon this application for a writ of prohibition is whether Dulcie Williams, the defendant in the proceedings before the Court of Petty Sessions at Sydney, was rightly convicted for maintaining without authorisation by or under the Wireless Telegraphy Act an appliance for the purpose of receiving messages by wireless telegraphy contrary to the Wireless Telegraphy Act, 1905-1919.

Section 6 (1) of that Act is in the following terms:—

"Except as authorised by or under this Act, no person shall—

(a) establish, erect, maintain or use any station or appliance for the purpose of transmitting or receiving messages by means of wireless telegraphy; or

(b) transmit or receive messages by wireless telegraphy.

Penalty: Five hundred pounds, or imprisonment with or without hard labour for a term not exceeding five years."

It is provided in sec. 2 of the 1905 Act as amended by the Wireless Telegraphy Act 1919 that Wireless Telegraphy "includes all systems "of transmitting and receiving telegraphic or telephonic messages by means of electricity without a continuous metallic connection between the transmitter and the receiver."

The evidence shows that officers of the Postmaster-General's Department visited defendant's premises on the 26th day of September, 1934, and found there a five valve all-electric wireless receiving set connected to an indoor aerial. They heard the broadcasting station 2KY broadcasting speech. On the following day the defendant admitted to the officers that she owned the wireless receiving set, that it had been installed for a week, and that she had no current wireless listener's license. The defendant was convicted and was fined £1 with eight shillings costs or alternatively three days imprisonment.

The objections taken in the Court of Petty Sessions are repeated in the grounds upon which the Order Nisi was granted: these grounds are as follows:—

(1)

(a) That the Wireless Telegraphy Act 1905-1919 is ultra vires the Commonwealth of Australia Constitution.

(b) That the Regulations as to Broadcasting made under the Wireless Telegraphy Act are ultra vires the said Act.

(c) That the Constitution gives no authority to the Commonwealth Parliament to make laws or authorise regulations of a general character in relation to radio broadcasting.

(2) That there was no evidence that the appliance (if any) maintained by the Applicant was for the purpose of receiving messages by means of wireless telegraphy within the meaning of the Wireless Telegraphy Act, 1905-1919.

(3) That there was no evidence that the Applicant did maintain an appliance for the purpose of receiving messages by means of wireless telegraphy as alleged.

(4) That there was no evidence to support the conviction."

1. The first question for consideration is whether, upon the assumption that the relevant provision of the Wireless Telegraphy Act is valid, the defendant committed an offence thereunder.

Sub-sec. 6 of the Act prohibits inter alia the maintenance of any appliance for the purpose of receiving messages by means of wireless telegraphy (which includes telephony) except as authorised by or under the Act. There is no doubt that the defendant was not authorised by or under the Act to maintain the wireless set which she did in fact maintain.

Provision is made under the regulations for an authority or license to maintain a wireless receiving set. It has been argued that the regulations, so far as they deal with broadcasting, are ultra vires the Act. But even if this were so, the only result would be that no valid provision was made for giving a license under the regulations. The success of the argument would not give the defendant a license or other authority. Thus the alleged invalidity of the regulations cannot affect the liability of the defendant in this case. It is therefore necessary to consider carefully the section of the Act itself under which the defendant was charged.

2. The appliance the maintenance of which without authority is prohibited by sec. 6 of the Act is an appliance for the purpose of transmitting or receiving messages by means of wireless telegraphy, which, as defined in the Act, includes all systems of transmitting and receiving wireless telephonic messages. Telephony consists in the reproduction of sounds, with or without amplifiers, at a distance.

It has been suggested that a telephone is an instrument which provides communication from point to point only, and that if what is heard at the receiving end is available for all bystanders to hear, the communication is not telephonic in character. This argument does not appear to be sound. If an amplifier is attached to an ordinary telephone receiver the essential character of the operation, which consists in what is ordinarily described as the reproduction of sounds at a distance, is not changed. Similarly the fact that a large number of receiving instruments can pick up the same message does not alter the telephonic nature of the operation. It can readily be arranged that an ordinary conversation conducted over an ordinary telephone should be audible simultaneously at many receivers which are suitably connected by wires to the system. In such a case there is no doubt that the communication is still of a telephonic nature. Accordingly the grounds which have been suggested for the purpose of reaching a conclusion that wireless broadcasting is not a system of transmitting and receiving telephonic communications do not appear to me to justify that conclusion.

3. The appliance in this case was maintained for the purpose of receiving whatever might be broadcasted from wireless broadcasting stations—whether speeches or music or other audible sounds. It is urged that even if the operation of broadcasting is telephonic in character, yet the definition of wireless telegraphy (which has already been quoted) limits wireless telegraphy for the purpose of the Act to systems of transmitting and receiving messages, and that what was received by the defendant's wireless set could not properly be described by the term "message."

It is difficult to enumerate all the forms of message which may be used by mankind. A message may be communicated by spoken or written words, by notches cut in a stick, by audible or visible symbols which are not ordinary words or not words at all, but to which a meaning can be attached by those who understand the relevant code. Direct conversation is not

(Continued on next page)

AUSTRALIAN HIGH COURT JUDGMENT—
(Continued)

usually regarded as a message, though a more or less formal oral deliverance to a number of persons is often, with a well established extension of the more ordinary meaning of the word, called a message.

An understanding of the nature of a message for the purposes of the Act can be obtained from the Act itself. The words of the Act show that a message is something which is transmitted and which may be received. There is a distance between the transmitter and the receiver, and the function of the appliance referred to in the Act is to assist in bridging that distance. This appears from the words of sec. 6. Thus the essential characteristic of a message appears to be found in communication from a distance, as distinguished from direct communication between persons who are face to face.

As a general rule such communications are made for the purpose of conveying "information, news, or intelligence." But the sender may use for this purpose a language that is not generally intelligible. A communication may be a message even if the person actually dispatching it does not understand it. A message sent in code, consisting of permutations of figures, is none the less a message because it means nothing to persons who are not in a position to apply the key to decipher it. The Morse signals which are tapped out by a key at a transmitting telegraphic instrument, and which are recorded by a receiving instrument, constitute a message even before they are interpreted. Where a teleprinter is used, a message has been sent though no one supposes that the actual letters have been sent along the telegraph wire. Thus, in the case of an electric telegraph, a message is received when visible symbols of some kind, generally, but not necessarily, accompanied by audible sounds, are received by a receiving instrument.

It is not out of place to recall that the first telegraphs consisted of manually operated semaphores. Such apparatus is still in use, particularly at sea. The working of such a telegraph leaves no permanent result anywhere in any record. The message can be received by any persons who are within the area from which the apparatus is visible. What such a telegraph sends out is called a message though it is broadcasted to the world.

A telephone message can be heard only through a suitable receiving instrument. The fact that such an instrument is necessary does not affect the character of a communication as a message.

It would therefore appear that neither the number of possible recipients of a communication nor the necessity for a special receiving apparatus is material in determining whether a particular communication is a message. In other words, it has long been recognised that a message does not cease to be a message merely because it is either intended for or may in fact be received by a large number of persons simultaneously. Thus broadcasting by wireless may be a means of transmitting messages which are receivable by large numbers of persons who possess suitable receiving apparatus.

If the broadcasting of speech is in this connection the transmission of messages (i.e. of communications which because they are sent to a distance may be properly called messages), then the reception of such speech by means of an appliance maintained for the purpose of picking up whatever is broadcasted involves the maintaining of an appliance for the purpose of receiving messages by means of wireless telegraphy as defined in section 2 of the Act.

4. It is true that the defendant's wireless receiving set would pick up musical programmes as well as spoken communications and that it was doubtless maintained also, and perhaps mainly, for this purpose. But even if the reception of a musical programme is not the receiving of a message, this fact does not affect the truth of the proposition which has just been stated, namely, that the reception of speech is, in this connection, reception of a message in the sense in which that word has long been used in connection with telegraphy and telephony. For this reason it is not, in my opinion, strictly necessary to decide in this case whether or not the transmission or reception of musical programmes or of sounds as such can be described as the transmission or reception of a message. If, however, it were necessary to decide this question, I would agree with the conclusion reached by my brothers Rich and Starke. I would so agree upon the ground that the essence of a message is to be found in the fact that it is a communication sent from one person to another person or other persons, and that therefore the broadcasting of music does involve the transmission and reception of messages.

Thus, in my opinion, if sec. 6 of the Wireless Telegraphy Act is valid, the defendant was rightly convicted.

5. The next question which arises is therefore the question of the validity of the Act.

The contention raised on behalf of the defendant is that, even if the Act (as a matter of construction) authorises the control of broadcasting, the Constitution does not confer upon the Commonwealth Parliament any power to legislate with respect to broadcasting.

The Constitution provides in sec. 51 (v) that the Commonwealth Parliament may make laws for the peace, order and good government of the Commonwealth with respect to "Postal, telegraphic, telephonic, and other like services."

It is contended for the defendant that broadcasting does not fall within any of the subjects mentioned.

In the earlier part of this judgment I have stated my reasons for the opinion that broadcasting is a form of wireless telephony. It consists in the transmission by wireless of sounds to a distance. The transmission of music by such means is no less telephonic than the transmission of spoken words. It is in my opinion unnecessary to investigate the precise means whereby transmission and reception are effected. Some discussion of these matters is to be found in the cases of **Chappell & Co. Ltd. v. Associated Radio Co. of Australia Ltd.,** 1925 V.L.R. 350 and **Buck v. Jewell-Lasalle Realty Co.** 283 U.S. 191.

The Canadian Constitution does not refer to telephonic services. The Dominion Parliament, however, has exclusive power to control "Lines of steam or other ships, railways, canals, telegraphs and other works and undertakings connecting the Province with any other or others of the Provinces, or extending beyond the limits of the Province"; — British North America Act 1867 sec. 92 (10). It has been held that in this section "telegraphs" includes telephones — **Corporation of the City of Toronto v. Bell Telephone Company of Canada** 1905 A.C. at p. 57.

There is now the further authority of the Judicial Committee of the Privy Council for the proposition that broadcasting also falls within the description of "telegraphs"—**In re the Regulation and Control of Radio Communication in Canada** 1932, A.C. 304. If broadcasting is included in "telegraphs" in the Canadian Constitution, then a fortiori broadcasting is covered by the words "telegraphic" and "telephonic" in the Australian Constitution.

6. It is not however, sufficient that the operation of broadcasting and receiving broadcasted material should be telephonic in character. The Commonwealth Parliament, so far as telephony is concerned, can legislate only with respect to a telephonic service or services. It is contended that broadcasting is not a service in the sense in which that term is used in sec. 51 (v) of the Constitution.

In the first place it was suggested that "service" in sec. 51 (v) should be read in a sense similar to that in which it is used in sec 69, which provides for the transfer to the Commonwealth of specified departments of the public service in each State, including "posts, telegraphs, and telephones." The services so transferred are, it is suggested, the same services as those with respect to which the Parliament can legislate under sec. 51 (v).

In my opinion sec. 69 refers to departments of the State public services in the sense of the servants of the State employed in the departments mentioned. Sec. 69 gives to the Commonwealth the control of those servants from the dates proclaimed or otherwise fixed under the section. The effect of this transfer is stated in detail in sec. 84, and legislative power with respect to the departments is vested exclusively in the Commonwealth Parliament by sec. 52 (ii). The property used in connection with such a department is transferred to the Commonwealth under sec. 85.

These sections, however, do not confer upon the Commonwealth Parliament power to legislate with respect to the subject matter with which these transferred departments deal.

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Parallel instances can be found in naval and military defence and in customs. Power to control the actions of officers constituting the defence services and the customs services is to be found in the sections last quoted. But the power to legislate on matters of defence is conferred by sec. 51 (vi) and on matters of customs by sec. 51 (i) and (ii) and sec. 90.

Similarly, in the case of postal telegraphic telephonic and other like services, sec. 51 (v) in my opinion gives a power which is really, and not only nominally, additional to that given by the other sections quoted. It cannot be limited to a power to legislate with respect to public servants.

7. But it is more strongly urged that the power conferred by sec. 51 (v) is a power to legislate only in respect of services in the sense of publicly controlled services of the same general character as those which the colonies controlled before federation. The argument tends to become elusive, but it was expressed by saying that these services were public utilities, including installation, maintenance, operation and organisation, provided and controlled by Parliaments, for the purpose of spoken or written converse between any person and any other person by means of postal, telegraphic and telephonic apparatus and equipment. It was said that it was a characteristic feature and an essential feature of these services that any member of the public had the right to avail himself of them for both sending and receiving. Attention was called to the fact that broadcasting in Australia was provided in part by a Broadcasting Commission and in part by what are known as B Class Stations. The regulations require licenses for both transmitting and receiving broadcasts. It is said that, if such a system be a service at all, it is not a service in the sense in which the term is used in the phrase "postal, telegraphic, telephonic and other like services."

I am unable to see any satisfactory reason for adopting so narrow a construction of sec. 51 (v) as that which is suggested. The character of any service is determined by reference to the function which it performs. A telephonic service consists of the means and organisation provided for sending telephonic communications. Under a power to legislate with respect to telephonic services a Parliament may pass laws to provide and instal telephone apparatus, and to determine rules in accordance with which any such apparatus may be used. On the other hand, the Parliament need not make any such provision at all. If it does make such provision, it may give complete control to a Minister in charge of a department, or it may "farm it out." A Parliament which disapproved of telephones might, so far as legal powers are concerned, repeal all statutes dealing with telephones and prohibit the existence of any telephone service, just as it might (in the exercise of powers under sec. 51) prohibit the existence of any defence force or of any lighthouses or copyrights or patents. It might also allow any persons to instal and use telephones without any governmental authority of any kind.

It is impossible to express or apply any definite measure of legislative power upon the principle suggested for the defendant. To say that postal telegraphic and telephonic services must necessarily be "public" services is to introduce what, in this connection, is a very vague conception. It is a question of policy whether there should be any and what legislation upon such subjects as communication services. A telephone service may be provided by a private person or by an ordinary public company, or by a public company or other corporation operating under a franchise or other special power, or by a Government department. The necessity for acquiring rights to erect poles and to place conduits in public highways has in practice made it necessary for the legislature to confer special powers upon a company or specially created body or upon a Government department. But, whatever form of management and control may be adopted, it is management and control of the same thing—the provision of facilities for telephonic communication, as generous or as limited as Parliament has thought proper.

No standard can be suggested according to which it is possible to determine that one statute providing for the control of telephonic communications is valid because the control is "public" and because all the members of the public have "rights" to use the telephone, whereas another statute is not valid because the control thereunder is not "public" enough, or the service is not sufficiently available to members of the public. The validity of the Post and Telegraph Act can hardly depend upon the extent to which facilities are given to the public or upon the extent of the prohibitions applied by Parliament to sending letters and other articles through the post. It appears to me to be impossible to attach any definite meaning to sec. 51 (v) short of that which gives full and complete power to Parliament to provide or to abstain from providing the services mentioned, to provide them upon such conditions of licenses and payment as it thinks proper, or to permit other people to provide them, subject or not subject to conditions, or to prohibit the provision of such facilities altogether.

If, however, the argument presented on this aspect of the case is sound, it should be remembered that the Wireless Telegraphy Act, the regulations thereunder, and the Australian Broadcasting Commission Act 1932, do in fact permit both broadcasting and the reception of broadcasted material by authorised persons, but under a large measure of public control, exercised either by the statutory Broadcasting Commission or by the Postmaster-General.

Under the power to make laws with respect to telephonic services it is, in my opinion, within the power of the Commonwealth Parliament to regulate as it may think proper that form of wireless telephony known as broadcasting.

8. If, however, this opinion should not be well founded, it is necessary to consider the words "or other like services."

In the first place, it is clear that it was intended by these words to extend the legislative power beyond postal telegraphic and telephonic services. Otherwise the words would be meaningless.

The reasons for the addition of the words "other like services" can be readily understood if reference is made to the history of the subject. In **The Attorney-General v. The Edison Telephone Company of London (Limited)** 6 Q.B.D. 244 it was held, after much argument, that Edison's telephone was a "telegraph" within the meaning of the Telegraphs Acts 1863 and 1869, although the telephone was not invented or contemplated in 1869, and that a telephone conversation was a "message," or at all events "a communication transmitted by a telegraph," and therefore a "telegram" within the meaning of those Acts. It was held that the legislature deliberately used language "embracing future discoveries as to the use of electricity for the purpose of conveying messages." At the time when this decision was given (1880) wireless was completely unknown. But the Court anticipated the possible discovery of wireless when it said (p.249), that the definitions in the Acts included under "telegraph"—"electric signals made, if such a thing were possible, from place to place through the earth or the air," as well as "a set of common bells, worked by wires pulled by the hand, if they were so arranged as to constitute a code of signals." As to the application of the Telegraph Act 1869 to "private" telephone systems see **Postmaster-General v. National Telephone Co. Ltd.** 1909 A.C. 269.

The Constitution of the United States of America provides in Article I Section VIII that Congress shall have power to establish "post offices and post-roads." It was held in **Pensacola Telegraph Company v. The Western Union Telegraph Company,** 96 U.S. 1 that under this power and the power to regulate commerce with foreign nations, and among the several States, Congress could control telephonic messages. It was doubtless hoped by the draftsmen of the Commonwealth Constitution to avoid the uncertainty which led to such litigation.

9. But, in the next place, only "services" can be comprehended within the words. I have already given reasons for my view that legislation with respect to the provision and control of broadcasting facilities, for both transmitting and receiving, is legislation with respect to a service.

10. Further, any service covered by the words in question must be a "like" service. By what test can it be determined whether a service is a "like" service as compared with postal, telegraphic and telephonic services?

It was suggested for the defendant that these services were, when controlled by the States (and are now, when controlled by the Commonwealth), in their nature such that all members of the public could use them for purposes of communication

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and that such communications were secret or private in character. Broadcasting, on the other hand, under the system in operation in Australia, is open for use only to those who have licenses for transmitting or receiving, and certainly what is broadcasted cannot be described as secret or private.

It does not appear to me to be a necessary incident of postal, telegraphic or telephonic services as such either that they should be open for use to all members of the public or that they should possess to any particular extent characteristics of secrecy or privacy.

A postal service, for example, would be none the less a postal service because it could only be used, in an autocratic State, by the friends of the autocrat, or because licenses or the payment of heavy fees were required before persons could use it, or because it was enacted that copies of all letters posted should be shown to a censor or even made public in some manner. Such provisions might be highly objectionable, but they would, in my opinion, be provisions with respect to "a service." Similar observations apply to telegraph and telephone services. In addition to these considerations it may be pointed out that any person who obtains the appropriate license can transmit or receive broadcasted matter—just as anybody who buys the necessary stamps can use the post offices, and just as anybody who pays the charges imposed by law can send a telegraphic or telephonic message.

11. Reference has already been made to the contention that these services, in order to be services, must be the subject of public control in some sense. It has similarly been contended that likeness in method of control should be accepted as the test of likeness for the purposes of sec. 51 (v). Thus if the Commonwealth Parliament made the control of the Post Office similar to that now in operation with respect to broadcasting, then it might be that the latter subject could be dealt with by the Commonwealth Parliament as it is actually dealt with in existing legislation, because then the two services would be "like services." Alternatively, it was put that broadcasting could be made a "like service," so as to fall within federal legislative power, by assimilating the form of management of broadcasting to the present form of management of postal telegraphic and telephonic services in Australia.

I can see no reason for interpreting the legislative powers conferred upon a Parliament by a Constitution in relation to one subject by reference to what that Parliament elects to do with respect to another subject, unless there is a positive direction which requires uniformity of treatment as between the two subject matters. I am unable to find any such positive direction in the word "like."

It may be added that if similarity in method of control were the test of "likeness" of services, then the Commonwealth Parliament could legislate about all kinds of matters provided only that a system of control similar to that which happens to obtain in, e.g., the Post Office, were adopted. It is not possible to accept such a proposition.

12. There are difficulties in the way of accepting the view suggested on behalf of the defendant that the means used by the postal telegraphic and telephonic systems constitute the essential features of "likeness." It is true that both telegraphs and telephones use electric energy. So does broadcasting. But so also, do power transmission systems. The Post Office uses horses, motor cars, ships and aeroplanes. But the power to legislate with respect to postal services cannot reasonably be said to contain a power to deal with horses etc., as separate subjects in themselves, or with any system or service which also uses horses, etc.

13. The common characteristic of postal, telegraphic and telephonic services which is relevant in this connection is, in my opinion, to be found in the function which they perform. They are, each of them, communication services. This is also the characteristic of a broadcasting service in all its forms, which is therefore in my opinion, a "like service" within the meaning of sec. 51 (v) of the Constitution. If a new form of communication should be discovered, it too might be made the subject of legislation as a "like service."

14. It was argued for the respondent that the Commonwealth Parliament has power to legislate with respect to broadcasting under the power to make laws with respect to trade and commerce with other countries and among the States—the Constitution sec. 51 (i). It was put that any broadcast is necessarily inter-state in character, or at least that any broadcast may be made inter-state by any increase in the power, and that authority to control inter-state broadcasting must, owing to the very nature of the subject matter, necessarily and inseparably include a power to deal also with broadcasting which did not purport to be inter-state in its operation. It was also said that there was a right in the Commonwealth Parliament to protect and to prevent interference with interstate broadcasting, as an element of inter-state trade and commerce. One broadcasting station can readily interfere with another, and a defective or ill-managed receiving set can interfere with reception by other sets. Accordingly, it was said, the subject must be treated as a whole, and, if the Commonwealth Parliament had any power at all in relation to broadcasting under the trade and commerce power, the subject matter was such that that Parliament had all the power. No actual evidence was given in the Court below as a basis for the argument, though possibly what was alleged as to the nature of broadcasting may be regarded as common knowledge. I abstain from expressing any opinion upon the extent of the trade and commerce power in this direction because, in the view that I have taken, it is unnecessary to do so.

In my opinion, the order of the Court of Petty Sessions was right and the appeal should be dismissed.

JUDGMENTS BY MR. JUSTICE RICH & MR. JUSTICE EVATT

THIS is an appeal from a Court of Petty Sessions exercising Federal jurisdiction. The appellant was convicted under sec. 6 of the Wireless Telegraphy Act 1905-1919. The appliance which she maintained was a broadcasting receiving set. The questions raised by the appeal are—whether such an instrument is within the Wireless Telegraphy Act and if so, whether it is within the power of the Federal Parliament to penalise the possession or maintenance of broadcasting receivers. As the interpretation of the Act must be controlled or affected by the constitutional power, we proceed to express our opinion upon the second question first. The constitutional power primarily relied upon is sec. 51 (5)—power to make laws with respect to postal, telegraphic, telephonic and other like services. The power was expressed in this form, we have little doubt, because of the known difficulties which had arisen in the United States. The constitution of the United States had conferred power to establish "post offices and post roads." When the electric telegraph came into use the objection was made that it was outside the power. The objection was answered it is true. The answer given provides one of the principles of constitutional interpretation.

Waite, C.J., said: "The powers granted are not confined to the instrumentalities of commerce, or the postal service known or in use when the constitution was adopted, but they keep pace with the progress of the country, and adapt themselves to the new developments of time and circumstances." **Pensacola Telegraph Co. v. Western Telegraph Co.** 96 U.S.1 at p9; 24, Lawyers' Edtn. 708 at p. 710. But notwithstanding this principle the difficulty served as a warning to the framers of the Australian Constitution and accordingly they expressed themselves in terms calculated to cover developments in science and organisation enabling the control of analogous and ancillary services.

We do not think that it is disputed that wireless telegraphy and telephony are a means, although perhaps unthought of in 1897 by the framers of the Constitution, whereby the services described in sec. 51 (5) may be conducted. What is disputed is that the application of wireless telegraphy or telephony to broadcasting falls within the power. The object of the power is to place the control of distant communication carried on according to a systematic plan under Federal authority. Broadcasting both in its means and in the fact that its main purpose is the transmission of sound instantaneously over long distances, possesses the prominent features of telephony. Looked

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at from the point of view of the public, however, it differs in the fact that it is the receipt and not the sending of the sound that provides the service, of which the members of the public are at liberty to avail themselves.

It does not give the advantage of one man communicating with another when he wishes. What it does give is the advantage of allowing a listener with a suitable receiving set to entertain himself with such sounds as strike his ear as pleasurable be they musical, vocal or of any other description, which those operating at the transmitting station regard as satisfying a public want. The distinction is apparent, but the question is whether it takes broadcasting beyond the legislative power. In dealing with such a question it must not be forgotten that it is a constitutional power intended to provide for the future and bearing upon its face an attempt to cover unknown and unforeseen developments. A wide operation should be given to such a power.

In the next place the description "telegraphic and telephonic" carries with it not by derivation but by usage, a reference to electrical means of transmission of signals and speech. Broadcasting, whether conducted by private enterprise or by a governmental body is a public service, and it is telephonic in its nature. In the case of the Regulation and Control of Radio Communication in Canada, 1932 A.C. 304, the Privy Council had to deal with the application of both these words to broadcasting by radio. The question arose under sec. 92 (10) of the British North America Act 1867 which has the effect of placing under the power of the Dominion lines of steam or other ships, railways, canals, telegraphs and other works and undertakings "connecting the Province with any other or others of the Provinces, or extending beyond the limits of the Province."

It happened that in a previous case (City of Montreal v. Montreal Street Railway 1912 A.C. 333, 342) an observation had been made that the works in this provision were physical things, not services. When in the subsequent case the Privy Council was called on to decide whether broadcasting was within the power of the Dominion, Lord Dunedin, speaking for their Lordships, said that they were of the opinion that it was and fell "within both the word 'telegraphs' and the general words 'undertakings connecting'," etc. Lord Dunedin went on to say in reference to the word "services" that "undertakings" is not a physical thing, but is an arrangement under which, of course, "physical things are used," thus showing that he regarded broadcasting as fairly within the expression "services."

He returned to the statement that their Lordships thought broadcasting fell within the description of telegraphs and said "No doubt in everyday speech telegraph is almost exclusively used to denote the electrical instrument which, by means of a wire connecting that instrument with another instrument, makes it possible to communicate signals or words of any kind. But the original meaning of the word 'telegraph,' as given in the Oxford Dictionary, is: 'An apparatus for transmitting messages to a distance, usually by signs of some kind.'" This very strong authority, coupled with the principles of interpretation and the other considerations to which we have referred, appears to us ample justification for holding that wireless broadcasting is a telephonic service. Anything which comes within those words must be within the power conferred by sec. 51 (5) which cannot be restricted to those arrangements or systems of communication which were employed or used when the Constitution was adopted.

It remains to consider whether wireless broadcasting is within the Wireless Telegraphy Act 1905-1919. According to sec. 2 wireless telegraphy includes all systems of transmitting and receiving telegraphic or telephonic messages by means of electricity without a continuous metallic connection between transmitter and receiver. The difficulty in applying the Act to broadcasting lies, in our opinion, only in the use of the word "messages" which occurs also in sec. 6. All the other expressions are appropriate.

During the argument before us we had the advantage of an examination of the British statutes and other relevant material relating to telegraphy and wireless. It is clear that the word "message" has become almost a word of art in relation to telegraph and telephone services. This involves no departure from the meaning of which the word is naturally capable. But it does show that it is used to denote the transmission of any complete communication which, so to speak, forms a unit in the traffic going over a line or "the air." The word has no relation to the nature of the communication. Possibly some of the things which are transmitted by broadcast cannot be brought within its fair meaning, but most of them can. In our opinion, a wireless receiving set is an appliance for the purpose of receiving messages by means of wireless telephony which is included within the statutory definition of wireless telegraphy.

For these reasons we think the appeal should be dismissed with costs.

JUDGMENT BY MR. JUSTICE J. STARKE

Appeal by way of Prohibition

THE prosecutor Dulcie Williams, was charged before a Stipendiary Magistrate, sitting in the Court of Petty Sessions at Sydney, for that she did without authorisation by or under the Wireless Telegraphy Act 1905-1919 maintain an appliance for the purpose of receiving messages by means of wireless telegraphy, contrary to the Act, and she was convicted of that offence. She had on her premises an electric wireless receiver connected to an indoor aerial. The receiving equipment was capable of receiving messages or any audible sounds or matter from a wireless transmitting or broadcasting station. The Rule Nisi was granted upon several grounds, but the principal grounds are:

(1) That upon its true construction the Wireless Telegraphy Act 1905-19 only prohibits the maintenance of appliances for the purpose of receiving messages by means of wireless telegraphy and not for the purpose of receiving radio broadcasts.

(2) That if and so far as the Act regulates or authorises the regulation of radio broadcasting, it transcends the Constitution.

The Act, by sec. 6, provides that no person shall, except as authorised by or under the Act, maintain or use any appliance for the purpose of transmitting or receiving messages by means of wireless telegraphy. The Wireless Telegraphy Regulations, made or purporting to have been made under the Act, regulate generally radio broadcasting and the issue of listeners' licenses for stations used solely for the reception of programmes from broadcasting stations. Ordinarily, one would consider whether regulations are authorised by the Act under which they purport to have been made. But in the present case, it is advisable, I think, to determine the extent of the legislative power of the Commonwealth over radio broadcasting.

The Constitution sec. 51 (v) confers upon the Parliament power to make laws for the peace, order and good government of the Commonwealth with respect to "postal, telegraphic, telephonic and other like services." It was argued that the likeness of a service to those enumerated depends upon the character of the service; it must be a service, it was said, under the control of the Government, and it must provide for the transmission and reception of communications between citizens and be private in its nature. But in my opinion the likeness of the service depends upon no such considerations, but upon the likeness of the means by which the service is performed. Thus, there is no material distinction between a telegraphic and a telephonic service **(Attorney-General v. Edison, etc. Co.,** 6 Q.B.D. 244); in both cases communication takes place by means of a wire acted upon by electricity. In a wireless service, communication takes place without a continuous metallic connection between transmitter and receiver.

It is quite unnecessary to discuss the theory of radio transmission and reception. It is sufficiently referred to in **Chappell and Co. v. Associated Co.** 1925 V.L.R., at pp. 357-8, and in **Buck v. Jewell,** 283 U.S. at pp. 199-202. "The important matter," as Cussen J. said in Chappell & Co.'s case, "is that in all cases of reproduction of similar sounds at a distance, the modulations in the original atmospheric disturbances are in a sense preserved, though manifesting themselves at various stages and in various media in various ways." But more important, from a legal point of view, is the decision of the Privy Council in **In re Regulation and Control of Radio Communication in Canada** (1932 A.C. 304). Under the Canadian Constitution (British North America Act, 30 Vic. c. 3), the Provinces have exclusive powers (sec. 92) to make laws in relation to local

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works and undertakings other than such as are of the following classes . . . telegraphs and other works and undertakings connecting the Province with any other or others of the Provinces or extending beyond the limits of the Province (sub-sec. (10)). The matters so excepted become part of the exclusive legislative authority of the Dominion. (Sec. 91 ss (29)).

"Now, said their Lordships, "does broadcasting fall within the excepted matters? Their Lordships are of opinion that it does, falling . . . within both the word 'telegraphs' and the general words 'undertakings connecting the Province with any other or others of the Provinces or extending beyond the limits of the Province.'" (See pp. 314-316). In my opinion, therefore, the Constitution gives the Commonwealth full authority to legislate with respect to wireless telegraphy, including radio broadcasting.

The next question is how far the Commonwealth has exercised this power in the Wireless Telegraphy Act, 1905-19. The Act gives the Minister for the time being administering the Act, the exclusive privilege of establishing, erecting, maintaining and using stations and appliances for the purpose (amongst others) of transmitting messages by wireless telegraphy within Australia and receiving messages so transmitted. (Sec. 4). Wireless telegraphy includes all systems of transmitting and receiving telegraphic or telephonic messages by means of electricity without a continuous metallic connection between the transmitter and the receiver (sec. 2). These sections may be compared with sec. 80 of the Post and Telegraph Act, 1901-23.

"The Postmaster-General shall have the exclusive privilege of erecting and maintaining telegraph lines and of transmitting telegrams or other communications by telegraph within the Commonwealth, and performing all the incidental services of receiving, collecting or delivering such telegrams or communications except as provided by this Act or the regulations."

It will be observed that the word 'messages' is used in the Wireless Telegraphy Act, whereas in the Post & Telegraph Act the words are 'telegrams or other communications.' But a message is a communication, and the use of the one word rather than 'messages or other communications' does not suggest any special limitations of the privilege granted by the Wireless Telegraphy Act. Little difficulty seems to have been found in treating telephonic conversations as messages. (See **Attorney-General v. Edison, etc. Co.** supra at p. 258). Again, in the English Wireless Telegraphy Acts 1904, 1925 and 1926 (4 Ed. VII. c. 24, 15 and 16 Geo. V. c. 67, 16 and 17 Geo. V c. 54), the word 'messages' is used in a sense wide enough to include broadcasting. Thus in sec. 1 (7) of the 1904 Act, as amended in 1925, "wireless telegraphy" is defined to mean—"any system of communication by telegraph as defined in the Telegraph Acts 1863 to 1904 without the aid of any wire connecting the points from and at which the messages or other communications are sent and received: Provided that nothing in this Act shall prevent any person from making or using electrical apparatus for actuating machinery or for any other purpose than the transmission and reception of messages."

The scope and object of the Wireless Telegraphy Act, and the broad sense in which the word 'message' is used in connection with wireless telegraphy lead me to the conclusion that the word 'messages' in the Act includes the dissemination of any sounds or audible matter, e.g. musical performances, speeches, etc., by means of electricity without a continuous metallic connection between the transmitter and the receiver. The Act might well have followed the English legislation, but it is not so futile that it regulates some undefined communications called messages, and leaves radio broadcasting entirely unregulated and beyond the monopoly granted to the Minister in the interest of the whole Commonwealth.

All that remains for consideration is the validity of the regulations. By sec. 10 of the Act, the Governor-General may make regulations not inconsistent with the Act prescribing all matters which by the Act are required or permitted to be prescribed or which are necessary or convenient to be prescribed for carrying out or giving effect to the Act. If the construction I have given to the Act is right, namely that the Commonwealth has authority under it to control and regulate radio broadcasting, then the regulations, or at all events, the licensing clauses, appear to be within power and perfectly valid.

The Rule Nisi should be discharged.

JUDGMENT BY MR. JUSTICE J. DIXON

THE appellant was convicted under sec. 6 of the Wireless Telegraphy Act 1905-1919 of maintaining, without authorisation, an appliance for the purpose of receiving messages by means of wireless telegraphy. "Wireless telegraphy" is defined by sec. 2 to include all systems of transmitting or receiving telegraphic or telephonic messages by means of electricity without a continuous metallic connection between the transmitter and the receiver. What the appellant was in fact maintaining was an ordinary wireless broadcasting receiving set.

The contentions advanced in support of her appeal are that upon its proper interpretation the section under which she was charged does not extend to broadcasting receiving sets and that, if it does, it is to that extent invalid because the power conferred upon the Parliament by sec. 51 (v) of the Constitution to make laws with respect to postal, telegraphic, telephonic and other like services, does not cover broadcasting and there is no other power within which the provision can be brought.

In my opinion, the first of these contentions is well founded and to maintain a broadcasting receiving set for use in the ordinary manner is not an offence against sec. 6 of the Wireless Telegraphy Act 1905-1919. The second contention involves the long standing question of the power of the Commonwealth over broadcasting. From the beginning of broadcasting the difficulty which exists in bringing it within the legislative power of the Commonwealth has been well understood, but the Wireless Telegraphy Regulations governing it have hitherto enjoyed an immunity from attack which suggests a general acquiescence almost in the Commonwealth's assumption of the power. The difficulty, of course, lies in regarding broadcasting for general amusement, information, instruction, or edification, as a service which forms part of, or is like, postal, telegraphic and telephonic services. A similarity undoubtedly exists between the appliances used, on the one hand, in telegraphy and telephony and, on the other, in wireless broadcasting. But it is said that the likeness to which the Constitution refers is to be found in the character of the service performed for the public and not in the mechanical or electromagnetic nature or basis of the instruments employed for the purpose.

The present would appear to me to be anything but suitable for deciding this important constitutional question, if the opinion of the majority of the Court were adverse to the power. No one has thought fit to raise it in the interests of the States, which, apparently, are well content to suffer the Commonwealth to exercise the power. In the United States of America broadcasting by wireless has been held to fall within the power over interstate commerce: **Federal Radio Commission v. Nelson,** 289 U.S. 266 at p. 279: 77 L., Ed. 1166 at p. 1175. If, therefore, a Commonwealth statute dealing with broadcasting were enacted on the basis of the power with respect to trade and commerce between the States, some support might be found to exist, independently of sec. 51 (v), for the Federal claim to control the entire subject. But the Wireless Telegraphy Act 1905-1919 is not based in any way on the commerce power and, in my opinion, cannot be considered as a law with respect to the subject matter of that power.

The question has long been left in suspense and, if a majority of the Court had been, as I am, unable to arrive at the conclusion that broadcasting is within the power with respect to postal, telegraphic, telephonic and other like services, I should have been disposed to limit the expression of my opinion to the ground I have already stated, namely that the ordinary use of a broadcasting receiving set is not within the prohibition contained in sec. 6 (1) of the Wireless Telegraphy Act. As it is, I shall give my reasons for that conclusion and then state very shortly why, in my opinion, wireless broadcasting is not within the subject matter of sec. 51 (v).

The provision applies only when the purpose exists of transmitting or receiving messages by means of wireless telegraphy. It may be that the means employed come within the words forming part of the definition of wireless telegraphy—"by means of electricity without a continuous metallic connection between the transmitter and the receiver." Nevertheless, I do not think broadcasting programmes constitute or contain "messages." This word appears to me to mean a communication sent to one

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definite person by another. It does not mean matter in the form of speech or other sounds disseminated indiscriminately among the public who, being equipped with the mechanical means, desire to hear it. From a listener's point of view, a wireless receiving set may be regarded as a mechanical means of extending the range of natural hearing restricted to sounds which at the place of emission have been mechanically dealt with so that they may be so heard. The very word "broadcast" is used because the sounds are addressed to all who have thus extended their range of hearing by an appropriate appliance. Its meaning involves publicity. The expression "transmit and receive a message" could not, I think, be applied to a speech delivered at a gathering through amplifiers by a speaker a great part of whose audience was beyond the natural range of hearing. But when a speech is broadcast, the operation differs only in the fact that the listeners are not congregated together and, without television, cannot see the speaker.

In the Act, the word "message" is, I think, appropriate only to individual communication. In saying it means a communication to one definite person by another, I do not mean to exclude messages which are simultaneously despatched to many. Each of these is, in fact, a separate message, although identical in expression with the others. Nor do I mean to emphasise the singular in the "one" and the "other." The senders may be a body or collection of people, and the recipients may be a body or collection of people. The difference is between definite individuals and a form of public performance, recital, or utterance.

It may be objected that by the licensing system broadcast listeners are defined and, although a multitude, they are definite individuals. The objection rather misses the substance of the distinction. But, in any case, it is not to the point, because it is not licensed but unlicensed reception that must be considered in determining what is prohibited under the word "message."

It is not surprising if sec. 6 of the Act does not cover broadcast reception. It was passed in 1905 before broadcasting commenced. Of course, a communication sent by radio could be picked up then, as now, by anyone with a suitable receiver. But the object of the Act was to regulate uses of wireless for purposes of communication like the telegraph and telephone. It was for that reason that the word "message" was employed as part of the definition of the offence. It was for that reason also that unauthorised appliances were made forfeit to the Crown by sec. 7.

The Wireless Telegraphy Act is a law with respect to postal, telegraphic, telephonic, and other like services, enacted in the exercise of the power conferred upon the Parliament by section 51 (v) of the Constitution. Upon the construction which I have placed upon the statute, there is, I think, no doubt of its validity. But, as I have already said, I am unable to concur in the opinion that the power is wide enough to include wireless broadcasting and to support the statute if, upon its proper interpretation, it authorises Part III of the Wireless Telegraphy Regulations, 1924-1934 which deals with broadcasting.

The grant of power contained in sec. 51 (v) is expressed in a form plainly adopted in order that it should include every present and future mode of performing the services called postal, telegraphic and telephonic. The feature which the services, so described, possess in common is that they supply an organised means of enabling people at a distance to communicate one with another either by writing or by word of mouth.

The object of the postal service is to provide a system by which a missive may be dispatched by one person and delivered to another. The missive is not necessarily a written message. It may be a journal or a book or any physical thing susceptible of transmission through an organisation ready to undertake the task of receiving articles from individual senders, transmitting them and delivering them to individual addresses. In postal services the physical identity of the missive is preserved.

A telegraphic service resembles the postal service in providing a system by which a communication may be sent by one person for delivery to another separated from him by distance. But rapidity of transmission is obtained by the use of signals, at first mechanical, but later electro-magnetic. This means that the contents of the message are repeated. Perhaps the characteristics which differentiate a telegraph from a postal service are the greater expedition of the telegraph, its limitation to messages and the fact that the message is reproduced and not conveyed in its original material form.

A telephone service provides an interrelated system for oral communication at a distance. It depends, so far at any rate, on the reproduction of sound by electric-magnetic devices. Its purpose is to enable a definite person obtaining access to an instrument at a fixed point to interchange spoken communication at a distance with another definite person having access to another such instrument.

They are all services because they consist in an established system organised for the purpose of performing a function to satisfy the demands of the members of the community. The demand they go to satisfy in common is for means of interchanging intelligence at a distance. The primary requirement of the community they fulfil is for a method by which an individual who desires to communicate with another at a distance may dispatch and have delivered to him his message, or establish direct oral communication with him. No doubt the deed of receiving communications, if sent, is an important want of a community. The two things are mutual. But the ability of the individual to originate the communication received is the first condition. The expression "other like services" covers, I should think, every system or organised process of furnishing means of individual inter-communication, notwithstanding that, at the time when the Constitution was adopted, it was undiscovered and unthought of. The power, of course, extends to everything which is incidental or arises out of the main purpose or its fulfilment. Moreover, although almost from their respective beginnings, these services have in Australia been conducted by government, that is not an essential characteristic.

Electric telegraph and telephone services may use metallic circuits or wireless. Wireless is used in broadcasting, and broadcasting includes the transmission of speech to a distance. It affords an advantage to the public by an organised system and, therefore, may be called "a service." But here, in my opinion, the points of resemblance are exhausted.

Broadcasting provides a means by which those, who secure for themselves an appropriate receiving set, may hear speeches, music, entertainments, announcements and the like, addressed to the public at large from some central point. There is no inter-communication; no means is provided by which one individual can originate a message or establish communication with another, nothing to satisfy the purpose for which any of the enumerated services exist. It appears to me to be outside the scope and purpose of the power. It is said that carrying on such an operation performs a service to the public and that, according to high judicial authority, the adjective "telegraph" may be applied because the means adopted is wireless telephony. This does not meet the difficulty. It takes each of the two words "telephonic" and "service." It applies each of them in a manner differing from that in which they are used in sec. 51 (v). It then combines them and requires the combination to serve the purpose of including a quite different thing. The expression "postal, telegraphic and telephonic services" describes a well known category of public services which, in my opinion, possessed definite characteristics. The addition of the expression "other like services" emphasises the fact that the category looked to those characteristics. In my opinion, altogether different characteristics belong to wireless broadcasting.

For these reasons I think the appeal should be allowed.

JUDGMENT BY MR. JUSTICE McTIERNAN.

I agree that this appeal should be dismissed. Since the decision of the Judicial Committee in the Radio case, 1932, A.C. 304, the view must be accepted that Broadcasting as established and regulated by the Regulations, made pursuant to the Wireless Telegraphy Act, 1905-1919, may be classed with telegraphic and telephonic services. It follows from this decision that Section 51 (v) of the Constitution upon its true interpretation authorises Parliament to legislate with respect to the service of Broadcasting. See also Attorney-General v. Edison Telephone Company of London, 6 Q.B.D. 244, and Attorney-General for New South Wales v. Brewery Employees Union of New South Wales, 6 C.L.R. 501, per Griffith, C. J., and of Halsbury Laws of England, Volume 27 p. 250.

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AUSTRALIAN HIGH COURT JUDGMENT—(Continued)

But it is said that the provisions of the Wireless Telegraphy Act do not authorise the making of regulations with respect to Broadcasting, as the scope of the Act is limited to systems of transmitting and receiving telegraphic or telephonic messages by means of electricity without a continuous metallic connection between the transmitter and the receiver. (See Section 2 of the Wireless Telegraphy Act, 1905-1919). This contention depends on the view that the transmission of such messages does not include broadcasting of programmes such as are provided for by the Regulations. In my opinion it is quite in accord with common usage to describe the transmission by radio of sounds representing such programmes as the transmission of messages. The word "messages" as applied to the subject-matter of the Wireless Telegraphy Act, 1905-1919 was not intended to have a meaning more limited than it usually bears as applied to the subject-matter of Wireless telegraphy and telephony.

Commonwealth of Australia Agreements

With Amalgamated Wireless (Australasia) Limited

1.

Original Agreement, dated 28th March, 1922.

ON the 9th December, 1921, a Select Committee was appointed by separate resolutions of the Senate and House of Representatives in the following terms:—

That this House approves of the execution by the Prime Minister of the Agreement proposed to be made between the Commonwealth and Amalgamated Wireless (Australasia) Limited a draft of which has been laid upon the table of the House, subject to investigation and approval, with such alterations as they may deem necessary by a Committee consisting of six members of this House (two nominated by the Prime Minister, two by the Leader of the Opposition, and two by the Leader of the Country Party) and three Members of the Senate.

The Agreement executed in pursuance of this resolution reads as under:—

AGREEMENT made this twenty-eighth day of March One thousand nine hundred and twenty-two between the COMMONWEALTH OF AUSTRALIA (hereinafter called "the Commonwealth") of the one part and AMALGAMATED WIRELESS (AUSTRALASIA) LIMITED of Sydney in the State of New South Wales (hereinafter called "the Company") of the other part whereby it is agreed as follows:—

1. The Company shall forthwith take all necessary steps to increase the capital of the Company to the sum of One million pounds (£1,000,000) divided into one million (1,000,000) shares of One pound (£1) each.

2. The Commonwealth shall forthwith, after the expiration of one month from the date of this Agreement apply for and the Company shall allot to the Commonwealth Five hundred thousand and one shares (500,001) for which the Commonwealth shall pay on allotment the sum of two shillings (2s.) per share. Further calls in respect of the said shares shall be limited to the following amounts and dates namely:—

Six shillings (6s.) per share not earlier than the first day of July One thousand nine hundred and twenty-two; six shillings (6s.) per share not earlier than the first day of January One thousand nine hundred and twenty-three: and six shillings (6s.) per share not earlier than the first day of July One thousand nine hundred and twenty-three.

3. The Company shall forthwith take all necessary steps to alter its Memorandum and/or Articles of Association so as to provide—

(i) that on any increase of capital the Commonwealth shall be entitled to subscribe so much capital and be allotted so many shares that at all times the Commonwealth will hold a majority in number and value of the shares in the Company;

(ii) that every shareholder shall have one vote for every share held by him provided that a holder of shares allotted to the Commonwealth under this Agreement shall not be entitled to vote in respect of the election or removal of Directors representing the holders of shares other than those allotted to the Commonwealth under this Agreement;

(iii) that so long as the Commonwealth or its nominees continue to hold a majority in number and value of the shares there shall be seven Directors of the Company, of whom three shall be nominated by and represent the Commonwealth and three shall be elected by and represent the holders of shares other than those allotted to the Commonwealth under this Agreement, and the seventh Director shall be selected by a majority vote of the other six Directors, and if the voting is equal shall be selected by arbitration in the manner provided by clause 20 of this Agreement in respect of matters in dispute between the Commonwealth and the Company, and shall hold office for a period of three years subject to removal at any time during that period by the unanimous vote of the other Directors. The Board of Directors so constituted shall appoint its own Chairman;

(iv) that dividends may be declared and paid by the Board of Directors;

(v) that the Directors nominated by and representing the Commonwealth shall need no other qualification and shall not be subject to any disqualification or to removal by the Company, and shall not be subject to periodical retirement but shall hold office subject to the pleasure of the Commonwealth which may from time to time retire them and make new appointments;

(vi) that the Commonwealth may from time to time by instrument in writing appoint any person to be the holder of any shares of the Commonwealth, and that such holder shall be entitled to be registered as the holder of such shares and have all the rights and privileges of a holder of such shares;

(vii) that no action or question or decision relating to or affecting—

(1) the policy of the Commonwealth in connexion with Naval or Military or External affairs; or

(2) any proposed sale or disposition of the Company's business or any part thereof; or

(3) any proposed change in the status, powers, objects, or constitution of the Company;

shall be taken, determined or made without the consent of the Commonwealth as expressed through its representatives on the Board of Directors.

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COMMONWEALTH — A.W.A. AGREEMENTS—
(Continued)

(viii) that the Company shall not enter into or be a party to any Commercial Trust or Combine but shall always be and remain an independent British business;
(ix) that other things being equal the Company shall give preference to goods manufactured in the Commonwealth when purchasing machinery, plant and supplies; and
(x) any other matters and things necessary or expedient to protect the interests of the Commonwealth under this Agreement.

4. The Company will forthwith proceed with the development, manufacture, sale and use of apparatus for wireless communication and for wireless transmission of energy within the Commonwealth and its territories and in ships and aircraft owned registered or trading within the Commonwealth or its territories, and for communication with the countries overseas, and the erection of wireless stations and the conduct of wireless services for the purpose of such communications.

5. In particular the Company will forthwith undertake the following programme:—

(a) To construct, maintain, and operate in Australia the necessary stations and equipment for a direct commercial wireless service between Australia and the United Kingdom;
(b) To provide and operate a system of feeder for wireless connexion between the main high-power stations and the capital cities of all the States;
(c) To equip and organise the feeder stations so as to provide communication with merchant ships round the coast of Australia;
(d) To arrange that the rates to be charged for messages between Australia and the United Kingdom transmitted or received by the Company shall not exceed the following:—

Full rate messages	2s. per word
Deferred messages	1s. per word
Week-end messages	6d. (minimum 10s. per message)
Government messages	1s. per word
Press messages	5d. per word
Deferred press messages	3d. per word

(e) To arrange for the operation of suitable corresponding stations in the United Kingdom;
(f) To provide the main trunk stations in Australia and the United Kingdom within two years from the date of this Agreement;
(g) To arrange within two years from the date of this Agreement for erection and operation of a station in Canada capable of commercial communication with the high-power station in Australia, and so equipped as to afford facilities for distributing traffic throughout North America;
(h) To take over within one month after signing this Agreement the existing Commonwealth Radio Stations, excepting those wholly under the control of the Department of Defence, but including the stations in Papua, Territory of New Guinea, and Flinders and King Islands, and also if required by the Minister for Home and Territories the station at Willis Islets, and to operate and re-organise the service provided by those stations in such a way as to provide a service at least equivalent to that now being supplied by the Commonwealth Radio Service.

6. The sites, buildings, masts, plant and other assets of the stations to be taken over by the Company in accordance with paragraph (h) of clause 5 of this Agreement shall be taken over at a valuation to be made by a committee including two representatives of the Company and two representatives of the Commonwealth, with an independent Chairman to be agreed upon by the other four representativs or a majority of them, and in default of agreement to be determined by arbitration in the manner provided by clause 20 of this Agreement, the basis of valuation shall be the value of the assets for the purpose of supplying the new service to be undertaken by the Company in pursuance of this Agreement. The amount of the valuation shall be credited to the Commonwealth in part payment for the 500,001 shares to be allotted to the Commonwealth, and shall be deducted from the last payments of capital to be made by the Commonwealth.

7. During the period of construction and re-organisation or for a period of three years from the date of this Agreement, whichever is the less, the Commonwealth shall pay to the Company monthly all amounts expended in carrying on the existing Commonwealth Radio Stations, and the Company shall pay to the Commonwealth monthly all sums received as revenue from the working of those stations.

In the case of the existing Radio Stations in the Territory of New Guinea, for a period of seven years from the date of this Agreement, the Commonwealth shall pay to the Company monthly all amounts expended in carrying on those stations, and the Company shall pay to the Commonwealth monthly all sums received as revenue from the working of those stations.

8. The Company shall conform to the policy of the Commonwealth as decided from time to time by the Minister administering the Wireless Telegraphy Act in respect of the operations of Wireless Telegraphy and Telephony within the Commonwealth and territories under the authority of the Commonwealth, and also with respect of **personnel** and employees in the Territory of New Guinea.

Provided that if compliance with this clause involves the Company in any obligations or the doing of any act not specifically provided for in this Agreement the Company shall be compensated in respect of any loss that results therefrom. Such compensation shall, if necessary, be fixed by arbitration in the manner provided by clause 20 of the Agreement.

9. The Company shall take over the existing **personnel** of the Commonwealth Radio Service at rates of remuneration equal to those payable at the time of taking over, and shall conserve to the employees so taken over any pension rights, retiring allowance or furlough rights which would have accrued to those employees if the service with the Company had been a continuation of service with the Commonwealth.

Provided that the cost of such pension rights, retiring allowance or furlough rights shall be born by the Commonwealth and the Company in proportion to the respective periods of employment with the Commonwealth and the Company;

Provided further that any contributions made by such employees towards such rights shall be divided between the Commonwealth and the Company in the same proportion as that specified in the last preceding proviso.

10. The Company shall operate the stations referred to in paragraphs (b) and (h) of clause 5 in such a way as to facilitate the performance by the Commonwealth of its obligations under the International Radio Telegraph Convention and the International Convention for the safety of life at sea.

11. Any alterations in the rates for traffic within the Commonwealth or between the Commonwealth and any territory under the authority of the Commonwealth or between any such territories shall be subject to the approval of the Government representatives on the Board of Directors. Provided, however, that such consent shall not be withheld if the Board is satisfied that such alterations are necessary for the purpose of meeting additional costs occasioned by increased wages awarded by any Arbitration Court or other Industrial Tribunal of the Commonwealth or of a State or territory. All other rates shall be fixed solely by the Board of Directors.

12. The Company shall within six months after the date of this Agreement or within such extended time as the representatives of the Commonwealth on the Board may approve enter into an agreement providing for the erection and operation of the stations mentioned in paragraphs (f) and (g) of clause 5 of this Agreement. The Agreement shall contain guarantees of such a nature and to such an amount as are approved by the Commonwealth representatives on the Board of Directors for the provision of a direct commercial wireless service between Australia and stations in the United Kingdom and Canada.

For the purposes of this Agreement, the Commercial Wireless Service means a service capable, as regards plant, apparatus and **personnel,** of maintaining communication throughout 300 days of every year on the minimum basis of twenty words per minute each way for twelve hours per day.

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COMMONWEALTH — A.W.A. AGREEMENTS—
(Continued)

If no such agreement is entered into within six months after the date of this Agreement or within such extended time (if any) as is approved under this clause, the Commonwealth shall be entitled to give notice to the Company of the cancellation of this Agreement, and thereupon the Agreement shall be deemed to be cancelled accordingly.

13. The Commonwealth shall at all times grant to the Company free of charge all permits and licenses necessary for the full realisation of the programme set out in clause 5 of this Agreement and for the development and manufacture of apparatus as set out in clause 4 of this Agreement.

14. In time of war or public danger the Company shall if required by the Commonwealth hand over to the Commonwealth the control of its stations, its apparatus, its services and its manufacturing plant during such times of war or public danger subject to an equitable financial adjustment to be determined by arbitration in the absence of mutual agreement.

15. So long as this Agreement remains in force the Commonwealth will not impose any condition or restriction of any kind upon the operations of the Company calculated to obstruct the business of the Company:

Provided that the obligations of the Commonwealth under this clause do not extend to any wireless service not included in clause 5 of this Agreement and competing with the land telegraph lines of the Commonwealth.

16. The Commonwealth shall refund to the Company any Customs duty paid by the Company on the importation into Australia of any plant or apparatus which is required for the construction or installation of the first high-power station erected in Australia and which cannot conveniently be manufactured in Australia.

17. Any notice, communication, opinion, agreement, approval or other matter or thing to be given, made, expressed or done by the Commonwealth under these presents shall be deemed to have been duly given, made, expressed or done if given, made, expressed, or done in writing, signed, on behalf of the Commonwealth by or on behalf of the Prime Minister of the Commonwealth and delivered to or posted by prepaid post, addressed to the Company at the address of its registered office in Australia.

18. Any notice, communication, agreement, approval or other matter or thing to be given, made, expressed or done by the Company under these presents shall be deemed to have been duly given, made, expressed or done if given, made, expressed, or done in writing, signed, on behalf of the Company by its secretary or other proper officer, and delivered to or posted by prepaid post addressed to the Prime Minister at his official address at the seat of Government of the Commonwealth.

19. Any delay or disability in the carrying out of this Agreement arising directly from the Act of God, war, restraints of Princes, strikes or lock-outs, or workmen, or other industrial disturbances, shall not entitle any party to damages or to a cancellation of this Agreement, but this Agreement shall to the extent of such delay or disability be deemed to be suspended and shall forthwith come into full force and effect when such delay or disability shall have ceased.

20. In the event of any disagreement between the Commonwealth and the Company as to the meaning of any clause hereof or touching any matter arising out of the same or connected therewith, the matter in dispute shall be referred to one arbitrator mutually selected, or failing mutual selection shall be determined by arbitration under the **Arbitration Act** 1915 of the State of Victoria or any amendment thereof for the time being in force.

21. Nothing in this Agreement shall be construed to prejudice or limit in any way any right or power of the Commonwealth to acquire on just terms compulsorily or otherwise any share or interest of any person in the Company.

22. This Agreement shall have no force and effect, and shall not be binding on either party, unless and until within six months after the date hereof, or within such extended time as is mutually agreed upon, 300,000 new shares of £1 each are issued and are subscribed for by private shareholders and 2s. per share is paid up thereon.

Further calls on the said shares shall be made on the same dates and for the same amounts as calls on the shares held by the Commonwealth.

In witness whereof the parties hereto have executed these presents the day and year first above-mentioned.

Signed, Sealed and Delivered by the Honourable William Morris Hughes, Prime Minister of the Commonwealth of Australia, for and on behalf of the said Commonwealth in the presence of— (Sgd.) P. E. Deane	(Sgd.) W. M. Hughes
The Common Seal of the Amalgamated Wireless (Australasia) Limited was hereunto affixed in the presence of— (Sgd.) J. F. Wilson.	(Sgd.) T. Langley Webb. Ernest T. Fisk.

2.

Amendment of 1924.

Act No. 24 of 1924.

THE COMMONWEALTH OF AUSTRALIA WIRELESS AGREEMENT

No. 24 of 1924.

An Act to approve the Agreement made between His Majesty's Government of the Commonwealth of Australia and Amalgamated Wireless (Australasia) Limited.

(Assented to 17th September, 1924.)

BE it enacted by the King's Most Excellent Majesty, the Senate, and the House of Representatives of the Commonwealth of Australia, as follows:—

1. This Act may be cited as the **Wireless Agreement Act,** 1924.

2. The Agreement made between His Majesty's Government of the Commonwealth of Australia and Amalgamated Wireless (Australasia) Limited (a copy of which is set forth in the Schedule to this Act) is approved.

THE SCHEDULE

An Agreement made the twentieth day of August One thousand nine hundred and twenty-four between the Commonwealth of Australia (hereinafter called "the Commonwealth") of the one part and Amalgamated Wireless (Australasia) Limited of Sydney in the State of New South Wales (hereinafter called "the Company") of the other part Whereas by an Agreement dated the twenty-eighth day of March One thousand nine hundred and twenty-two made between the parties hereto (hereinafter referred to as "the Principal Agreement") the Company agreed with the Commonwealth to do certain things therein set forth And whereas in pursuance of Clause twelve of the Principal Agreement the Company has entered into an agreement with Marconi's Wireless Telegraph Company Limited (hereinafter called "the Marconi Company") providing for the erection and operation of the stations mentioned in sub-clauses (f) and (g) of Clause 5 of the Principal Agreement which Agreement with the Marconi Company contains guarantees of a nature and to an amount approved of by the Commonwealth's representatives on the Board of Directors of the Company for the provisions of a direct commercial wireless service between Australia and the Stations in the United Kingdom and Canada And whereas at the time of the making of the Principal Agreement the parties thereto believed that the British Government would be ready and willing to grant licenses for the erection and operation of a trunk station and other stations in the United Kingdom for communication with Australia And whereas the British Government refuses to grant licenses for the erection and operation of Commercial Wireless Stations in the United Kingdom with a view to communication with Australia and the Marconi Company is by reason thereof unable to obtain the necessary license to erect or operate the said trunk station in the United Kingdom for that purpose And whereas the Commonwealth is desirous that the Company should (notwithstanding the fact that the Marconi Company is prevented at the present time from providing a main trunk station in the United Kingdom) proceed with the

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COMMONWEALTH — A.W.A. AGREEMENTS—(Continued)

erection of the main trunk station in Australia and has requested the Company to endeavour to arrange with the Marconi Company to proceed with the erection of such station and the Company has agreed to do so provided the Company is relieved from certain obligations under the Principal Agreement **now in consideration of the premises it is hereby agreed** as follows:—

1. This Agreement shall have no force or effect and shall not be binding upon either party unless and until it is approved by the Parliament of the Commonwealth of Australia.

2. This Agreement shall commence and come into full force and effect upon the date upon which it is so approved by the Parliament of the Commonwealth of Austraila.

3. Upon the Company entering into an agreement—

(a) providing to the satisfaction of the Representatives of the Commonwealth on the Board of Directors of the Company for the erection in Australia of a main trunk station capable of providing (as soon as a suitable corresponding station has been erected in the United Kingdom and/or Canada) a commercial wireless service to communicate with such corresponding stations with a traffic capacity as regards each of such corresponding stations of at least twenty-one thousand six hundred (21,600) words per day each way for three hundred (300) days per year at an estimated capital cost not exceeding One hundred and twenty thousand pounds (£120,000).

(b) containing guarantees of such a nature and to such an amount as are approved by the Commonwealth Representatives on the Board of Directors for the erection of the said main trunk station and for its capability to provide the service stipulated in the last preceding paragraph;

the Company shall be relieved from the following obligations under the Principal Agreement, namely:—

(a) Its obligation to arrange for the operation of suitable corresponding stations in the United Kingdom under sub-clause (e) of Clause 5 of the Principal Agreement;

(b) Its obligation under sub-clause (d) of Clause 5 of the Principal Agreement to arrange the rates to be charged for messages between Australia and the United Kingdom transmitted or received by the Company;

(c) Its obligation to provide a main trunk station in the United Kingdom in pursuance of sub-clause (f) of Clause 5 of the Principal Agreement;

(d) Its obligation to arrange for the erection and operation of a station in Canada in accordance with sub-clause (g) of Clause 5 of the Principal Agreement;

(e) Its obligation under Clause 12 of the Principal Agreement to enter into an agreement providing for the erection and operation of stations in the United Kingdom and Canada in pursuance of sub-clauses (f) and (g) of Clause 5 of the Principal Agreement;

(f) Its guarantee referred to in Clause 12 of the Principal Agreement to make provision for a direct commercial wireless service between Australia and the stations in the United Kingdom and Canada hereinbefore referred to.

4. The Company will charge for its part in the transmitting and receiving messages to and from Australia and the United Kingdom not more than one-half of the respective amounts scheduled in paragraph (d) of Clause 5 of the Principal Agreement and will pay to the Postmaster-General such amounts as may be due at standard tariff rates in respect of messages handled by the Post Office.

5. Clause 7 of the Principal Agreement is amended by the substitution of the words "four years" for the words "three years." The valuation of assets provided for in Clause 6 of the Principal Agreement shall be determined before the expiration of the extended term of four years referred to in this paragraph.

6. The Principal Agreement shall be deemed to be amended so as to give effect to the stipulations herein contained and subject thereto to remain in full force and effect.

IN WITNESS whereof the parties hereto have executed these presents the day and year first above-mentioned.

Signed, sealed and delivered by the Right Honorable Stanley Melbourne Bruce, Prime Minister of the Commonwealth of Australia for and on behalf of the said Commonwealth in the presence of— R. R. GARRAN	S. M. Bruce (L.S.)
The Common Seal of Amalgamated Wireless (Australasia) Limited was hereunto affixed by G. Mason Allard and W. T. Appleton two Directors of the Company in the presence of— J. F. WILSON, Secretary.	G. Mason Allard W. T. Appleton (L.S.)

3.
Amendment of 1927.
Act No. 37 of 1927.
THE COMMONWEALTH OF AUSTRALIA WIRELESS AGREEMENT.
No. 37 of 1927.

An Act to approve the Agreement made between His Majesty's Government of the Commonwealth of Australia and Amalgamated Wireless (Australasia) Limited.

(Assented to 22nd December, 1927.)

BE it enacted by the King's Most Excellent Majesty, the Senate, and the House of Representatives of the Commonwealth of Australia as follows:—

1. This Act may be cited as the Wireless Agreement Act, 1927.

2. The Agreement made between His Majesty's Government of the Commonwealth of Australia and Amalgamated Wireless (Australasia) Limited (a copy of which is set forth in the Schedule to this Act) is approved.

3. The Consolidated Revenue Fund is hereby appropriated for the purposes of this Act to the extent necessary for the purpose of carrying out the Agreement on the part of the Commonwealth.

THE SCHEDULE

An Agreement made the fifteenth day of November One thousand nine hundred and twenty-seven between The Commonwealth of Australia (hereinafter called "the Commonwealth") of the one part and Amalgamated Wireless (Australasia) Limited of Sydney in the State of New South Wales (hereinafter called "the Company") of the other part Whereby it is agreed as follows:—

Part 1.—Preliminary.

1. This Agreement shall have no force or effect and shall not be binding upon either party unless and until it is approved by the Parliament of the Commonwealth of Australia.

2. This Agreement shall commence and come into full force and effect upon the date upon which it is so approved by the Parliament of the Commonwealth of Australia.

3. This Agreement shall be read and construed as supplemental to and amending the existing Agreements between the same parties dated the 28th March, 1922 and 20th August, 1924 respectively, and unless the context otherwise requires, as one with the said existing Agreements.

4.—(1.) In this Agreement unless the context otherwise requires—

"Commercial Wireless Services" includes wireless telegraphy, wireless telephony and all further developments of wireless transmission or reception for commercial purposes;

"Post and Telegraph Act" means the **Post and Telegraph Act** 1901-1923, and includes any amendments thereof;

"Principal Agreement" means the Agreement dated the 28th March 1922 made between the parties hereto as amended by the Agreement of the 20th August 1924 between the same parties;

"Wireless Telegraphy Act" means the **Wireless Telegraphy Act** 1905, and includes any amendments thereof;

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COMMONWEALTH — A.W.A. AGREEMENTS—(Continued)

"Wireless telephone broadcasting station" means a station operating under license under the Wireless Telegraphy Act for the purpose of the transmission of speech or music intended for simultaneous reception by all listeners as distinct from point to point communication.

(2). In this Agreement the words "terminal charges," "transit charges" and "land-line charges" have the same meanings respectively as in the International Telegraph Convention and Regulations thereunder and the International Radio-Telegraph Convention and Regulations thereunder.

Part II.—Provisions Relating to Broadcasting and to the Use of Patents

This part of the Agreement was terminated by the Commonwealth Government as from March 1st, 1934.

Part III.—General Provisions

12.—(1.) The Company shall retain all stations taken over by it under Clause 5 (h) of the Principal Agreement (hereinafter referred to as the "said Stations") and shall complete, within three years from the commencement of this Part, the reorganisation of the said stations, including the modernisation of the equipment of the said stations, and shall continue to operate those stations in accordance wtih the Principal Agreement and this Agreement.

(2) In lieu of the method of payment for the said stations which is set out in Clause 6 of the Principal Agreement, the Company shall, on completion of the transfer of the said stations, pay to the Commonwealth the amount of the assets valuation thereof namely the sum of £56,500, the method of payment to be by deduction from payments due by the Commonwealth to the Company.

(3) As from 28th March, 1927, the Commonwealth shall pay to the Company as a contribution towards the maintenance of the said stations an annual subsidy of £45,000 per annum, and the Company shall pay to the Commonwealth thirty per centum of the revenue earned by the Company in the continuance of the services which were carried on by the said stations at the commencement of the Agreement made on the 28th day of March, 1922, between the parties to this Agreement.

(4) For the purposes of the last preceding sub-clause revenue earned by the Company from traffic of a kind which would at the commencement of the Principal Agreement have been carried on by one or more of the said stations, but which is diverted by the Company to another station, shall be deemed to be revenue earned by the Company in the continuance of the services which were carried on by the said stations at the commencement of the Agreement made on the 28th day of March, 1922, between the parties to this Agreement.

(5) The second paragraph of Clause 7 of the Principal Agreement is amended by omitting the words "seven years" and inserting in their stead the words "five years."

13. In operating the stations referred to in the Principal Agreement, and in establishing and operating any new station which may be licensed by the Commonwealth, the Company shall comply with the provisions of any International Radio Convention, International Telegraph Convention, and International Convention for the Safety of Life at Sea, to which the Commonwealth is for the time being a party, and the Wireless Telegraphy Act. In particular, the Company shall comply, as from 28th March, 1926, with the requirements of the Telegraph Convention and the Radio Convention concerning the fixing and the payment to the Commonwealth of terminal or transit or land line charges on all messages received at or despatched from the Company's wireless stations.

14.—(1) Clauses 4 and 13 of the Principal Agreement are hereby defined to mean that the Company is entitled, subject to the terms of the licenses granted or to be granted by the Commonwealth to the Company, and to the provisions of any International Radio Convention, or International Convention for the Safety of Life at Sea to which the Commonwealth is for the time being a party, and to the Wireless Telegraphy Act, to establish and operate commercial wireless services between Australia and ships at sea, between Australia and commercial or private aircraft (except aircraft trading or operating exclusively within Australia), between Australia and any Territory under the authority of the Commonwealth (not being part of the Commonwealth), and between Australia and other countries, and to negotiate and enter into agreements for the conduct of such wireless services, and in such cases the licenses and permits (other than licenses for wireless telephone broadcasting stations and dealers' licenses) shall be free of charge.

(2) Nothing in this clause shall affect the provisions of the Principal Agreement as regards feeder stations or the development and manufacture or sale of wireless apparatus by the Company.

(3) Notwithstanding anything contained in sub-clause (1) of this clause the Commonwealth retains the right to determine whether or not any service which the Company proposes to carry on in addition to the proposed services between Australia and Fiji and any service which is in existence at the date on which this Agreement is approved by the Parliament are necessary in the public interest.

(4) Clause 5 (h) of the Principal Agreement is hereby defined as including an obligation on the Company to transmit and receive all official meteorological messages, and such messages shall in each year be transmitted and received by the Company without charge until the number of words contained in those messages exceeds by five per centum the number of words contained in similar messages transmitted and received by the Company free of charge during the previous year.

(5) Notwithstanding anything in Clause 11 of the Principal Agreement, the fixation of all rates for traffic to be charged by the Company shall be subject to the approval of the Commonwealth.

(6) Clause 15 of the Principal Agreement is hereby defined to mean that the Commonwealth shall not impose any conditions or restrictions of any kind upon the Company which exceed the conditions and requirements of the International Radio Convention, the International Telegraph Convention, the Wireless Telegraphy Act and the Post and Telegraph Act, and no Department of the Commonwealth shall carry on any commercial wireless service in competition with the Company.

(7) Clauses 17 and 18 of the Principal Agreement are to be read and construed as if the words "the Prime Minister" and "The Prime Minister of the Commonwealth" were deleted and the words "the Minister for the time being administering the Wireless Telegraphy Act" were substituted therefor.

(8) Clause 4 of the agreement of 20th August, 1924, between the parties to this Agreement is to be read and construed as if the words "and will pay to the Postmaster-General such amounts as may be due at standard tariff rates in respect of messages handled by the Post Office" were deleted.

15.—(1) The Commonwealth shall, if so requested by the Company, provide for the Company the necessary land line connections for the operation of its wireless stations and shall transmit over the internal communication service of the Commonwealth any overseas messages handed in by the public at any post office or handed over to the Commonwealth by the Company for such transmission and the Company shall pay to the Commonwealth for such lines and such services the usual rates charged by the Commonwealth.

Provided that no charge shall be made to the Company for lines from the Company's coastal stations to the local post office, or, at the Company's option, to the Company's local office, and provided that in all cases where terminal, transit or land line charges are paid to the Commonwealth in accordance with Clause 13 of this Agreement no further charge shall be made for transmission of messages over the internal communication service of the Commonwealth.

(2) In this Clause "overseas messages" means messages received from or intended for transmission to—

(a) a ship; or
(b) a place outside Australia, or
(c) commercial or private aircraft (other than aircraft trading or operating exclusively within Australia).

16.—(1) The Company shall be entitled at all times, subject to the requirements of the Post and Telegraph Act, to accept from and deliver to the public through its own offices and agencies any overseas messages intended for transmission or received for delivery through its commercial wireless services and to relay such messages from one part of the Commonwealth to another through its wireless stations and/or land line connections as it may consider most expedient, and where

(Continued on next page)

COMMONWEALTH — A.W.A. AGREEMENTS— (Continued)

necessary, to a ship at sea, subject to payment of the terminal and/or transit charges, and the Company shall also be entitled to exchange, free of terminal, transit and land line charges, service messages among its wireless stations, but the Company shall not, otherwise than as provided in this Agreement, transmit or receive inland messages unless required by the Commonwealth in cases of interruption to line circuits.

(2) In this Clause—

"Overseas messages" means messages received from, or intended for transmission to—

(a) a ship; or

(b) a place outside Australia; or

(c) commercial or private aircraft (other than aircraft trading or operating exclusively within Australia);

"Service messages" means not only service telegrams as defined in the Regulations under the International Telegraph Convention and in the Regulations under the International Radio Convention, but also includes any messages relating to the general conduct and supervision of the service, and to experimental work carried on by the Company.

17. The Company shall at all times, subject to the conditions of the necessary license, be permitted to conduct research and experimental work for the further development of wireless and to establish and operate wireless stations and apparatus for the purpose of such research and experimental work, provided that the Company shall take all reasonable precautions to avoid interference with other wireless services.

18. (1) All the stations and services licensed in accordance with this Agreement and the Wireless Telegraphy Act shall be subject to inspection by any officer of the Commonwealth thereto authorised in writing by the Minister for the time being administering the Wireless Telegraphy Act, and the Company shall supply to the Commonwealth such particulars of the traffic as the Commonwealth from time to time requires.

(2) Any information obtained by any authorised officer in pursuance of sub-clause (1) of this Clause shall be used only for the purpose of the administration of the Wireless Telegraphy Act, and the Post and Telegraph Act, and this Agreement, or any proceeding relating thereto.

19. In any wireless telephone service licensed by the Commonwealth and established by the Company in accordance with Clause 14 of this Agreement, the Company shall have the same facilities as herein provided for wireless telegraph services, and the Company shall pay the aforesaid terminal and/or transit charges in the case of written messages, and in the case of personal conversation between members of the public the Company shall pay such terminal charges as are fixed by the Commonwealth.

Part IV.—Other Provisions

20. Clause 20 of the Principal Agreement shall apply in like manner in relation to any disagreement arising between the Commonwealth and the Company under this Agreement as it applies in relation to disagreements arising under the Principal Agreement.

21. All rights granted to the Commonwealth or to any broadcasting station, broadcast listener, radio dealer, manufacturer, or newspaper, under Part II. of this Agreement shall cease immediately upon the termination of that Part, and the Company shall thereafter be at liberty to demand royalties from all users of patent rights of the Company and to institute and carry on proceedings to prevent infringement of the patents.

Provided that no demand shall be made or proceedings instituted in respect of any use of the patents which occurs during the currency of Part II. of this Agreement and is in accordance with that Part.

22. Nothing in this Agreement shall be construed to prevent the Company establishing and carrying on any other wireless service under license from the Commonwealth.

23. The Company agrees that it will not, without the consent of the Commonwealth, appoint to or engage for its service any person who is not a natural born British subject, and that it will use its best endeavours to induce all its present and future officers and employees to become members of the Reserve branch of the Defence Force.

In witness whereof the parties hereto have executed these presents the day and year first abovementioned.

Signed, Sealed and Delivered by the Right Honourable Stanley Melbourne Bruce, Prime Minister of the Commonwealth of Australia, for and on behalf of the said Commonwealth in the presence of GEO. S. KNOWLES. — S. M. BRUCE (L.S.)

The Common Seal Amalgamated Wireless (Australasia) Limited was hereunto affixed by Sir George Mason Allard and Ernest E. Fisk, two directors of the Company, in the presence of J. F. WILSON. — G. MASON ALLARD, E. T. FISK (L.S.)

4.

APPENDIX.

Canberra, F.C.T.,
14th November, 1927.

Sir,—

I am directed by the Prime Minister to forward with a view to its execution by your Company, the enclosed agreement (in duplicate) which has been negotiated between representatives of the Commonwealth and of your Company, and has been executed by the Prime Minister on behalf of the Commonwealth.

It is understood that this agreement is executed upon the basis that, concurrently with the execution of the agreement, your Company will, as already verbally agreed, forward to the Prime Minister:—

(a) a letter, under the seal of the Company—

(i) confirming the statement made by the representative of your Company, that your Company has the right, for at least the next ten years, to use, and to grant licenses and/or sub-licenses to use, all present and future patents of the principal Radio Company operating in each of the following countries, namely, Great Britain, the United States of America, France, and Germany, and

(ii) setting out the names of each such principal Radio Company; and

(b) a letter, under the seal of the Company, confirming the undertaking given by the representative of your Company, for the continuance of the arrangement now in force whereby your Company handles free of charge to the Postmaster-General's Department telegrams between stations of the Company in cases of interruption to land line services in return for the Postmaster-General's Department handling service messages of your Company free of charge.

I have the honour to be, Sir,
Your obedient servant,
(Sgd.) P. E. DEANE, Secretary.

E. T. Fisk, Esq.,
Managing Director,
Amalgamated Wireless (Australasia) Ltd.,
Wireless House,
York Street, Sydney.

S.1334 Amalgamated Wireless (Australasia) Limited,
Wireless House,
97 Clarence Street,
Sydney.
15th November, 1927.

The Right Honorable, the Prime Minister,
Commonwealth of Australia,
Canberra, Federal Capital Territory.

Sir,

We desire to inform you that this Company has the right, during the whole period of the Company's existence, to an exclusive and perpetual license to use the whole or any of the inventions the subject of the letters patent and other rights of Marconi's Wireless Telegraph Company Limited of London, for

(Continued on next page)

COMMONWEALTH — A.W.A. AGREEMENTS— (Continued)

wireless telegraphy, wireless telephony and wireless signalling by means of electrical waves, including the right to grant sub-licenses.

This Company also has the right, during the whole period of the Company's existence to an exclusive and perpetual license to use the whole or any of the inventions the subject of the letters patent and other rights of Gesellschaft fur Drahtlose Telegraphie mit beschrankter haftung (otherwise known as the Telefunken Company) of Germany, for wireless telegraphy, wireless telephony and wireless signalling by means of electrical waves, including the right to grant sub-licenses.

This Company also has the exclusive right, for more than ten years from the present date, to use in Australia all wireless patents of the Radio Corporation of America, together with the right to grant sub-licenses.

The common seal of Amalgamated Wireless (Australasia) Limited was hereunto affixed by Chas. P. Bartholomew and E. T. Fisk, two directors of the Company, by order of the Board, in the presence of (Sgd.) J. F. WILSON, Secretary. — (Sgd.) CHAS. P. BARTHOLOMEW, E. T. FISK

S.1332 Amalgamated Wireless (Australasia) Limited,
Wireless House,
47 York Street,
Sydney.
15th November, 1927.

The Right Honorable, the Prime Minister,
Commonwealth of Australia,
Canberra, Federal Capital Territory.

Sir,

We desire to inform you that we are prepared to continue the arrangement at present existing between this Company and the Postmaster-General, under which the Company handles post office inland traffic through certain of its wireless telegraph stations in the event of breakdown of land lines, and, in turn, the Company enjoys the privileges of sending service messages over the Post Office lines free of charge.

2. We agree that the arrangement shall continue on its present lines indefinitely so long as it operates with equity to both parties.

AMALGAMATED WIRELESS (AUSTRALASIA) LIMITED

The common seal of Amalgamated Wireless (Australasia) Limited was hereunto affixed by Chas. P. Bartholomew and E. T. Fisk, two directors of the Company, by order of the Board, in the presence of (Sgd.) J. F. WILSON, Secretary. — (Sgd.) CHAS. P. BARTHOLOMEW, E. T. FISK

Third Annual Report of the Australian Broadcasting Commission

YEAR ENDED 30th JUNE, 1935

To The Honourable,
His Majesty's Postmaster-General to the Commonwealth of Australia

Sir:

In accordance with the provisions of Section 32 of the Australian Broadcasting Commission Act, 1932, we have the honour to present to you the Third Annual Report of the Australian Broadcasting Commission and to inform you that during the twelve months extending from 1st July, 1934 to 30th June, 1935, the Commission continued to provide and to render broadcast programmes from the A Class Australian National Broadcasting Stations, and to discharge all the other duties assigned to it by the abovementioned Act. The stations operating were those which were taken over by the Commission at its inception on 1st July, 1932, viz.:

Stations 2FC, Sydney; 2BL, Sydney; 2NC, Newcastle; 2CO, Corowa; 3LO, Melbourne; 3AR, Melbourne; 4QG, Brisbane; 4RK, Rockhampton; 5CL, Adelaide; 5CK, Crystal Brook; 6WF, Perth; and 7ZL Hobart. Since the close of the period under review two new regional stations, 7NT North Regional, Tasmania, and 3GI, Gippsland Regional, Victoria, have been made available for the transmission of the Commission's programmes. It is expected that six more will be in operation during the next twelve months.

LICENSES

(a) Australian Statistics:

We are glad to be able to report that public interest in broadcasting, as evidenced by the number of listeners licenses held by residents of the Commonwealth, has continued to increase rapidly.

High Rate of Increase

In the preceding twelve months (i.e., ended 30th June 1934) the increase in licenses was greater than in any previous year. This progress has been very nearly maintained, and the year 1934-35 saw the second highest license increase in the history of Australian broadcasting. The respective increases were 129,682 for the year ended 30th June, 1934, and 122,693 for the year ended 30th June, 1935. The total number of listeners licenses held in Australia was, at 30th June, 1935: 721,852, or 10.74% of the population of the Commonwealth—a percentage double that of three years ago, when the Commission was formed.

Increase in Various States

Further, the rate of increase has been comparatively evenly maintained in all States, and in both city and country in each State; West Australia advancing by 2.14% of population; South Australia by 2.03%; New South Wales by 1.87%; Tasmania by 1.62%; Victoria by 1.54% and Queensland by 1.52%—an average of 1.74% for the whole of Australia. Since the Commission's last report was furnished, South Australia has replaced Victoria as the State with the highest proportion of licenses to population; its percentage now being 12.97% as compared with 12.90% for Victoria. New South Wales has continued to make good progress; and has the highest number of license-holders in the Commonwealth, as well as the third highest percentage—10.53%. Western Australia and Tasmania both maintained well their rate of improvement. Queensland, with 7.02%, has the lowest percentage, but a good rate of increase has been maintained over the last two years, in marked contrast with the six years immediately preceding.

The Commission, while recognising that various influences may have contributed towards the high rate of license-increase which has been maintained, draws attention to the above figures as indisputable evidence of the increasing popularity of broadcasting, of the part which it is playing in the everyday life of the community; and of its potential influence upon the mental and cultural development of the people of the Commonwealth.

The following comparative table gives a record of the development of broadcasting in Australia since transmitting licenses were first issued in 1924-25:

NEW SOUTH WALES

Year Ended 30th June	Licenses in Force	Ratio to 100 of Population	Increase (—Decrease) Number	Increase (—Decrease) Per 100 of Population	Organisation Supplying Programmes.
1925	34,857	1.54	—	—	Broadcasters (Sydney) Ltd.—Farmer and Company Ltd.
1926	37,082	1.61	2,225	.07	Broadcasters (Sydney) Ltd.—Farmer and Company Ltd.
1927	59,880	2.55	22,798	.94	Broadcasters (Sydney) Ltd.—Farmer and Company Ltd.
1928	80,197	3.34	20,317	.79	Broadcasters (Sydney) Ltd.—Farmer & Company Ltd.—2FC Ltd. (a)
1929	101,012	4.13	20,815	.79	Broadcasters (Sydney) Ltd. — 2FC Ltd.—N.S.W. Broadcasting Co. Ltd. (b)
1930	111,253	4.49	10,241	.36	N.S.W. Broadcasting Co. Ltd.—Australian Broadcasting Co. Ltd. (c)
1931	122,748	4.91	11,495	.42	Australian Broadcasting Co. Ltd.
1932	141,745	5.63	18,997	.72	Australian Broadcasting Co. Ltd.
1933	178,387	7	36,642	1.37	Australian Broadcasting Commission.
1934	227,289	8.66	48,902	1.86	Australian Broadcasting Commission.
1935	279,166	10.53	51,877	1.87	Australian Broadcasting Commission.

Notes:
(a) 2FC Limited (Station 2FC) from 1/12/27.
(b) N.S.W. Broadcasting Co. Ltd. (Stations 2FC and 2BL) from 14/8/28.
(c) Australian Broadcasting Co. Ltd. (Station 2FC) from 16/7/29. (Station 2BL) from 21/7/29.

VICTORIA

Year Ended 30th June	Licenses in Force	Ratio to 100 of Population	Increase (—Decrease) Number	Increase (—Decrease) Per 100 of Population	Organisation Supplying Programmes.
1925	20,290	1.22	—	—	Associated Radio Co.—Broadcasting Co. of Australia.
1926	64,587	3.83	44,297	2.61	Associated Radio Co.—Broadcasting Co. of Australia Pty. Ltd.
1927	118,965	6.95	54,378	3.12	Associated Radio Co.—Broadcasting Co. of Australia Pty. Ltd.
1928	137,758	7.91	18,793	.96	Associated Radio Co.—Broadcasting Co. of Australia Pty. Ltd.—Dominion Broadcasting Co. Ltd. (d)

A.B.C. THIRD ANNUAL REPORT—(Continued)

Year Ended 30th June	Licenses in Force	Ratio to 100 of Population	Increase (—Decrease) Number	Increase (—Decrease) Per 100 of Population	Organisation Supplying Programmes.
1929	142,750	8.11	4,992	.2	Dominion Broadcasting Co. Ltd.
1930	140,072	7.88	—2,678	—.23	Dominion Broadcasting Co. Ltd.—Australian Broadcasting Co. Ltd. (e)
1931	137,265	7.66	—2,807	—.22	Australian Broadcasting Co. Ltd.
1932	139,592	7.75	2,327	.09	Australian Broadcasting Co. Ltd.
1933	171,318	9.46	31,726	1.71	Australian Broadcasting Commission.
1934	207,324	11.36	36,006	1.97	Australian Broadcasting Commission.
1935	237,247	12.90	29,923	1.54	Australian Broadcasting Commission.

Notes:
(d) Dominion Broadcasting Co. Ltd. (Stations 3LO and 3AR) from 1/3/28.
(e) Australian Broadcasting Co. Ltd. (Station 3LO) from 21/7/29. (Station 3AR) from 7/8/29.

QUEENSLAND

Year Ended 30th June	Licenses in Force	Ratio to 100 of Population	Increase (—Decrease) Number	Increase (—Decrease) Per 100 of Population	Organisation Supplying Programmes.
1925	1,267	.15	—	—	Queensland Radio Service.
1926	8,450	.98	7,183	.83	Queensland Radio Service.
1927	23,249	2.63	14,799	1.65	Queensland Radio Service.
1928	25,287	2.82	2,038	.19	Queensland Radio Service.
1929	24,744	2.7	—543	—.12	Queensland Radio Service.
1930	23,335	2.51	—1,409	—.19	Queensland Radio Service.—Australian Broadcasting Co. Ltd. (f)
1931	24,216	2.55	881	.04	Australian Broadcasting Co. Ltd.
1932	29,060	3.02	4,844	.47	Australian Broadcasting Co. Ltd.
1933	36,314	3.72	7,254	.7	Australian Broadcasting Commission.
1934	52,185	5.5	15,871	1.67	Australian Broadcasting Commission.
1935	67,546	7.02	15,361	1.52	Australian Broadcasting Commission.

Note: (f) Australian Broadcasting Co. Ltd. from 29/1/30.

SOUTH AUSTRALIA

Year Ended 30th June	Licenses in Force	Ratio to 100 of Population	Increase (—Decrease) Number	Increase (—Decrease) Per 100 of Population	Organisation Supplying Programmes.
1925	3,331	.62	—	—	Central Broadcasters Ltd.
1926	12,657	2.27	9,326	1.65	Central Broadcasters Ltd.
1927	16,791	2.96	4,134	.69	Central Broadcasters Ltd.
1928	20,319	3.53	3,528	.57	Central Broadcasters Ltd.
1929	24,021	4.15	3,702	.62	Central Broadcasters Ltd.
1930	25,729	4.43	1,708	.28	Central Broadcasters Ltd. — Australian Broadcasting Co. Ltd. (g)
1931	30,333	5.21	4,604	.78	Australian Broadcasting Co. Ltd.
1932	37,235	6.36	6,902	1.15	Australian Broadcasting Co. Ltd.
1933	50,261	8.49	13,026	2.13	Australian Broadcasting Commission.
1934	64,303	10.49	14,042	2.39	Australian Broadcasting Commission.
1935	76,515	12.97	12,212	2.03	Australian Broadcasting Commission.

Note: (g) Australian Broadcasting Co. Ltd. from 13/1/30.

WESTERN AUSTRALIA

Year Ended 30th June	Licenses in Force	Ratio to 100 of Population	Increase (—Decrease) Number	Increase (—Decrease) Per 100 of Population	Organisation Supplying Programmes.
1925	3,562	.97	—	—	Westralian Farmers Ltd.
1926	4,000	1.07	438	.1	Westralian Farmers Ltd.
1927	3,903	1.03	—97	—.04	Westralian Farmers Ltd.
1928	3,774	.96	—129	—.07	Westralian Farmers Ltd.
1929	3,890	.96	116	—	Westralian Farmers Ltd. — Postmaster-General's Department (h)
1930	5,755	1.38	1,875	.42	Postmaster-General's Department — Australian Broadcasting Co. Ltd. (i)
1931	9,144	2.17	3,389	.79	Australian Broadcasting Co. Ltd.
1932	12,746	3.02	3,602	.85	Australian Broadcasting Co. Ltd.
1933	20,604	4.87	7,858	1.85	Australian Broadcasting Commission.
1934	31,476	7.15	10,872	2.47	Australian Broadcasting Commission.
1935	41,257	9.29	9,781	2.14	Australian Broadcasting Commission.

Notes:
(h) Postmaster-General's Department from 20/12/28.
(i) Australian Broadcasting Co. Ltd. from 21/7/29.

TASMANIA

Year Ended 30th June	Licenses in Force	Ratio to 100 of Population	Increase (—Decrease) Number	Increase (—Decrease) Per 100 of Population	Organisation Supplying Programmes.
1925	567	.26	—	—	
1926	1,281	.58	714	.32	Associated Radio Co.
1927	2,461	1.14	1,180	.56	Associated Radio Co.
1928	3,172	1.46	711	.32	Associated Radio Co. — Tasmanian Broadcasters Pty Ltd. (j)
1929	4,782	2.21	1,610	.75	Tasmanian Broadcasters Pty. Ltd.
1930	8,048	2.76	1,266	.55	Tasmanian Broadcasters Pty. Ltd.
1931	8,263	3.74	2,215	.98	Tasmanian Broadcasters Pty. Ltd.—Australian Broadcasting Co. Ltd.

(Continued on next page)

(b) World Statistics:

The subjoined table shows how striking has been the growth of interest in broadcasting throughout the civilised world, and also how well Australia has kept pace with this development, ranking sixth, in proportion of listeners to population, among all nations, second in the British Empire, and first among the Dominions.

The figures have been supplied by L'Union Internationale de Radiodiffusion, and relate to 31st December, 1934; the leading "listening" nations being placed in order of precedence according to proportion of licenses (or their equivalent) to population:

WORLD LICENSE DISTRIBUTION.—

(Continued—see page 44)—

Newfoundland (264,000—2,632) .996; Spain (23,677,794—23,004) .899; Lithuania (2,476,154—20,240) .817; Salvador (1,550,000 — 10,000) .645; Palestine (1,035,000 — 5,900) .57; Roumania (18,052,896 — 100,981); .559; Hongkong (849,751 — 4,201) .494; Yugoslavia (13,934 — 66,530) .477; Algeria (6,553,451 — 30,904) .471; Portugal (6,825,883 — 27,895) .408; Morocco (4,681,194 — 18,267) .39; Tunia (2,410,692 — 8,1063 .336; Siam (12,000,000 — 24,202) .201; Honduras (854,184 — 1,500) .175; Egypt (14,500,000 — 251,170) .173; Bulgaria (6,081,049 — 9,000) .148; Phillipines (14,158,000 — 20,929) .147; Guatemala (2,195,242 — 1,958) .089; Federated Malay States (2,827,111 — 2,526) .089; Greece (6,204,820 — 5,000) .08; Syria and the Levant (2,768,000 — 2,070) .074; Turkey (13,660,275 — 6,930) .05; Ceylon (5,312,548 — 2,342) .05; Manchuria (32,377,317 — 12,384) .038; Kenya (3,106,945 — 1,152) .037; Dutch East Indies (60,731,025 — 17,950) .029; Madagascar) 3,779,569 — 269) .007.

PROGRAMME ANALYSIS:

The following percentage analysis of all programmes broadcast by the Commission during the year—a total of no fewer than 53,927 programme-hours—reveals little change from that of the preceding year. Music—including opera, musical comedy, and vaudeville—occupied slightly more than half of the total broadcasting time, as in earlier years. The reduction in the percentage-time occupied by plays was due not to a reduction in number, but rather to a shortening of the plays. Lectures, descriptive broadcasts, and essential services, occupied a higher percentage-time than in the preceding twelve months.

The details are:

Item	Percentage of Total Programme Time.	
MUSICAL:		
Classical	11.61%	
Popular	29.48%	
Modern Dance	5.78%	
Old Time Dance	.36%	
Community Singing	1.42%	
		48.65%

A.B.C. THIRD ANNUAL REPORT—(Continued)

Year Ended 30th June	Licenses in Force	Ratio to 100 of Population	Increase (—Decrease) Number	Per 100 of Population	Organisation Supplying Programmes.
					(k)
1932	9,567	4.28	1,304	.54	Australian Broadcasting Co. Ltd.
1933	12,593	5.59	3,026	1.31	Australian Broadcasting Commission.
1934	16,582	7.14	3,989	1.71	Australian Broadcasting Commission.
1935	20,121	8.76	3,539	1.62	Australian Broadcasting Commission.

Notes :
(j) Tasmanian Broadcasters Pty. Ltd. from 19/7/27.
(k) Australian Broadcasting Co. Ltd. from 13/12/30.

COMMONWEALTH OF AUSTRALIA

Year Ended 30th June	Licenses in Force	Ratio to 100 of Population	Increase (—Decrease) Number	Per 100 of popul'n
1925	63,874	1.08	—	—
1926	128,060	2.14	64,186	1.06
1927	225,249	3.68	97,189	1.54
1928	270,507	4.33	45,258	.65
1929	301,199	4.75	30,692	.42
1930	312,192	4.88	10,993	.13
1931	331,969	5.12	19,777	.24
1932	369,945	5.67	37,976	.55
1933	469,477	7.14	99,532	1.47
1934	599,159	9.00	129,682	1.95
1935	721,852	10.74	122,693	1.74

Educational Broadcasts:

Much of the Commission's work, in all branches of its activities, is of an educational nature; but, apart from this, direct educational work has been done by means of a large number of broadcasts to schools. During the year this service was considerably expanded, until all States, except Tasmania, were broadcasting lectures of this type—the intention being, as before, to supplement, but not to replace, the class work of the school teachers. The broadcast lessons have been divided into two general classes, primary and secondary.

The Commission's problems in connection with School Broadcasting are complicated by the fact that education in Australia is under State, not Commonwealth, control; the resulting divergencies in school curricula and requirements for public examinations have rendered it desirable for each State Branch to arrange its own syllabus of broadcasts. Again, the fact that in the majority of capital cities there is only one National transmitting Station has made it extremely difficult for the Commission to devote as much time as it would have liked to this type of broadcast; the result has been that in New South Wales and Victoria considerably more time has been allocated to broadcast lessons than has been possible in Queensland, South Australia and Western Australia. Another disadvantage, which fortunately will soon be removed with the completion of new country relay stations, has arisen through the unsatisfactory nature of daylight reception in the more remote parts of the country (where the lessons would be of great value), and the consequent necessity of purchasing expensive receiving sets, the cost of which is often beyond the resources of small country schools.

In spite of these obstacles, the Commission devoted approximately thirteen hours each week to School Broadcasts, and in the course of that time dealt with such diverse subjects as English Language and Literature, Health, Musical Appreciation, Geography, English History, Australian History, Ancient History, European History, Nature Study, Science,

WORLD LICENSE DISTRIBUTION As at 31st December, 1934

Country	Population	Total	Population Per 100 of Licenses
1. U. S. of America	127,900,000	20,750,000*	16.223
2. Denmark	3,550,000	568,175	16.
3. Great Britain	46,047,046	6,780,569	14.725
4. Sweden	6,211,566	733,190	11.803
5. Netherlands	8,351,117	909,127	10.886
6. Australia	6,689,719	681,634	10.189
7. New Zealand	1,551,785	148,284	9.555
8. Germany	65,188,626	6,142,921	9.422
9. Iceland	115,000	10,350	9.
10. Switzerland	4,066,400	356,865	8.775
11. Canada	10,353,778	813,000	7.852
12. Austria	6,760,000	527,295	7.8
13. Belgium	8,213,449	603,860	7.352
14. Danzig	414,114	26,462	6.39
15. Norway	2,870,000	157,434	5.485
16. South Africa	1,828,175	98,562	5.485
17. Czecho-Slovakia .	14,726,158	693,694	4.71
18. Chili	4,287,445	200,000*	4.664
19. Luxembourg	299,993	13,750	4.583
20. France	41,834,923	1,755,946	4.197
21. Argentine	12,025,000	500,000	4.158
22. Hungary	8,688,319	340,117	3.914
23. Cuba	4,000,000	150,000*	3.75
24. Finland	3,697,505	129,123	3.492
25. Latvia	1,900,045	64,567	3.397
26. Mexico	16,552,722	500,000*	3.02
27. Japan	90,395,041	1,951,858	2.159
28. Ireland	3,000,000	60,000	2.
29. Esthonia	1,113,647	16,827	1.51
30. Bolivia	3,500,000	50,000*	1.428
31. U.S.S.R.	168,000,000	2,323,000	1.382
32. Poland	32,133,000	374,000	1.163
33. Italy	42,621,000	430,000	1.008

* Listeners are not licensed, and the totals shown are estimates of the number of receiving sets in operation.

Item	Percentage of Total Programme Time	
DRAMA:		
Grand Opera	1.83%	
Musical Comedy, etc.	2.34%	
Plays	1.74%	
		5.91%
LECTURES, Etc.:		
General, Speeches Stories	8.16%	
Technical, Farming, etc.	1.35%	
Broadcasts to Schools	1.60%	
Descriptive Broadcasts	1.45%	
		12.56%
SPORT:		
Running Descriptions	5.89%	
Commentaries, Results, etc.	4.9%	
		10.79%
ESSENTIAL SERVICES:		
News, etc.	4.69%	
Reports (Weather, Markets, etc.)	6.13%	
Announcements	1.98%	
		12.8%
DEVOTIONAL:		
Church Services	3.54%	
Studio Broadcasts	1.47%	
		5.01%
CHILDREN'S SESSIONS	4.28%	
Total		100%

A.B.C. 3rd ANNUAL REPORT—(Continued)

Mathematics, French Language and Literature, Civics and Current Topics, Speech Training, Business Methods, and Simple Anatomy. The introduction of mathematics was an experiment which proved unexpectedly successful, although its treatment requires very close co-operation between broadcasters and students. The Commission printed and distributed some twelve thousand booklets setting out the syllabus followed in each subject.

The value of this aspect of the Commission's work may best be gauged from the fact that no fewer than 800 schools listen regularly to the programmes, in addition to some six hundred pupils who live in such remote parts of Australia that they have to be educated by means of correspondence courses. Our service to these correspondence-taught children is a particularly romantic aspect of the Commission's activities, and there is evidence that the broadcast lessons are of great value to children so situated. In New South Wales one half-hour period each week is devoted to talks for the correspondence pupils, and Victoria will be introducing special talks in the first term of 1936.

The Commission takes this opportunity of expressing its appreciation of the ready help and co-operation of the Education Department in each State, and of the schools and other educational authorities who have assisted in the work. It wishes also to express its special appreciation of the services of the members of the honorary Advisory Committees, who have done such splendid work in helping to compile the several courses of broadcast lessons.

Descriptive Broadcasts:

The past year was a particularly favourable period for descriptive broadcasts. Events such as the visit to Australia of His Royal Highness the Duke of Gloucester, the England-Australia Air Race, and the many other public functions, congresses, pageants and demonstrations associated with the celebration of the Victorian Centenary lent themselves to this form of treatment. Expert descriptors brought home to the listening public throughout Australia not only the atmosphere and excitement of the scenes, but also the deeper significance of these important events. Especial reference should be made to the broadcasting of the dedication by His Royal Highness the Duke of Gloucester of the Shrine of Remembrance (the Melbourne War Memorial), of the Anzac Memorial, Hyde Park, Sydney, and to the broadcasting of the Dawn Service held at the Cenotaph in Sydney on Anzac Day.

The broadcasting of the progress of the great International Air Race presented difficulties of a type not previously encountered, but careful organisation enabled most of these difficulties to be satisfactorily surmounted, and there was every indication of public appreciation of the success achieved. The Commission also records with pleasure the initiative of its representative at Albury, who, by broadcasting instructions to the crew of the 'plane, contributed to the safe night landing at that town of one of the leading competitors in the race, the Dutch air-liner piloted by Messrs. Parmentier and Moll. The broadcast associated with this particular incident will be remembered as one of the most dramatic in the history of broadcasting in this country.

The Commission has also arranged descriptive broadcasts from factories and works, coal mines, dairy farms, timber mills, and vineyards, indicating the methods employed in the principal Australian industries. This work, apart from the heightened entertainment and interest arising from the local colour introduced, has definitely served a useful educative purpose.

A comprehensive sporting service, including running descriptions, general commentaries and detailed results, has been maintained in connection with all leading sporting events in Australia, and to some extent, in other parts of the world. The "ball-by-ball" method of broadcasting the Test Cricket Matches played in England was detailed in the last Annual Report and is still remembered as one of the most popular broadcasting features introduced by the Commission. Similar methods will be adopted for the broadcasting of the Test Matches shortly to be played in South Africa. The All-England Lawn Tennis Championship Singles Semi-final between the Australian representative, Mr. J. H. Crawford, and the previous champion, Mr. F. J. Perry, was also described to listeners in the same way; a comprehensive cable service enabling a complete description of the play to be broadcast as from Wimbledon itself.

A number of actual running descriptions of overseas sporting events, including the English Derby and Grand National horse-races, the Oxford-Cambridge Boat Race and the English Association Football Cup Final, were received on short-wave from the British Broadcasting Corporation's Empire Station and re-transmitted for the benefit of listeners in Australia.

ESSENTIAL SERVICES:

Full services designed to be of special value to listeners in more remote parts of the country, including news services, both local and cable (arranged by contract with the newspapers), and reports covering live stock and produce markets, weather data, rainfalls, river gaugings, stock exchanges and news of a similar nature, were maintained throughout the year, and special S.O.S. messages from the police and other public authorities were broadcast whenever required.

DEVOTIONAL:

By arrangements with various churches, religious services were broadcast every Sunday and on other sacred days, and, in addition, proceedings and descriptions of processions and functions of the Eucharistic Congress and the All-Australian Anglican Assembly were transmitted from Melbourne during the Centenary Celebrations.

WOMEN'S SESSIONS:

Items of special interest to women were given a regular place in the programmes, at appropriate times each day, and the relevant mail showed that they were widely appreciated.

CHILDREN'S SESSIONS:

During the year innovations were made in connection with Children's Sessions. The most popular of these has proved to be the dramatising of stories in such a way as to commend them to the younger listeners. Competitions and other similar activities in which children could participate have helped to maintain and enlarge the interest of listeners in these sessions.

COMMUNITY SINGING:

Community Singing Concerts, regularly arranged and broadcast in all States, were again well attended, and, as will be noted later herein, were a source of substantial revenue to charities.

B.B.C. RECORDED PROGRAMMES:

By arrangement with the British Broadcasting Corporation the Commission broadcast a series of recorded features of the Corporation's programmes. Apart from their purely entertainment or educational value, these records enabled the Australian listener to familiarise himself with the work of the B.B.C. Production Department, to follow descriptions of outstanding overseas events, and to hear not only the views but also the voices of leading English men and women.

SHORT-WAVE BROADCASTING:

A number of short-wave transmissions received from overseas were converted to the wave-length of Australian stations and re-broadcast here. The majority came from the British Broadcasting Corporation; notable among them being addresses to his subjects by His Majesty the King, both at Christmas and during the celebrations of the Silver Jubilee Anniversary of Their Majesties' accession to the throne, the description of the wedding of His Royal Highness the Duke of Kent to Princess Marina in Westminster Abbey, and the launching of the "Queen Mary" by Her Majesty. Messages from many other parts of the world were also clearly re-transmitted, and helped substantially to enrich the programmes. In addition, the Commission itself arranged for talks by prominent men and women overseas to be given per radio telephone especially for Australian listeners; the talk between Sir Harrison Moore (whose subsequent death we regret to record) and the Secretary-General of the League of Nations, Mr. Avenol, from Geneva, on 17th June, 1935, being worthy of special mention.

The Commission has been glad to make some small return for this assistance by contributing programmes regularly to short wave station 3LR, Lyndhurst (Victoria), and occasionally, by arrangement with Amalgamated Wireless (Australasia)

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A.B.C. 3rd ANNUAL REPORT—(Continued)

Limited, to the short wave stations VK2ME (New South Wales) and VK3ME (Victoria). A contribution to the British Broadcasting Corporation's Empire programmes has been made by the arranging, by radio telephone, of broadcasts of special overseas interest.

ARTISTS:

The Commission continued its policy of providing, whenever possible, employment for local artists, not only because of the intrinsic value of their performances, but also in the hope of discovering and developing artistic talent among Australians and of fostering among listeners generally a liking for, and pride in, the musical, dramatic and literary output of their own country. In all, during the year, there were no fewer than 38,115 local performers engaged on the Commission's programmes. This compares with 26,472 engagements in 1933-34 and 20,099 in 1932-33.

RECORDINGS:

A natural corollary of the increasing employment of artists has been a reduction in the time allotted to recorded broadcasts. These occupied, during the past year, only 37.54% of total programme-time. This proportion is substantially lower than in previous years.

PUBLICATIONS:

Copies of selected addresses having some special interest have been printed and made available free of charge to listeners.

EXHIBITIONS:

The Commission has continued its policy of co-operating with the Radio Trade by supporting public exhibitions which the latter had arranged. This has been done in all States, with good results.

CHARITIES:

The Commission was able, in the course of its work, to give valuable assistance to many public charitable organisations and institutions. Its community singing concerts, boys' clubs entertainments, old time dances, and birthday "calls," resulted in the collection of more than £9,450, included in which was a sum of £3,551 devoted to the relieving of distress arising out of the disastrous floods at Port Pirie. Much indirect assistance was also given to deserving causes by the broadcasting of appeals and similar announcements.

ACCOMMODATION:

The studios at Adelaide have been completely remodelled; premises have been secured in Launceston for studios to serve the new Station 7NT, North Regional, Tasmania*; and plans for studios in both Hobart and Perth are approaching finalisation. Accommodation will be required also in country centres to serve the new Regional Stations which are now being built or will be built in the near future.

* Opened 3rd August, 1935.

The greatest liability facing the Commission, however, is in respect of new studios in both Sydney and Melbourne, where operations are being carried on at present under great disadvantages in leased premises. It is hoped that negotiations, which are now in hand for suitable building sites, will shortly be completed.

In anticipation of the heavy financial commitments which will be involved in the purchase of land and the erection of buildings, the Commission has set aside substantial reserves from its revenue during the past three years as will be seen from the accompanying accounts. This has been done in preference to relying wholly, or even substantially, upon borrowed capital; the Commission's object being to ease the burden of interest charges during future years, when the cost of programmes will grow out of proportion to the increase in revenue. Although the rate of license-increase has been very satisfactory, and has exceeded all expectations, it must be recognised that saturation-point will one day be reached; but the demand for improved services will not slacken, even though revenue should become stationary.

EXTENT OF SERVICE:

During the year the extent of the Commission's service remained unchanged in respect of both the number and the power of the National Stations. The well-maintained rate of license-increase is therefore all the more gratifying. There was, however, a considerable extension of broadcasting hours, which have now been standardised on the following basis:

BROADCASTING HOURS:

4QG, 4RK, 5CL, 5CK, 6WF, 7ZL:

Mondays to Fridays

7 a.m. to 9 a.m.
10.30 a.m. to 2 p.m.
3 p.m. to 4.30 p.m.
5.30 p.m. to 11.30 p.m.

Saturdays

7 a.m. to 8.30 a.m.
11 a.m. to 11.30 p.m.

Sundays

10.30 a.m. to 1.30 p.m.
(4QG and 4RK 10 a.m. to 1.30 p.m.)
3 p.m. to 5 p.m.
(6WF 5.20 p.m.)
5.45 p.m. to 10.30 p.m.

2FC and 3LO:

Mondays to Fridays

7 a.m. to 8 a.m.
9.30 a.m. to 11.30 a.m.
12 noon to 2 p.m.
3 p.m. to 4.15 p.m.
5.30 p.m. to 11.30 p.m.

Saturdays

7 a.m. to 8 a.m.
9.30 a.m. to 11.30 a.m.
12 noon to 5 p.m.
5.30 p.m. to 11.30 p.m.

Sundays

10 a.m. to 12.15 p.m.
3 p.m. to 4.45 p.m.
6 p.m. to 10.30 p.m.

2BL and 3AR:

Mondays to Fridays

7 a.m. to 9.30 a.m.
(3AR 9.35 a.m.)
11.30 a.m. to 5.30 p.m.
6 p.m. to 10.30 p.m.

Saturdays

7 a.m. to 9.30 a.m.
11.30 a.m. to 5.30 p.m.
6 p.m. to 12 midnight.

Sundays

10.55 a.m. to 3 p.m.
4.30 p.m. to 10 p.m.

2CO and 2NC:

Mondays to Fridays

7 a.m. to 11.30 a.m.
12 noon to 2 p.m.
3 p.m. to 4.15 p.m.
5.30 p.m. to 11.30 p.m.

Saturdays

7 a.m. to 9 a.m.
10 a.m. to 11.30 a.m.
12 noon to 5 p.m.
5.30 p.m. to 11.30 p.m.

Sundays

10 a.m. to 12.15 p.m.
1 p.m. to 4.45 p.m.
6 p.m. to 10.30 p.m.

N.B.—When races are being broadcast on Wednesday afternoons through 4QG, 4RK, 5CL, 5CK and 6WF, the following variations of the schedule will be noted:

5CL } 5CK } 2 p.m. to 5.10 p.m.
4QG } 4RK } 2 p.m. to 5 p.m.
6WF—2.30 p.m. to 5.10 p.m.

FINANCE:

The appended financial statements will show that the Commission's financial position has improved greatly during the twelve months which ended on 30th June, 1935. In the past, the heavy capital expenditure associated with the initiation of such extensive activities as those of the National Broadcasting Service necessitated a policy of rigid economy, and the effect of that policy is revealed in the Balance Sheet now submitted. The substantial surplus on the year's accounts (£95,078/16/2) and the excess of assets and reserves over current liabilities (£147,401/16/0) are the result of a careful supervision of expenditure, and indicate that the Commission will soon be able to commence an extensive building programme to meet studio requirements, which are growing more pressing from day to day. This has been referred to herein under the heading of "Accommodation." The total revenue for the year was £405,534/12/1, only £485/13/1 coming from sources other than the Commission's proportion of revenue from license fees. The principal item of expenditure was artists' fees and programme costs, including payments to artists, musicians, lecturers, announcers and accompanists, and expenses incurred in production. The total paid out on this account was £171,296/12/7. Payment of copyright fees (including payment to the Australasian Performing Right Associa-

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AUSTRALIAN BROADCASTING COMMISSION
BALANCE SHEET AS AT 30th JUNE, 1935

Liabilities

Previous Year £ s. d.			1934-5 £ s. d.
6,666 13 4	Loan from Commonwealth Government		—
16,103 11 6	Sundry Creditors		13,314 6 8
50,000 0 0	Reserve for Buildings		145,000 0 0
2,322 19 10	Accumulated Fund	£2,322 19 10	
	Add Balance from Profit and Loss Statement .	78 16 2	
			2,401 16 0
£75,093 4 8			£160,716 2 8

Assets

Previous Year £ s. d.		£ s. d.	1934-5 £ s. d.
	Land & Buildings — Freehold	16,418 18 3	
	Less Depreciation	139 17 3	
14,649 18 5			16,279 1 0
	Office Furniture, Musical Instruments and Equipment .	25,802 15 1	
	Less Depreciation	8,401 0 8	
17,120 5 1			17,401 14 5
1,329 19 0	Stores and Stationery		1,910 16 0
	Sundry Debtors—		
	Postmaster-General for License Fees	49,921 6 6	
	Other	238 2 5	
13,463 1 10			50,159 8 11
1,394 1 7	Payments in Advance		1,889 12 6
	Other Investments—		
	Fixed Deposits	60,000 0 0	
	Add Accrued Interest	183 5 10	
			60,183 5 10
25,548 12 6	Cash in Hand and at Bank		12,892 4 0
1,587 6 3	Preliminary Expenses		—
£75,093 4 8			£160,716 2 8

PROFIT & LOSS STATEMENT TO YEAR ENDED 30th JUNE, 1935

Expenditure

Previous Year £ s. d.		1934-5 £ s. d.
170,405 13 10	To Artists' Fees and Programme Expenses .... (Payments to Artists, Orchestras, Lecturers, Announcers, Accompanists, and Production Costs)	171,296 12 7
26,387 0 9	Copyright Fees	40,200 13 9
8,060 5 3	Broadcasting Rights	9,370 5 5
7,282 15 0	Rental of Telephone Lines for Broadcasting and Outside Pick-up Costs	11,281 18 10
1,800 0 0	Commissioners' Fees	1,777 13 6
33,362 17 11	Staff Salaries	34,031 2 4
8,901 6 11	Rent of Offices	8,351 3 5
8,183 2 4	Publicity	6,387 6 0
3,442 12 7	Depreciation	3,851 17 5
1,587 6 4	Preliminary Expenses Written off	1,587 6 3
23,324 4 10	Other Expenses	22,319 16 5
32,994 7 4	Balance carried down	95,078 16 2
£325,731 13 1		£405,534 12 1
32,500 0 0	To Transfer to Reserve for Buildings	95,000 0 0
494 7 4	Balance to Accumulated Fund	78 16 2
£32,994 7 4		£95,078 16 2

Revenue

Previous Year £ s. d.		1934-5 £ s. d.
314,126 12 6	By Revenue from License Fees	405,048 19 0
—	Interest on Investments	314 10 10
11,605 0 7	Other Revenue	171 2 3
£325,731 13 1		£405,534 12 1
32,994 7 4	By Balance brought down	95,078 16 2
£32,994 7 4		£95,078 16 2

tion Limited) amounted to £40,200/13/9, broadcasting rights (principally for sporting events) cost £9,370/5/5, staff salaries were £34,031/2/4, Commissioners' fees, £1,777/13/6, and pick-up charges for mechanical services made up a further £11,281/18/10 of the total. Of the surplus of £95,078/16/2, £95,000 has been transferred to the reserve for buildings, which now amounts to £145,000.

The accounts of the individual States show that all branches except those in Western Australia and Tasmania produced revenue in excess of expenditure. The greatest surplus was shown in New South Wales, where it increased from £18,916 in 1933-34 to £45,294 in 1934-35. The Victorian surplus was £31,871 as compared with £15,931 in the preceding twelve months. The deficit in Western Australia was reduced from £3,329 to £894 during the year, and the deficit in Tasmania from £8,934 to £6,486.

TECHNICAL:

The Commission desires to express its appreciation of the valuable and courteous co-operation extended to it by the Postmaster-General's Department.

STAFF:

The Commission is pleased to record its appreciation of the valuable services rendered by its staff during the year.

For reasons which have already been reported to you, the services of the late General Manager, Mr. W. T. Conder, terminated in June last.

(Note: Since the termination of the period under review, the vacancy so

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A.B.C. 3rd ANNUAL REPORT—(Continued)

created has been filled from within the Commission's service by the appointment, as from 1st November, 1935, of Mr. Charles J. A. Moses, who previously held the position of Federal Liaison Officer).

PERSONNEL OF COMMISSION:

Under the terms of their original appointment, the period of office of three of the Commissioners, Dr. R. S. Wallace, Hon. R. B. Orchard, C.B.E., and Mrs. Claude Couchman, expired on 25th May, 1935. Mr. Orchard and Mrs. Couchman were reappointed for a further term of three years. Dr. Wallace did not seek reappointment, and to the vacancy so created Mr. J. W. Kitto, O.B.E., was appointed for three years. The Commission takes this opportunity of expressing its indebtedness to Dr. Wallace for the valuable contribution made by him to the cause of broadcasting, and in particular to the solution of the Commission's problems during his period of office.

We have the honour to be, Sir,

Your obedient servants,

W. J. CLEARY (Chairman)
H. R. BROOKES (Vice-Chairman)
R. B. ORCHARD (Commissioner)
ELIZABETH M. R. COUCHMAN (Commissioner)
J. W. KITTO (Commissioner)
Australian Broadcasting Commission

Auditor-General on Broadcasting 1934-5

THE Annual Report of the Auditor-General upon the financial statement of receipts and expenditure during the year ended June 30, 1935, was recently released.

Paragraph 118 shows that the published accounts of A.W.A. for year ended June 30, 1935, disclose a net profit of £119,824 from wireless services and other sources, which represents a return of 16.08 per cent. on the paid-up capital of £744,283, and is £18,110 less than the net profit for the previous year. Dividends at the rate of 10 per cent. per annum absorbing £74,428 have been paid for 1934-35, the Commonwealth receiving £35,000/1/3 based on its capital holding of £350,000 14/-—500,001 shares paid to 14/-.

Under the Wireless Agreement Act, 1927, the company received the sum of £32,896/4/7 from the Government, on account of the year 1934-35. This sum, which represents the Commonwealth's net payment towards the maintenance of the coastal and island radio stations, is subject to slight adjustment in respect of the June quarter.

Broadcasting

During the year 2,190 unlicensed listeners were convicted, fines and costs totalling £5190.

At June 30, licensed listeners numbered 718,896. There are fourteen national stations, nine originating stations including the short-wave station at Lyndhurst, Vic., and five regional stations. Fifty-seven commercial stations were broadcasting at the end of the financial year.

Listeners' License Fees

The broadcast listeners' license fee of 21/- is distributed between Consolidated Revenue and the Australian Broadcasting Commission; 9/- is paid to revenue and 12/- to the Commission.

Income statement showed that balance of undistributed fees in Trust Fund, Wireless Broadcasting Account at June 30, 1934, was £183,958/16/-, license fees received from broadcast listeners and experimenters during 1934-35, £767,488 2/6, total £951,446/18/6.

Expenditure by the Australian Broadcasting Commission totalled £405,048 19/-. Revenue £335,358/10/6, leaving a balance of undistributed fees in Trust Fund Wireless Broadcasting Account of £211,039/9/-, making a total of £951,446 18/6.

Australian Broadcasting Commission

The total revenue of £405,534/12/1 was made up of £405,048/19/- from listeners' license fees; £90 rent from property; £81/2/3 proceeds of concerts, and £314/10/10 interest on fixed deposits. The expenditure totalled £310,455/15/11, leaving a revenue surplus of £95,078 16/2.

The following gives a comparison of the commission's operations over the past two years.

Artists fees and programme expenses (including payments to artists, orchestras, lecturers, announcers, accompanists and production costs, 1933-34, £170,406. 52.3 per cent., 1934-35 £171,297, 42.2 per cent. Copyright fees, 1933-34, £33,787, 10.4 per cent, 1934-35, £40,201, 9.9 per cent. Broadcasting rights, 1933-34, £8,060, 2.4 per cent, 1934-35, £9,370, 2.3 per cent. Rental of telephone lines for broadcasting and outside pick-up costs, 1933-34, £7,283, 2.2 per cent., 1934-35, £11,282, 2.8 per cent. Commission's fees, 1933-34, £1,800, .6 per cent., 1934-35, £1,778, .4 per cent. Staff salaries 1933-34 £33,363, 10.2 per cent., 1934-35, £34,031, 8.4 per cent. Rent of offices and furniture, 1933-34, £8,901, 2.8 per cent, 1934-35 £8,351, 2.1 per cent. Publicity, 1933-34, £8,183, 2.5 per cent., 1934-35,, £6,387, 1.6 per cent. Depreciation, 1933-34, £3,443, 1.0 per cent., 1934-35, £3,852 .9 per cent. Preliminary expenses written off, 1933-34, £1,588, .5 per cent., 1934-35, £1,587, .4 per cent. Other expenses 1933-34, £23,324, 7.2 per cent., 1934-35, £22,320, 5.5 per cent. Balance carried down, 1933-34, £25,594, 7.9 per cent., 1934-35, £95,079, 23.5 per cent.

By revenue from license fees, 1933-34, £314,127, 96.4 per cent., 1934-35, £405,049, 99.9 per cent. Other receipts, 1933-34, £11,605, 3.6 per cent. 1934-35, £486, .1 per cent.

Total 1933-34, £325,732, 100.0 per cent,. 1934-35, £405,535, 100.0 per cent.

For year ended June 30, 1934, revenue was £325,732 and for 1935, £405,535. Expenditure 1934, £300,138, 1935, £310,456. Surplus 1934, £25,594; 1935, £95,079. Reserve for building and accumulated fund, 1934, £52,323; 1935, £147,402.

There has been a consistent increase in broadcast listeners' licenses, and the Commission is now enjoying a very large income. Revenue for the year 1934-35 was greater by £79,803 than that for 1933-34, and the surplus shown in the comparative statement, £95,079, is equal to 23.5 per cent. of the revenue as against £25,594 or 7.9 per cent. of the revenue for the previous year. Expenditure increased by £10,318 from £300,138 to £310,456. This increase was principally due to copyright fees, £6,414; broadcasting rights, £1,310; and rent of telephone lines and outside pick-up costs, £3,999. Other items of expense remained practically stationary except publicity, which showed a decrease of £1,796.

Copyright fees paid by the Comsion to the Australian Performing Rights Association are subject to an agreement dated July 2, 1934. The amounts payable to that association in respect of the year 1934-35 was £36,217/4/5.

For comparative purposes, the following latest figures available are of interest:

In New Zealand, where the license fee is 23/-, there was a surplus of £63,937—equal to 38.39 per cent. of the revenue of £166,535, the hours of transmission numbering 25,700.

The British Broadcasting Commission had a surplus of £220,490—equal to 10.7 per cent. of the revenue of £2,058,983, the hours of transmission numbering 63,109.

The Australian Broadcasting Commission had a surplus of £147,402—equal to 15.01 per cent. of the revenue for three years, viz,. £981,886, the number of hours of transmission in the latest year being 51,446.

AUDITOR-GENERAL ON BROADCASTING—(Continued)

A summary of balance-sheet items at the end of June for two years follows:

ASSETS:—Land and buildings: Freehold less depreciation, 1934 £14,650, 1935 £16,279; office furniture, musical instruments and equipment, less depreciation 1934 £17,120, 1935 £17,402; stores and stationery, 1934 £1,330, 1935 £1,911; sundry debtors, 1934 £13,463, 1935 £50,159; payments in advance, 1934 £1,394, 1935 £1,890; fixed deposits with accrued interest, 1935 £60,183; cash in hand and at bank, 1934 £25,549, 1935 £12,892; preliminary expenses, 1934 £1,587, 1935 nil. Total, 1934 £75,093; 1935, £160,716.

LIABILITIES:—Loan from Commonwealth Government, 1934 £6,667, 1935 nil; sundry creditors, 1934 £16,103, 1935 £13,314; reserve for buildings, 1934 £50,000, 1935 £145,000; accumulated fund, 1934 £2,323, 1935 £2,402. Total, 1934 £75,093, 1935 £160,716.

In addition to providing and broadcasting programmes for the National Broadcasting Stations, the Commission is required to provide studios, offices and other necessary accommodation.

At June 30, 1935, land and buildings owned by the Commission totalled only £16,279, representing the value of studios at Adelaide, and land at Perth and Hobart. Rents paid for studio and office accommodation during the year amounted to £7,193. In view of the buoyant revenue and the cost of listeners' licenses, it appears to me that a larger surplus than £147,402 out of a revenue of £981,886 in three years, might reasonably have been accumulated to provide capital for the Commission's own buildings.

The Auditor-General also included in his report, an opinion by the Solicitor-General as to whether goods imported by the P.M.G.'s Department, intended for the use of the Australian Broadcasting Commission in connection with national broadcasting, were liable to Customs duty. This is as follows:

"On September 21, 1934, I advised (in Opinion No. 149 of 1934) that goods imported by the Postmaster-General's Department, and intended at the time of exportation for the use of the Australian Broadcasting Commission, in connection with the National Broadcasting Service, were articles to be used for the purpose of trade, and, as such, were not eligible for admission free of duty under Item 370 of the Customs Tariffs 1933.

"I have now given further consideration to this question, and think the view expressed in that Opinion cannot be maintained.

"The National Broadcasting Service provided for in the Australian Broadcasting Commission Act 1932, and the technical services of which are provided by the Postmaster-General's Department, is established by that Act. The constitutional basis of the service is placitum (v) of Section 51 of the Constitution—'postal, telegraphic, telephonic, and other like services.' The postal, telegraphic and telephonic services established under this placitum, and at present in existence, are all recognised as being definitely governmental functions, and the question arises whether the provision by the Commonwealth of equipment to facilitate the transmission of communications by wireless telephony is also the discharge of a Governmental function. The fact that its constitutional basis is 'other like services' in placitum (v) conveys, I think, an implication that it is the discharge of a Governmental function.

"In pursuance of the power contained in placitum (v) of section 51, the Commonwealth has enacted the Australian Broadcasting Commission Act 1932. Under that Act, the Australian Broadcasting Commission is required to broadcast programmes from national broadcasting stations (Section 16). National broadcasting stations are stations made available by the Minister for the purpose of the transmission of the national broadcasting programmes (Section 4).

"The Commission is only concerned with the programmes to be transmitted. The Postmaster-General is responsible for the provision and operation of all technical services associated with such transmission (Section 44), and is to provide certain equipment and apparatus for the use of the Commission (Sections 46, 47).

"It will be seen, therefore, that the means of transmission of the programmes are provided by the Commonwealth, and such provision is clearly, in my opinion, a Governmental function. In exercising this function, the Commonwealth is providing a like service to the telegraphic and telephonic services. In the latter cases, the Commonwealth provides apparatus and equipment, by means of which communications may be sent from one place to another in Australia. The majority of such communications originate with the general public, but, in the case of the national broadcasting service, most of the communications originate with a body created by the Commonwealth. In principle, however, the Commonwealth occupies the same position in relation to these two services as to the services which it provides in relation to national broadcasting. In the last-mentioned connection, the Commission, in relation to the Commonwealth, is in the same position as a member of the public who sends a communication by telephone. In both cases the system provided by the Commonwealth is used. It is the provision of the system which constitutes the exercise of the function of the Government. The fact that the system, whether it be telegraphic, telephonic or wireless telephonic, is or may be used for trading purposes, is not material.

"The fact that the wireless telephonic system is provided primarily to enable the Broadcasting Commission to operate, does not, I think, materially affect the position. Nor is it material that the Commission is a creature of the Commonwealth.

"The system established is capable of being used for the transmission of ordinary commercial and social communications and messages of public interest. Such communications and messages may be transmitted over the system, and some are, indeed, so transmitted, but advertising is not permitted (see Section 21 of the Australian Broadcasting Commission Act 1932). The important fact is that, in setting up and maintaining apparatus and equipment for transmitting communications and messages by wireless telephony, the Commonwealth is acting within its constitutional powers, and is providing a like service to the telegraphic and telephonic services, the provision of which, in Australia, is recognised as a Governmental function.

"In my opinion, therefore, any equipment or materials, imported by the Commonwealth for the purposes of establishing or maintaining the technical services, are imported for the purpose of carrying out purely Governmental functions, and are not for the purposes of trade.

"This opinion is given on the assumption that wireless telephonic services are 'other like services' within the meaning of placitum (v) of Section 51 of the Constitution. The question of the power of the Commonwealth to legislate with respect to wireless telephonic services may be dealt with in the decision of the High Court in a case against one Dulcie Williams, recently heard in Sydney."

Report of the British Television Committee

Presented by the Postmaster-General to Parliament by Command of His Majesty – January, 1935

The Right Hon. Sir Kingsley Wood, M.P., His Majesty's Postmaster-General

THE TELEVISION COMMITTEE

The Right Hon. The Lord Selsdon, K.B.E. (Chairman).
Sir John Cadman, G.C.M.G., D.Sc. (Vice-Chairman).
Col. A. S. Angwin, D.S.O., M.C., B.Sc., Assistant Engineer-in-Chief, General Post Office.
Noel Ashbridge, Esq., B.Sc., Chief Engineer, British Broadcasting Corporation.
O. F. Brown, Esq., M.A., B.Sc., Department of Scientific and Industrial Research.
Vice-Admiral Sir Charles Carpendale, C.B., Controller, British Broadcasting Corporation.
F. W. Phillips, Esq., Assistant Secretary, General Post Office.
Secretary: J. Varley Roberts, Esq., M.C., Telegraph and Telephone Department, General Post Office, E.C.1.

Terms of Reference and Proceedings of the Committee

1. The appointment of the Committee was announced in the House of Commons on the 14th of May, 1934, with the following terms of reference:—

"To consider the development of Television and to advise the Postmaster General on the relative merits of the several systems and on the conditions under which any public service of Television should be provided."

2. A notification was made in the Press on the 29th of May, 1934, and again on the 11th of June, 1934, intimating that the Committee were prepared to receive evidence on the subject of Television from any interested society, firm or individual.

3. We have examined 38 witnesses—some of them on more than one occasion—representing many different interests, on the various aspects of Television. A list of witnesses who have appeared before us is set out in Appendix I. In addition, we have had the benefit of consultation with members of various Departments of the Government, who have afforded us every facility and assistance; and we have received numerous written statements regarding Television from various sources.

4. A note of the formal evidence given is presented in Appendix II (Volumes I to IV), but owing to the fact that much of this information, containing secrets of commercial value, was necessarily received in confidence and under promise of secrecy, we trust that this pledge may be maintained and that accordingly the record, while available for yourself and your responsible officers, will not be published. For similar reasons we recommend that Appendix III, containing reports on developments in the United States and Germany, and Appendix IV, containing a description of each television system we have examined in this country, should not be published. Appendix V, containing certain financial details, is also of a confidential nature (see paragraph 63).

(Appendix II not printed)
(Appendix III not printed)
(Appendix IV not printed)
(Appendix V not printed)

5. We have inspected, in some cases upon several occasions, all the different television systems belonging to firms who were prepared to provide demonstrations. Of the systems under development in this country, the most distinctive are those of the Baird, Cossor, Marconi-E.M.I. and Scophony Companies.

6. Further, we despatched with your approval a delegation headed by the Chairman, to investigate and report upon progress in television research in the United States, and a delegation headed by Mr. O. F. Brown, to Germany for a similar purpose. We have also been furnished with information regarding the position in certain other countries.

7. In America, our delegation visited and inspected many of the chief centres of television experimental research, as well as the plant and laboratories of the principal Broadcasting, Telephone and Telegraph Authorities. They had also the advantage of consultation in Washington with the Federal Communications Commission. To all of these Corporations and Authorities we desire to make the fullest and most sincere acknowledgment of the kindness and courtesy extended to the delegation, who were given every possible opportunity for the fullest examination of methods and plant, and the frankest interchange of opinion. A detailed report of the proceedings and conclusions of the delegation is submitted as Appendix III, A.

8. In Germany, our delegation made a similar inspection of the television experimental installations belonging to the Reichspost and also of those of several private firms in Berlin, and they had many profitable discussions with officials of the Reichspost and others regarding various aspects of Television. As in America, so also in Germany, every facility was accorded to our delegation in their investigations, for which we likewise desire to express our sincere appreciation. A report on the visit to Germany is submitted as Appendix III, B.

Basic Principles of Television

9. Television may be defined as the transmission by telegraphy and reproduction in transitory visible form of images of objects in movement or at rest. The equipment utilised usually consists of combinations of optical and electrical apparatus which at the transmitting or "pick up" end of the system convert the image of the object into electric currents, and of similar combinations at the receiving end of the system which resolve the electric currents into visible forms.

10. When an object is viewed by direct vision, light reflected from the object under observation impinges on the eye and is focussed by the lens on to the retina where it stimulates nerve cells. Each cell communicates with the brain, and the sensation of sight and the perception of any scene result from the relative stimulation applied to the brain by the cells in the retina. As the light sensitive cells of the retina have finite dimensions, details in an object which produce an image on the retina smaller than a single cell cannot be individually perceived. The eye, therefore, really sees a large number of infinitely small objects, which in the aggregate form the image.

11. Thus all vision is of a granular structure, as is also pictorial reproduction, and, in order to transmit pictures or images over electric circuits, a suitable granular structure is adopted, the relative brilliancy of each grain or elementary area of the picture being transmitted telegraphically to the distant point, where by suitable means an equivalent brilliancy is given to a corresponding area on the receiving screen.

12. The transmission of the relative brilliancy of each grain or elementary area of the picture must be effected in some ordered sequence, and the process by which this is achieved is termed "scanning." The usual method employed is to allow light from a selected area of the subject to impinge on a device known as a photo-electric cell, which delivers an electrical output proportional to the light stimulation it receives. This electrical output, after amplification, is used to control the output of a radio transmitter by me-

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thods similar to those in use for the transmission of speech and music. The position of the selected area of the subject is varied in a definite path so that the whole of the subject is covered in a period which should be less than the time of persistence of vision. The path of selection is usually a series of horizontal or vertical parallel lines, and the process somewhat resembles the action of the human eye in reading a page of printed matter, letter by letter and line by line. A further refinement consists in making the path of selection run first along every alternate line and then, as a second process, along the lines omitted in the first process. This is known as interlaced scanning, and it appears to be successful in reducing "flicker."

13. At the receiver, the radio signal is detected and amplified by methods similar to those used for radio-telephony. The electrical signal from the receiver thus resembles the signal from the photo-electric cell or cells at the transmitter, and is used to control the brilliancy of illumination of an elementary area of the screen on which the received picture is to be displayed.

14. It is essential to arrange that the area illuminated on the viewing screen at any given instant shall correspond in position with the area of which the illumination is then being determined by the scanning device. In other words, precise synchronism is necessary between the movements of the scanning device and the receiving device. Various methods have been proposed for achieving this synchronism; it can, for instance, be accomplished by the sending of two series of special synchronising signals by the transmitter—one series to ensure the correct motion of the picture spot along each line and the second series to signal the instant of termination of one picture and the commencement of the next. As these series of signals occur respectively between successive lines of the picture and between successive pictures, their transmission need not interfere with the picture signals, and they can be sent on the same radio transmitter.

15. The relative brilliancy of each successive grain of the picture is transmitted with such rapidity that persistence of vision produces the effect at the receiving end of a complete picture, the degree of definition and steadiness of which is dependent upon the fineness of the individual grains composing the picture, i.e., the number of lines used for scanning it, and the speed at which complete pictures are successively transmitted.

16. One of the difficulties which has been encountered in direct scanning is the small amount of light available to actuate the photo-electric cell obtained by reflection from objects which are being televised.

17. Accordingly, considerable experimental development has taken place upon a technique whereby the scene to be televised is first photographed on ordinary cinematograph film which, after being developed, is scanned by light transmitted through it. This system can be used to provide a method of delayed Television where direct scanning by a mechanical device would be difficult or impossible. In order to reduce the period of delay, equipment has now been produced in which the cinematograph camera is associated with the film scanner, and the film, after exposure, is immediately developed, fixed, washed and partially dried. It then passes through the scanner, and after further drying is stored for future use if required. In this way, the advances which have been made in photographic processes in the production of rapid and sensitive emulsions can be utilised to overcome the difficulties which are at present encountered due to the comparatively feeble sensitivity of photo-electric cells.

18. The direct scanning of open air scenes and studio subjects without abnormally powerful illuminating devices has also been made possible by the use of cathode rays in combination with photo-sensitive surfaces or minute photo-electric cells. For instance, in one such device which is being developed in America, Germany and this country, the image to be televised is focussed by means of lenses on to a photo-electric mosaic contained in a cathode ray tube. The cathode ray beam is directed on the surface of the mosaic and by a method of magnetic control the image is scanned repeatedly. Electrical energy is thus drawn off from the photo-electric mosaic by the cathode ray which is proportional to the light intensity of the picture and can be transmitted to operate the distant television receiver.

19. Our observations lead us to the opinion that this system of "direct pick up" has already attained a considerable degree of effectiveness, and we should say that satisfactory reproduction of outdoor moving scenes can now be attained by this method in conditions of light, etc., approximating to those under which satisfactory cinematograph pictures can be taken, provided that the recording apparatus can be located reasonably close to and at a moderately constant distance from the scene to be televised. We should regard it as probable that satisfactory reproduction could, even at this stage of development, be obtained of such scenes as a procession, a lawn-tennis match, or the actual finish of a horse race, though the transmission of a view of the whole course of a race, a cricket match, or a football match, would present much greater difficulty.

Experiments in Television

20. We are informed that the Post Office has always given facilities to qualified persons or firms who have applied for permission to conduct experiments in Television, but the licenses issued have been restricted to purely research and experimental work and have given no authority for the conduct of any form of public service.

21. The view taken was that when any system of Television showed sufficient promise to justify its trial for public transmission, the British Broadcasting Corporation should provide reasonable facilities for such a trial service on a limited scale at one or more of their broadcasting stations.

Low Definition Television

22. As far back as the autumn of 1929 the British Broadcasting Corporation gave the Baird Company facilities for experimental transmissions of Television from a broadcasting station. During the next two or three years a large number of experimental transmissions were carried out by the Baird Company independently, as well as in liaison with the British Broadcasting Corporation.

23. Improvements were gradually made in the system, and in August, 1932, the Corporation arranged with Baird Television Limited for public experimental transmissions from their London Station (Brookmans Park) of Television on a wavelength of 261 metres, and of the accompanying sound on a wavelength of 398 metres from the Midland Regional transmitter (Daventry). The Corporation agreed to provide special programme material and also staff for operating the television apparatus, which was installed in Broadcasting House by the Baird Company on a loan basis. These transmissions, the experimental nature of which was emphasised in a notice issued to the Press, have continued up to the present time, although their frequency has been reduced since 31st March, 1934, to two half-hour periods a week which are extended to three-quarters of an hour when circumstances permit.

24. In the case of these transmissions the size of the elements (elementary areas) composing the picture is such as to admit of transmission being effected in a series of thirty lines per picture and each picture is repeated 12½ times per second (see paragraphs 12-15).

25. Any pictures built up with a structure of the order of thirty lines are, however, comparatively coarse in texture. Little detail can be given, and generally speaking the pictures are only fitted for the presentation of "close-ups"—e.g., the head and shoulders of a speaker—and the quality of reproduction leaves much to be desired. Moreover, any frequency of the order of 12½ pictures per second gives rise to a large amount of "flicker."

26. Whilst low definition Television has been the path along which the infant steps of the art have naturally tended and, while this form of Television doubtless still affords scientific interest to wireless experimenters, and may even possess some entertainment value for a limited number of others, we are satisfied that a service of this type would fail to secure the sustained interest of the public generally. We do not, therefore, favour the adoption of any low definition system of Television for a regular public service. We refer later in our report (see paragraph 34) to the question of the temporary continuance of the present low definition transmissions pending the institution of a public television service of a more satisfactory type.

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High Definition Television

27. With a view to extending the application of Television to a wider field and thereby increasing its utility and entertainment value, much attention has been given in recent years to the problem of obtaining better definition and reduced "flicker" in the received pictures.

28. The degree of definition it is essential to obtain is necessarily a matter of opinion, but the evidence received and our own observations lead us to the conclusion that it should be not less than 240 lines per picture, with a minimum picture frequency of 25 per second. The standard which has been used extensively for experimental work is 180 lines, but we should prefer the figure of 240 and we do not exclude the possible use of an even higher order of definition and a frequency of 50 pictures per second.

29. To attain such degrees of definition and picture frequency, very high modulation frequencies are required, which in practice can only be handled by radio transmitters working on ultra-short waves the effective range of which is much more restricted than the range of the medium waves used for ordinary sound broadcasting (see paragraph 47).

30. For the reception of high definition pictures the cathode ray tube is now usually employed. The cathode ray tube receiver involves no moving parts, and the picture is presented as a fluorescence at the end of the tube. A stream of electrons (particles of negative electricity) is projected along the tube, and impinges on a coating of fluorescent material at the end of the tube, the impact of the electrons on the fluorescent material causing illumination. The amount of illumination can be controlled by varying the flow of electrons, and the point of impact can be changed by deflecting the jet by means of electric or magnetic forces. The jet is modulated or controlled in amount by the received signal, and suitable electrical circuits are provided to move the point of impact in exact synchronism with the transmitter (see paragraph 14).

31. The size of the picture produced naturally depends upon the size of the cathode ray tube. At present the most usual size gives a picture of about 8 in. by 6 in., although good results have been seen with larger tubes. The apparent size can, of course, be increased by viewing the tube through a suitable fixed magnifying device, though with a corresponding loss of definition. Experimental work is proceeding with a view to the projection of pictures on a screen of much larger dimensions, but this is still in an early stage of development.

32. We are informed that the price to the public of a receiving set capable of producing a picture of about the first-mentioned size, with the accompanying sound, would probably at first be considerable, and various estimates have been given ranging from £50 to £80; but it is reasonable to assume that, if and when receivers were made on a large scale under competitive conditions, this price would be substantially reduced.

33. Most of the high definition television systems follow in broad outline the methods of transmission and reception referred to above, with some variations in technique. We are impressed with the quality of the results obtained by certain of these systems, and whilst much undoubtedly remains to be done in order to render the results satisfactory in all respects, we feel that a standard has now been reached which justifies the first steps being taken towards the early establishment of a public television service of the high definition type in this country.

34. As regards the existing low definition broadcasts, these no doubt possess, as we have said, a certain value to those interested in Television as an art, and possibly, but to a very minor extent, to those interested in it only as an entertainment. We feel that it would be undesirable to deprive these "pioneer lookers" of their present facilities until at least a proportion of them have the opportunity of receiving a high definition service. On the other hand, the maintenance of these low definition broadcasts involves not only some expense, but also possibly considerable practical difficulties. We can only, therefore recommend—

(1) that the existing low definition broadcasts be maintained, if practicable, for the present; and

(2) that the selection of the moment for their discontinuance be left for consideration by the Advisory Committee (see paragraph 41),

with the observation that, if practicable so to maintain these broadcasts, they might reasonably be discontinued as soon as the first station of a high definition service is working.

Scope of Television and Its Relation to Sound Broadcasting

35. In our opinion there will be little, if any, scope for television broadcasts unaccompanied by sound. Television is, however, a natural adjunct to sound broadcasting and its use will make it possible for the eye as well as the ear of the listener to be reached. Associated with sound it will greatly enhance the interest of certain of the existing types of broadcast and will also render practicable the production of other types in which interest is more dependent upon sight than upon sound.

36. We are of the opinion that there are two factors which for a number of years will tend to prevent a television service being made use of to the same extent as present day sound broadcasting—

(1) The difficulties of wireless communication on ultra-short wavelengths, particularly in hilly districts, may seriously limit the extent to which the country can be effectively covered.

(2) Some time is likely to elapse before the price of an efficient television receiver will be comparable with that of the average type of receiver now in use for sound broadcasting.

Nevertheless the time may come when a sound broadcasting service entirely unaccompanied by Television will be almost as rare as the silent cinema film is to-day. We think, however, that in general sound will always be the more important factor in broadcasting. Consequently the promotion of Television must not be allowed to prevent the continued development of sound broadcasting.

37. No doubt the evolution of Television will gradually demonstrate the possibility of its application for many purposes other than those of entertainment and illustrative information. Its uses for purposes of advertisement are obvious, were such deemed desirable. We can conceive, moreover, its potential application—as distinct from existing practice in picture transmission—to public telegraphic and telephonic services, to the transmission of lists of prices, or of facsimile signatures or documents, and to its use by the police and the forces of the Crown, or as an aid to navigation.

38. We have assumed, however, that we were intended by our terms of reference to confine our attention to the question of the introduction of a public broadcast service of Television, and we do not, therefore, make any further observations regarding its other possible applications beyond expressing the earnest hope that it will be allowed the fullest possible freedom for development consonant with the public interest.

Television Operating Authority.

39. Holding the view which we do of the close relationship which must exist between sound and television broadcasting, we cannot do otherwise than conclude that the Authority which is responsible for the former—at present the British Broadcasting Corporation—should also be entrusted with the latter. We therefore recommend accordingly; and we have received an assurance that the Corporation is prepared fully to accept this additional responsibility and to enter whole-heartedly into the development of Television in conformity with the best interests of the license-paying public. In discharging this task the accumulated experience of the Corporation as regards sound broadcasting cannot fail to prove of great value. Presumably a separate license will be required from the Postmaster General specifically authorising the Corporation to undertake the broadcasting of Television.

40. We have, of course, considered the possible alternative of letting private enterprise nurture the infant service until it is seen whether it grows sufficiently lusty to deserve adoption by a public authority. This would involve the granting of licenses for the transmission of sound and vision to several different firms who are pioneering in this experimental field. We should regret this course, not only because it would involve a departure from the principle of having only a single authority broadcasting a public sound service on the air, and because the subsequent process of "adoption" (which we believe would be inevitable) would be rendered costly

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owing to the growth of vested interests, but also because we foresee serious practical difficulties as regards the grant of licenses to the existing pioneers as well as possibly to a constant succession of fresh applicants. It is therefore our considered conclusion that the conduct of a broadcast television service should from the outset be entrusted to a single organisation, and we are satisfied that it would be in the public interest that the responsibility should be laid on the British Broadcasting Corporation.

Advisory Committee.

41. Whilst we think that the British Broadcasting Corporation should exercise control of the actual operation of the television service to the same extent and subject to the same broad principles as in the case of sound broadcasting, we recommend that the initiation and early development of this service should be planned and guided by an Advisory Committee appointed by the Postmaster General, on which the Post Office, the Department of Scientific and Industrial Research and the British Broadcasting Corporation should be represented, together with such other members as may be considered desirable. We recommend that this Committee should be appointed forthwith, for a period of, say, five years.

42. The Committee should advise on the following:—

(a) The performance specification for the two sets of apparatus mentioned in paragraph 56, including acceptance tests, and the selection of the location of the first transmitting station.

(b) The number of stations to be built subsequently, and the choice of districts in which they should be located (see paragraph 57).

(c) The minimum number of programme hours to be transmitted from each station.

(d) The establishment of the essential technical data governing all television transmissions, such as the number of lines per picture, the number of pictures transmitted per second, and the nature of the synchronising signals.

(e) The potentialities of new systems.

(f) Proposals by the British Broadcasting Corporation with regard to the exact site of each station, and the general lines on which the stations should be designed.

(g) All patent difficulties of a serious nature arising from the operation of the service in relation to both transmission and reception.

(h) Any problem in connection with the television service which may from time to time be referred to it by His Majesty's Government or the British Broadcasting Corporation.

Normally the Committee would not concern itself with detailed financial allocations, or with business negotiations between suppliers of apparatus and the British Broadcasting Corporation. It is further considered that the Committee should deal with the compilation of programmes, the detailed construction of stations, or their day-to-day operation, unless specifically invited to do so under sub-paragraph (h).

43. It will be clear from the foregoing that the Committee would be composed of both technical and non-technical members, and it is anticipated that a part of the Committee's work would best be carried out by a technical sub-committee.

44. Such experimental work as may be necessary for the establishment of stations and the operation of the service would be carried out by the British Broadcasting Corporation in the usual course of its functions, but this would not, of course, preclude the enlistment of the co-operation of Government Departments or other organisations in technical researches.

Use of Ultra-Short Waves for Television and Their Effective Range.

45. As previously mentioned, the transmission of high definition Television is practicable only with ultra-short waves, and a wide band of frequencies is necessary. Fortunately, there should be no difficulty, at present at all events, in assigning suitable wave-lengths in the spectrum—between 3 and 10 metres—for public Television in this country, although in allocating such wavelengths regard must, of course, be paid to the claims of other services. The recent experimental work has been conducted upon wavelengths around 7 metres.

46. Technically, it is desirable that the transmitting stations should be situated at elevated points, and that the masts should be as high as practicable, consistent with any restrictions which may be deemed necessary by the Government. The mast at present in use in Berlin is about 430 feet high, and the question of employing masts of greater height is under discussion in Germany. Quality of reception varies, of course, with the location of the receiving station and the nature of its surroundings. It may be observed that reception on these ultra-short waves does not seem to be materially affected by atmospherics. The most frequent sources of interference appear at present to rise from some types of electro-therapeutic apparatus, and from the ignition systems of motor cars; but we understand that it is possible to prevent or reduce certain types of such intereference by simple remedial devices.

47. Present experience both here and abroad seems to indicate that these ultra-short waves cannot be relied upon to be effective for a broadcast service much beyond what is commonly called "optical range." Generally speaking, it is at present assumed that the area capable of being effectively covered by ultra-short wave stations of about 10 kilowatts capacity will not exceed a radius of approximately 25 miles over moderately undulating country. In more hilly districts this may be considerably reduced, and indeed in certain areas an entirely reliable service may be impracticable. It is clear, therefore, that unless and until the effective range be increased, a large number of transmitting stations would be required to provide a service covering most of the country, though we think that with 10 stations, probably at least 50 per cent. of the population could be covered from suitable locations.

Provision of Television Service.

48. We nevertheless envisage the ultimate establishment of a general television service in this country, and in this connection we contemplate the possibility of television broadcasts being relayed by land line or by wireless from one or more main transmitting stations to sub-stations in different parts of the country. We should observe that recent developments in cable technique render it possible for the first time to transmit, over considerable distances, frequencies such as are required for high definition Television.

49. While the establishment of such a service should be, in our opinion, the aim, we do not feel that we can advise you to proceed at once to approve the construction, at great expense, of a network of stations, intended to cover most of the country. The total number of stations required for such a purpose is as yet unknown to anyone; and the total cost is accordingly purely speculative. Moreover, Television will be a constantly developing art, and new discoveries and improvements will certainly involve continued modifications of methods—at least during its early years. A general service will only be reached step by step; but the steps should be as frequent as possible and in our opinion the first step should be taken now. Solvitur ambulando.

Choice of System and Patent Difficulties.

50. We have been furnished with a great deal of information—much of it of a confidential character—concerning various systems of Television. Continuous progress is being made in the art; and even during the few months of our investigations, research has brought a number of new and important discoveries. We do not think it would be right at this early stage of development, when practical experience is small and the patent position obscure, that we should attempt to pass final judgment on the several systems of Television. A technical description of each system which we have examined in this country, indicating its distinctive features and commenting upon its performance, is, however, submitted for your information in Appendix IV. Comments are also made in Appendix III on the systems examined in the United States and Germany.

51. The task of choosing a television system for a public service in this country is one of great difficulty. The system of transmission governs in a varying degree the type of set required for reception; and

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it is obviously desirable to guard against any monopolistic control of the manufacture of receiving sets. Further, whatever system or systems are adopted at the outset, it is imperative that nothing should be done to stifle progress or to prevent the adoption of future improvements from whatever source they may come. Moreover, the present patent position is difficult; the number of patents relating to Television is very large, and in regard to many of them there are conflicting views as to their importance and validity.

52. At the same time it is clear from the evidence put before us that those inventors and concerns, who have in the past devoted so much time and money to research and experiment in the development of Television, are looking—quite fairly—to recoup themselves and to gather the fruits of their labours by deriving revenue from the sale of receiving apparatus to the public, whether in sets or in parts, and whether by way of royalties paid by the manufacturers or by manufacturing themselves. It is right that this should be so, and that the growth of a new and important branch of industry, capable of providing employment for a large number of workers, should in every way be fostered and encouraged to develop freely and fully.

53. The ideal solution, if it were feasible, would be that, as a preliminary to the establishment of a public service, a Patent Pool should be formed into which all television patents should be placed, the operating authority being free to select from this pool whatever patents it desired to use for transmission, and manufacturers being free to use any of the patents required for receiving sets on payment of a reasonable royalty to the Pool. We have seriously considered whether we should advise you to refuse to authorise the establishment of a public service of high definition Television until a comprehensive Patent Pool of this type had been formed, on terms considered satisfactory by the Advisory Committee. From evidence we have received, however, we are convinced that, under present conditions, when the relative value of the numerous television patents is so largely a matter of conjecture, the early formation of such a Pool would present extreme difficulty. The Government would have no power to compel an owner of television patents to put them into the Pool against his will; and, with the best will in the world, patent holders might find it exceedingly difficult to agree among themselves on a fair basis for charging royalties and sharing the revenue so obtained. An attempt hastily to negotiate a Pool under these conditions would in all probability end in failure.

54. While, however, we have been compelled to abandon the idea that the formation of a comprehensive Patent Pool should be a condition precedent to the establishment of a public service, we are strongly of opinion that it is in the public interest, and in the interest of the trade itself, that such a Pool should be formed. In framing our recommendations we have kept this objective in mind; and we trust that events will shape themselves in such a way as to lead to the formation of a satisfactory Patent Pool at no distant date.

Start of Service.

55. We have come to the conclusion that a start could best be made with a service of high definition Television by the establishment of such a service in London. It seems probable that the London area can be covered by one transmitting station and that two systems of television can be operated from that station. On this assumption we suggest that a start be made in such a manner as to provide an extended trial of two systems, under strictly comparable conditions, by installing them side by side at a station in London where they should be used alternately—and not simultaneously—for a public service.

56. There are two systems of high definition Television—owned by Baird Television Limited and Marconi-E.M.I. Television Company Limited respectively—which are in a relatively advanced stage of development(and have indeed been operated experimentally over wireless channels for some time past with satisfactory results. We recommend that the Baird Company be given an opportunity to supply the necessary apparatus for the operation of its system at the London station, and that the Marconi-E.M.I. Company be given a similar opportunity in respect of apparatus for the operation of its system also at that station. Besides any other conditions imposed, acceptance of offers should be subject in each case to the following conditions precedent:—

(a) The price demanded should not, in the opinion of the Advisory Committee, be unreasonable.

(b) The British Broadcasting Corporation to be indemnified against any claim for infringement of patents.

(c) The Company to undertake to grant a license to any responsible manufacturer to use its existing patents or any patents hereafter held by it, for the manufacture of television receiving sets in this country on payment of royalty.

(d) The terms of a standard form of such license to be agreed upon by the Company with the Radio Manufacturers' Association, or, in default of agreement, to be settled in accordance with the provisions of the Arbitration Acts, 1889 to 1934, or any statutory modification thereof, either by a single arbiter agreed upon by the Company and the Radio Manufacturers' Association, or failing such agreement, by two arbiters—each of the parties nominating one—and an umpire nominated by the Postmaster-General.

(e) The Company to agree to allow the introduction into its apparatus at the station of devices other than those claimed to be covered under its own patents, in the event of such introduction being recommended by the Advisory Committee.

(f) Transmissions from both sets of apparatus should be capable of reception by the same type of receiver without complicated or expensive adjustment.

(g) The definition should not be inferior to a standard of 240 lines and 25 pictures per second.

(h) The general design of the apparatus should be such as to satisfy the Advisory Committee, and when it has been installed, tests should be given to the satisfaction of the Committee.

Development of Service

57. In the light of the experience obtained with the first station, the Advisory Committee should proceed with the planning of additional stations, until a network is gradually built up. The total number of stations and the speed at which they are provided will naturally depend upon the results obtained from the earlier stations, the popularity of the service, finance and other factors. A tentative programme for the location and provision of stations should be framed by the Advisory Committee, and reviewed by them at frequent intervals.

58. Whatever system be adopted for the second or any subsequent station, we recommend that conditions be imposed similar to those set out in paragraph 56, in so far as applicable. The Advisory Committee would, of course, endeavour to secure the incorporation in each fresh station of any improvements which had come to light, and they would also naturally consider the introduction, if possible, of such improvements into existing stations. There should be no serious difficulty in doing this, so long as the changes did not materially affect the receiving sets, or at any rate so long as the sets already in use could be adapted, without much expense, to the modified system.

59. A more difficult situation would arise if a completely new system, requiring an entirely new type of receiving set, should be evolved and should prove on trial to be definitely superior to the systems already in use. In such a case it might be necessary to adopt the improved system, in the first instance, at new stations only, and to postpone for a time its adoption at the older stations. For it is obvious that many persons would be deterred from purchasing television sets unless they had some assurance that these sets would not be rendered useless at an early date by a complete change in the transmitting system. No radical changes should, therefore, be made in the systems serving particular areas without reasonable notice being given by the

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British Broadcasting Corporation of the contemplated change. In the initial stages this notice should not be less than, say, two years. The Corporation would naturally consult the Advisory Committee on this point. While giving some reasonable measure of security in this direction, the aim should be to take advantage, as far as possible, of all improvements in the art of Television, and at the same time to work towards the ultimate attainment of a national standardised system of transmission.

Programmes

60. It is scarcely within our province to make detailed recommendations on the subject of television programmes. To what extent those programmes should consist of direct transmissions of studio or outdoor scenes, or televised reproductions of films, must be determined largely by experience, technical progress and public support, as well as by financial considerations. No doubt the televising of sporting and other public events will have a wide appeal, and will add considerably to the attractiveness of the service. We regard such transmissions as a desirable part of a public television service, and it is essential that the British Broadcasting Corporation should have complete freedom for the televising of such scenes, with appropriate sound accompaniment, at any time of the day.

61. With regard to the duration of television programmes, we do not consider that it will be necessary at the outset to provide programmes for many hours a day. An hour's transmission in the morning or afternoon which will give facilities for trade demonstrations and, say, two hours in the evening, will probably suffice. As regards the future, the British Broadcasting Corporation and the Advisory Committee will doubtless be guided by experience and by financial considerations.

Finance.

62. For reasons already explained, it will be clear that at this stage no human being can estimate the cost of constructing and working a national network—nor even of such a partial system of 10 stations, as is referred to in paragraph 47 — with anything resembling accuracy. Even with all the resources at our command we have been quite unable to do so, and we confine ourselves, therefore, to giving what we hope may prove to be a fairly close estimate of the cost of providing and working the London station referred to in paragraph 55 up to 31st December, 1936. We should explain that we have taken this period, firstly on the assumption that it may be possible to start the service during the latter part of 1935, and secondly because 31st December, 1936, is the date on which the British Broadcasting Corporation's present Charter is due to expire. The relevance of this point lies in the fact that, if the television service is continued and expanded on the lines contemplated, then its finance will inevitably become bound up with the question of the Corporation's finance in general. We gather that it is probable that this will come under review in connection with the renewal of the Charter, and accordingly we confine ourselves to the consideration of Television finance for the intervening period only, observing that within that time the Advisory Committee should be able to formulate an opinion as to the development of the service.

63. We estimated that the cost of providing the London station, including all running and maintenance expenses, programme costs and amortisation charges (calculated on the basis of a comparatively rapid obsolescence) for the period up to 31st December, 1936, will be £180,000. For obvious reasons we refrain from specifying here the details upon which this estimate is built, but these are available to you in the confidential section of the Report (see Appendix V). Lest, however, too hasty conclusions be drawn from this figure we add the following observations. It must not be assumed that an accurate estimate of the cost of a number of stations can be reached by the simple process of multiplication. By far the largest factor in the above figure is the programme cost. On the one hand, if the service is a success, the cost of programmes will certainly rise materially, just as the cost of sound programmes has risen. We have not budgeted during this early stage for a programme comparable in duration, variety, or quality, with existing sound programmes, although the service should be amply adequate to provide interest and entertainment for the public, as well as opportunity for daily demonstrations by retailers of sets. On the other hand, if and when a number of stations start working, it is contemplated that one programme may be relayed simultaneously to all stations (see paragraph 48), and that only a small portion of the daily output will consist in each case of topical items of local interest. In the case, therefore, of each additional station, the amount to be added to other charges in respect of programme costs will be merely fractional.

64. We have carefully considered the question of providing the necessary funds. Roughly speaking, the means suggested to us for so doing may be classified under two heads:—

(a) Selling time for advertisements, and

(b) License revenue.

65. Advertisements may take two forms: they may be either (i) direct advertisements for which time is bought by the advertiser such as, for instance, a dress show by Messrs. Blank; or (ii) the acceptance, as a gift, of programmes provided by an advertiser and coupled with the intimation of his name, in accordance with a standard formula, such as, for instance, "This programme comes to you through the generosity of Messrs. Dot & Dash," the latter system being usually known as that of "sponsored programmes." As regards direct advertisements, this proposal has been frequently examined in past years. In relation to sound broadcasting it was discussed and rejected by the Sykes Committee on Broadcasting in 1923 (Cmd. 1951, paragraphs 40-41). We do not differ from that Committee's view and accordingly do not recommend this course. As regards "sponsored programmes," for which the Broadcasting authority neither makes nor receives payment, the Sykes Committee saw no objection to their admission; and they are now specifically allowed under the British Broadcasting Corporation's License, although the Corporation has, in fact, only admitted them on rare occasions. We see no reason why the provision concerning sponsored programmes in the existing license should not be applied also to the television service and we think it would be legitimate, especially during the experimental period of the service, were the Corporation to take advantage of the permission to accept such programmes.

66. In attempting to provide funds from license revenue there appear to be four possible courses:—

(1) The raising of the fee for the general broadcast listener's license.

(2) The issue of a special television looker's license.

(3) The imposition of a license upon retailers.

(4) The retention of the existing listener's license at 10/- and the contribution from that license revenue of the necessary funds during the experimental period.

67. Of these courses, the first has the merit of certainty and simplicity. It is arguable whether an additional charge would seriously diminish the number of existing listeners, or even materially abate the normal rate of growth. It would provide a definite and substantial fund to start and maintain a television service. Moreover, if the view which we have already expressed as to the future development of Television in association with sound broadcasting be well-founded, then there is considerable logical justification for treating it as an indispensable adjunct to sound broadcasting, and accordingly laying any increased consequent charge upon the broadcast license. We, however, see no adequate answer to the inevitable complaint from country listeners "Why should we pay an increased charge for a service which only London or some other centres can receive?"—nor even to the further complaint within such areas as are actually served, "Why should we people with restricted means pay this increased charge for a service which we cannot receive, because the necessary apparatus is at present so dear that it is only within reach of the well-off?" We do not, therefore recommend the adoption of this course.

68. The second course, the issue of a special license, has also considerable logical justification. It provides a means whereby those who use—and can afford

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the apparatus necessary to use—this service may contribute towards the cost of it. We must, however, repeat at this juncture, that we are concerned with the means necessary to start this service—to try it out and to set it on its feet—and not with its permanent financing as part of the British Broadcasting Corporation's general system. From the former point of view the proposal, however logically justifiable, has the fatal practical defect that, if the license fee is placed high enough even to begin to cover the cost, it will strangle the growth of the infant service—while, if it is placed low enough to encourage growth, the revenue must for some time be purely derisory as a contribution towards the cost. We do not, therefore, recommend that at the start of the service there should be any extra license, but we think that the question should be reviewed when it is seen to what extent the use of the service has taken hold, and when the costs of further extensions of it can be more accurately estimated.

69. This conclusion naturally brought us to examine the question of the imposition of a license upon retailers of receiving sets, based upon the number of sets sold, not wholly—nor even mainly—with a view to the collection of funds, but as providing, in the absence of a special looker's license, the next best means of keeping a tally upon the number of users, and so measuring the extent to which the service is in demand. We regard the securing of such a tally as of great importance, and it is with some regret that we feel ourselves unable to recommend the imposition of a retailer's license on the sale of each set. Apart, however, from the administrative difficulties and the further difficulties which would inevitably arise later on when amateur constructors become sufficiently expert to construct home-made sets, the arguments which have been put before us, and which also moved the Sykes Committee (Cmd. 1951, paragraph 39), have convinced us that the adoption of such a course would be vexatious to traders and detrimental to the development of the service. We hope, however, that it may be possible to negotiate an arrangement with the trade, whereby periodical returns may be made of the total number of television sets sold in each town or district, since this would provide some measure of the growth of the demand.

70. We are therefore left with the conclusion that, during the first experimental period at least, the cost must be borne by the revenue from the existing 10/- license fee. The determination of the allocation of this contribution as between the British Broadcasting Corporation and the Treasury naturally presents a wide field of controversy, which we should have had to survey at length were we attempting to lay down a permanent basis. Since, however, as explained above, we are dealing only with a relatively limited sum, for a very limited period, we suggest that the best course would be for a reasonable share of the amount to be borne by each of the two parties—the Corporation and the Treasury—and we think that the matter should be considered and determined in this light by the Treasury after consultation with the Postmaster-General and the Corporation.

71. We may perhaps be permitted to anticipate three different types of objection which may be raised to the course proposed in the preceding paragraph. As regards any contingent contribution from the British Broadcasting Corporation, it may be argued that the new service will, at first, enure to the benefit of a limited number of people in a limited area, and that it is unfair that the general body of license holders should have any of their payments diverted from the ordinary programmes, to the improvement of which spare cash, if any, in the British Broadcasting Corporation's coffers should primarily be devoted. As regards a contingent Treasury contribution, it may be maintained that this is no time to cast any fresh burden upon the taxpayer in order to make an experiment of this nature. Further, it may be said that there is no hurry, and that the start of a service can well wait until the renewal of the British Broadcasting Corporation's Charter comes to be considered, when the financial question can be fully and finally settled. We respectfully submit in answer to the first contention, that, while we have already recognised its force (see paragraph 67) as regards any extra levy upon the general body of license holders, there can be no denying that the existing programmes represent amazingly good value for one-third of a penny per day and that, in these circumstances, the general body of listeners may not unreasonably be asked to help, at no extra cost to themselves, in a national experiment which, if successful, will ultimately enhance programme values for a large part of their members. As regards the second objection, we feel that the development of British Television, in addition to being of evident importance from the point of view of science and entertainment, and of potential importance from the angles of national defence, commerce and communications, will also directly assist British industries. Lastly, we are quite unable to agree that there is no urgency. On the contrary, our enquiries convince us that, apart altogether from any question of scientific prestige, any delay would be most regrettable; and we feel that, if our conclusions are accepted, it is most desirable that the minimum amount of time should be lost in giving effect to our recommendations.

Wireless Exchanges (Radio Relays)

72. We have considered the question, which has been raised in evidence, of the relaying of public television broadcast programmes by Wireless Exchanges. We see no reason why such a practice, if technically feasible, should not be allowed under the same conditions as are applicable in the case of sound broadcast programmes.

Private Experiments and Research

73. We hope that encouragement will continue to be given to all useful forms of experiment and research in Television by firms or private persons. It is true that much experimental work can be done by transmission from one room to another by wire without recourse to a radio link. In certain cases, however, the use of such a link is necessary; and we trust that the policy referred to in paragraph 20 will be maintained, and that adequate facilities for experimental work will continue to be given.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

74. Our principal conclusions and recommendations are summarised below:—

Type of Service

(1) No low definition system of Television should be adopted for a regular public service. (Paragraph 26.)

(2) High definition Television has reached such a standard of development as to justify the first steps being taken towards the early establishment of a public television service of this type. (Paragraph 33.)

Provision of Service

Operating Authority.

(3) In view of the close relationship between sound and television broadcasting, the Authority which is responsible for the former—at present the British Broadcasting Corporation—should also be entrusted with the latter. (Paragraph 39.)

Advisory Committee.

(4) The Postmaster-General should forthwith appoint an Advisory Committee to plan and guide the initiation and early development of the television service. (Paragraph 41.)

Ultra-short Wave Transmitting Stations.

(5) Technically, it is desirable that the ultra-short wave transmitting stations should be situated at elevated points and that the masts should be as high as practicable. (Paragraph 46.)

(6) It is probable that at least 50 per cent of the population could be served by 10 ultra-short wave transmitting stations in suitable locations. (Paragraph 47).

Patent Pool.

(7) It is desirable in the general interest that a comprehensive Television Patent Pool should eventually be formed. (Paragraphs 53 and 54.)

Initial Station.

(8) A start should be made by the establishment of a service in London with two television systems operating alternately from one transmitting station. (Paragraph 55.)

(9) Baird Television Limited, and Marconi-E.M.I. Television Company, Limited, should be given an opportunity to supply, subject to conditions, the necessary apparatus for the operation of their respective systems at the London station (Paragraph 56.)

Subsequent Stations.

(10) In the light of the experience obtained with the first station, the Advisory Committee should proceed with the planning of additional stations—incorporating any improvements which come to light in the meantime—until a network of stations is gradually built up. (Paragraphs 57 and 58.)

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(11) The aim should be to take advantage, as far as possible, of all improvements in the art of Television, and at the same time to work towards the ultimate attainment of a national standardised system of transmission. (Paragraph 59.)

Finance of Service

(12) The cost of providing and maintaining the London station up to the end of 1936 will, it is estimated, be £180,000. (Paragraph 63.)

(13) Revenue should not be raised by the sale of transmitter time for direct advertisements, but the permission given in the British Broadcasting Corporation's existing License to accept certain types of "sponsored programmes" should be applied also to the television service. (Paragraph 65.)

(14) Revenue should not be raised by an increase in the 10/- fee for the general broadcast listener's license. (Paragraph 67.)

(15) There should not be any separate license for television reception at the start of the service, but the question should be reviewed later in the light of experience. (Paragraph 68.)

(16) No retailer's license should be imposed on the sale of each television set, but arrangements should be made with the trade for the furnishing of periodical returns of the total number of such sets sold in each town or district. (Paragraph 69.)

(17) The cost of the television service—during the first experimental period at least—should be borne by the revenue from the existing 10/- license fee. (Paragraph 70.)

APPENDIX I

List of Witnesses and Organisations Represented

Messrs. Baird Television Ltd.: Major A. G. Church, D.S.O., M.C.; Mr. A. G. D. West, M.A., B.Sc.

Messrs. A. C. Cossor, Ltd.: Mr. W. R. Bullimore, Mr. J. H. Thomas, M.I.E.E.; Mr. L. H. Bedford, M.A., B.Sc.

Messrs. Electric and Musical Industries Ltd., and Messrs. Marconi-E.M.I. Television Co. Ltd.: Mr. Alfred Clark, Mr. I. Shoenberg, Mr. C. S. Agate, Mr. A. D. Blumlein, Mr. C. O. Browne, Mr. G. E. Condliffe, Mr. N. E. Davis, Mr. S. J. Preston.

Messrs. Ferranti Ltd.: Mr. V. Z. de Ferranti, Mr. A. Hall.

Messrs. General Electric Co., Ltd.: Mr. C. C. Paterson, O.B.E., M.I.C.E., M.I.E.E., Mr. T. W. Heather, M.C.

Messrs. Plew Television Ltd.: Dr. C. G. Lemon.

Messrs. Scophony Ltd.: Mr. S. Sagall, Mr. G. W. Walton, Mr. G. Wikkenhauser.

British Broadcasting Corporation: Sir J. C. W. Reith, G.B.E.

Newspaper Proprietors' Association: Col. the Hon. F. E. Lawson, Sir Thomas McAra, J.P., Mr. A. J. Polley, Mr. F. W. Jarvis, Mr. E. J. Robertson

Radio Manufacturers' Association: Mr. W. W. Burnham, Mr. R. Milward Ellis.

"Popular Wireless" and "The Wireless Constructor": Dr. J. H. T. Roberts, F.Inst.P.

The Television Society: Dr. C. Tierney, F.R.M.S., Mr. Ronald R. Poole, B.Sc., Mr. W. G. Mitchell, B.Sc.

And Sir William Jarratt, Mr. W. Barrie Abbott, B.L., Mr. J. Guibiansky, Mr. A. B. Storrar, Mr. R. W. Hughes.

Radio Research Board — 7th Annual Report

FOR THE YEAR ENDED 30th JUNE, 1935

The Radio Research Board of the Council is constituted as follows:—Professor J. P. V. Madsen (University of Sydney), Chairman; Mr. H. P. Brown (Director-General, Postmaster-General's Department); Electrical Commander F. G. Cresswell (Department of Defence); and Professor T. H. Laby, F.R.S. (University of Melbourne).

1. General.

STUDIES of fading and of the behaviour of the ionosphere from the point of view of its reflection of radio waves and investigations concerning atmospherics have been continued. The last year's operations constitute the second year's activities of the three-year period towards the cost of which the Postmaster-General's Department and the Council for Scientific and Industrial Research are contributing on a three to one basis.

Further changes in the staff of the Board have taken place. Early in the period under review, Dr. G. Builder resigned in order to take up an industrial appointment, and Dr. A. L. Green has also notified the Board that he intends to resign in September, 1935, for a similar reason. The Board welcomes this indication of the way its staff is regarded by the industry. Following the resignation of Dr. Builder, Mr. J. H. Piddington, M.Sc., is now engaged on the Board's work in a full-time capacity in Sydney, and as from the 1st July, 1935, Mr. R. W. Boswell, M.Sc., took up a similar appointment at Melbourne.

2. Work on Fading and the Ionosphere.

The investigation of these problems is still centred in New South Wales. As formerly, the object of this work is to investigate the fading of wireless signals. Since the ionosphere is eventually responsible for such fading, it follows naturally that a large part of the programme has been devoted to the examination of its structure and to its diurnal and seasonal fluctuations.

In general, the same points of attack on these problems have been followed as in previous years. During the past year, however, new methods of attack have been developed, while considerable advances in technique have been effected. This year has seen the adaptation of the cathode-ray tube to most of the methods of investigation followed. In particular, it has been found possible to adapt the method of height measurement using high-speed frequency changes outlined in previous reports. This has had the advantage of rendering much of the work independent of the rather cumbersome and delicate Einthoven galvanometer.

During the year, advantage has been taken of the co-operation of Dr. O. O. Pulley, Walter and Eliza Hall Fellow, in the University of Sydney, in order to bring into operation the pulse method of ionospheric investigation. It is anticipated that the application of this method to some of the problems under investigation will greatly facilitate the interpretation of the results in cases where more than one downcoming wave is being received. Automatic height recording by the pulse method has now been in operation for some weeks, and measurements of the ionisation densities in the various layers of the ionosphere have also been made using this method.

In connexion with the work on the theory of the interaction of radio waves mentioned in the last report, advantage has been taken of the visit to Europe of Associate-Professor V. A. Bailey (University of Sydney) in order to examine the latest observations made on this subject. It has been found that the measurements of Drs. Van der Pol and Van der Mark are in very good agreement with the theory previously outlined, and it has now been possible to obtain therefrom a good estimate of the air pressure in the E region of the ionosphere.

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RADIO RESEARCH BOARD ANNUAL REPORT—(Continued)

The results obtained with the 3-aerial technique, mentioned in the previous report, have now been analyzed and published. Adequate confirmation has been obtained of the conclusions (1) previously reached from a study of natural fading that there is normally present a considerable degree of lateral deviation of the downcoming rays when reception is at a point not too far distant from the emitting station. The 3-aerial apparatus, however, enables measurements to be made of the polarization of the downcoming ray, in addition to its direction of arrival, and it has been found possible, in one specific case, to show that a correlation exists between these two characteristics of the downcoming ray.

This conclusion, which awaits confirmation by further experiments, is nevertheless in good agreement with the theory previously proposed (2), on the influence of the earth's magnetic field on the limiting polarization of the downcoming ray. According to this hypothesis, the measured polarization of the sky ray at the receiver is that acquired by the ray as it leaves the ionosphere. This limiting polarization is, in turn, determined solely by the frequency of the wave relative to the "critical" frequency of the ionosphere and by the direction of propagation of the ray with respect to the lines of force of the earth's field. The occurrence of lateral deviation of the sky ray necessarily entails marked variations in the angle between the downcoming ray and the direction of the earth's field, so that, on theoretical grounds, it should be expected that there is a close connexion between the measured polarization and the direction of arrival of the ray at the receiver.

In the case of symmetrical propagation of the sky ray from Sydney to Liverpool, New South Wales, the angle between the direction of the downcoming ray reflected from the "F" region and the lines of force of the earth's field is approximately 149 degrees. Corresponding to the angles of lateral deviation and of incidence which have been measured by the 3-systems apparatus, this critical angle must have undergone variations between the limits 146 degrees and 154 degrees. Calculations have been made of the degree of ellipticity to be expected in the polarization of the downcoming ray under these conditions, and it has been found that the measured polarization characteristics agree with the theoretical predictions.

This result is of some importance, as it lends support to the use of the theory of limiting polarization on other occasions. It will be recalled that the earlier measurements of circular polarization with a right-handed sense of rotation (3), at Jervis Bay, are also in agreement with the theory, and that more recently an extension of the analysis to cover the propagation of very long waves (4), has resulted in an explanation being put forward of the rotation of the plane of polarization found to occur at sunrise and sunset.

It has been known for some time that Appleton's frequency-change device is somewhat difficult to apply to experimental investigations using very short waves, and it has been suggested (5) that similar results might be obtained if the carrier is modulated and the required frequency-changes imposed on the audio-frequency modulation.

Some preliminary work with the modulation-frequency-change (m.f.c.) technique has been carried out in England and repeated in Australia, and it is clear that the m.f.c. apparatus, as originally designed, suffers several disadvantages when compared with carrier-frequency change (c.f.c.). In general, the amplitude of the artificial fading fluctuations is very small unless subsidiary apparatus is introduced, such as the two square-law detectors employed by Appleton, so that, unless this addition is made, the records are difficult to decipher. Unfortunately, repeated rectification has the effect of greatly enhancing the disturbances due to atmospherics and interference from adjacent transmissions, while, in addition, the recent work has disclosed that the amplitude of the artificial fringes depends in a complicated way both on the intensities and on the relative phases of the ground and sky rays. In the c.f.c. experiments, the relative intensity of the ground and sky rays alone determines the fringe amplitude.

A new m.f.c. technique (6) has therefore been devised which does not require the use of double detection, and in which the fringe records are more simply related to the characteristics of the downcoming ray. In this case, suppression of the carrier is realized at the transmitter instead of the receiver, and only the modulation sidebands are emitted. Since it is not necessary to insert the carrier again at the receiver, it is possible to use the same apparatus there as for the c.f.c. technique.

A number of comparisons have been made of the c.f.c. and the two m.f.c. techniques in ionospheric measurements, and the following conclusions have emerged:—

(i) Both the m.f.c. and the c.f.c. devices measure the same quantity, namely, the equivalent path of the sky ray.

(ii) The amplitude of the fringes produced by a frequency-change in a m.f.c. experiment is much less than in c.f.c., unless subsidiary apparatus is introduced, such as the two square-law detectors employed by Appleton, or the carrier-suppression technique recently developed.

(iii) With either of these modifications, the interference fringe amplitude is occasionally as great as would have been obtained with the c.f.c. technique. Since, however, the fringe amplitude depends on the relative carrier phases of the ground and sky rays, as well as their relative intensities, the fringe amplitude is, on the whole, less when using m.f.c. technique.

(iv) The phase of the beginning of a set of m.f.c. fringes is independent of the momentary state of the natural fading, of the polarization of the sky ray, and of the orientation of the receiving loop aerial. M.f.c. technique is therefore not applicable to those experimental methods, previously developed for c.f.c. work, which depend for their success on the variation of fringe phases with the state of polarization, lateral deviation, and optical path of the sky ray.

(v) It is found that the system using carrier-suppression at the transmitter is the more satisfactory technique for ionospheric investigations, both in regard to apparatus and to the interpretation of records.

The investigations of the Board into the fundamentals of ionospheric propagation have on several occasions suggested methods by which a certain measure of control of wireless signal variations might be effected. The experiments with modulation-frequency-change technique have proved to be closely allied to a known process of controlling fading in wireless telegraphy (7) in which signals are emitted simultaneously on a number of adjacent frequencies. Since it is known that fading variations are different in the case of signals on neighbouring frequencies (8), it follows that a proper choice of the frequencies should result in a balancing of the fading effects in the several channels, and a consequent smoothing of the combined signals.

The most obvious way of sending signals on different frequencies is to modulate the carrier wave at an audible frequency, and thus to emit three waves, carrier and two sidebands. Investigations have shown, however, that it is not possible to obtain perfect control of fading with the simple modulation. The optimum conditions are realised when the depth of modulation is 100 per cent., and when the frequency of modulation is critically adjusted to correspond with the path-difference between the ground and sky rays. Under these conditions, the depth of fading can be reduced to one-third of normal. On the other hand, it has been found that the newly devised suppressed-carrier technique for m.f.c. experiments can easily be adapted to give perfect control of fading. In one instance when the depth of fading was found to be 80 per cent., the addition of control modulation at a frequency of 380 c.p.s. and the suppression of the carrier were found to reduce the fading fluctuations to less than 2 per cent.

It is clear from the theory that the method of control depends on a precise adjustment of the modulation frequency to the path-difference between the interfering rays. It has also been found that the odd-numbered harmonics of the fundamental control frequency are equally effective, but that the even harmonics leave the fading fluctuations undisturbed. It follows that, in certain special cases of the reception of more than one sky ray in addition to the ground ray, it should be possible to suppress one of the sky rays, and to examine the other by experimental methods which are already known. This should facilitate the interpretation of frequency-change records in complex cases.

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RADIO RESEARCH BOARD ANNUAL REPORT—(Continued)

It would appear that the modulation method of controlling fading has a wider field of application than that mentioned above, that is, as an adjunct to ionospheric research. In long-distance communication, where sky rays alone are receivable, there may be occasions during which the fading fluctuations are chiefly due to phase interference between two main sky rays (9). When this is so, it should be possible to smooth out the phase fading by a proper adjustment of the modulation frequency to the path-difference between the two main interfering rays.

Experiments have been made in Melbourne and Perth, distant respectively 700 and 3,300 kilometres from the transmitter in Sydney, and it has been found that a considerable improvement in constancy of signal can be obtained with the suppressed-carrier modulation. The communication circuits were first tested with frequency-change signals, and, from the appearance of the photographic records of the received waves, it was immediately obvious that over long periods of time the bulk of the energy was being carried by two main sky rays. In Melbourne, the path-difference between the two main sky rays was approximately 150 kilometres during the afternoon, and 400 kilometres after sunset, there being, however, occasional reversions to the lesser path-difference during the night, and further periods when three sky rays of comparable intensity were being received. Under these circumstances, it was found that a modulation frequency of 200 c.p.s. gave the best results at night over long periods.

The records obtained in Perth were in all cases much more complicated, and it was realised that multiply-reflected rays of high order were present. Nevertheless, after examining a large number of frequency-change test records, it was possible to select a path-difference of about 500 kilometres as representative of the night conditions. The corresponding modulation of frequency 150 c.p.s. was found to effect a considerable influence on the deep troughs of fading. An attempt to allow for a third sky ray resulted in the use of two modulations simultaneously, 50 and 150 c.p.s. A further improvement in constancy of signal was obtained, but it is obvious that a limit to the degree of fading control which can be achieved in long-distance communication is set by the temporal variations in intensity of individual rays.

The application of this system of fading control to telephonic circuits is very much complicated by the presence of the undesired control modulation. So far, no experiments have been made with a programme modulation in addition to the control, but it is interesting to notice that theoretical considerations point to at least one way of effecting the desired result. It has already been mentioned that the odd-numbered harmonics of the fundamental control frequency are also available for the purposes of correction. Experiments with these harmonics up to the 13th have shown that, in practice, it is somewhat difficult to select the modulation frequency with sufficient precision. However, in the case mentioned, it was possible to obtain good fading control when the corrective modulation was actually supersonic, so that it would appear to be possible to add the programme, consisting of audible notes, without interference from the control modulation.

It is perhaps of interest to recall that considerable difficulty was experienced in some early short-wave experiments conducted in Sydney, the transmissions being given from H.M.A.S. Platypus (10). Frequency-change signals were sent from the ship, but in no cases were sky rays observed. At that time, it was assumed that propagation conditions in the latitude of Sydney were very different from those previously experienced in England, but it now appears that the absence of sky ray interference in those experiments was due to a very effective, but unintentional, control of fading, produced by deep modulation of the signals due to the unsmoothed anode supply at the transmitter.

Special attention has been given to the development of stable oscillators. A dynatron oscillator has been built (11) employing temperature compensation in the coils and condenser. This has proved entirely satisfactory, and several beat frequency oscillators have been built using such temperature compensation.

Considerable attention has also been given to methods of obtaining frequency modulation using resistance-tuned oscillators. In this way, it has been found possible to obtain pure frequency modulation of any desired waveform by purely electrical means.

3. Work on Atmospherics.

In the following a resume is given of the information gained from the atmospherics observations made under the administration of the Board.

1. Origin of Atmospherics.

Considerable evidence has been adduced in favour of the hypothesis, due originally to Watson Watt, that all atmospherics originate in lightning flashes. This evidence has been confirmed and considerably extended by physicists of the Australian Radio Research Board, from observations taken during a voyage from England to Australia and detailed observations made in Australia relating to the greater part of the continent, the Tasman Sea, and adjacent parts of the Southern Ocean. It has been found ((12) p. 43, (13) p. 28) in the first place, that the points of origin of atmospherics, located by radio direction-finders, always lie within a region which subsequent meteorological reports revealed either that a thunderstorm had occurred or that the conditions made the occurrence of a thunderstorm probable, although none was observed owing to the sparsity of observing stations. This is, however, only a small part of the evidence, for it has been found that single atmospherics, on the one hand, and "sources of atmospherics"* on the other, have exactly the properties to be anticipated from the thunderstorm hypothesis.

2. Properties of an Atmospheric.

(i) Wave-form.—Appleton, Watt, and Herd concluded from their observations that an atmospheric consists of an aperiodic or "quasi-periodic" pulse lasting a few milliseconds (sometimes with shorter period ripples superposed). Australian observations (14) showed that the total duration of an atmospheric is usually between 0.2 and 0.5 sec., each atmospheric consisting of a succession of the order of 10 pulses of the type found by Appleton, Watt, and Herd, clear intervals separating the pulses. This corresponds exactly to the temporal structure of a lightning flash as deduced from the moving picture photographs of Walter and others. Atmospherics from sea sources have a rather longer average duration. This and other exceptional characteristics of thunderstorms over the sea are referred to later.

(ii) Polarization.—Atmospherics are frequently observed to be elliptically polarized, particularly at night. In day time, atmospherics from close sources only show such polarization (15). This property has been used to deduce the mean height of the point of origin of the atmospheric, and a value comparable with the mean height of a lightning flash, as directly observed, is obtained.

(iii) Equivalent Power of a Flash.—The term "equivalent power" denotes the power of a station emitting a steady signal which gives the same deflection, on an oscillograph connected to the output of a specified receiver, as the mean deflection produced by atmospherics from a thunderstorm situated immediately over the station. The equivalent power is a function of the frequency to which the receiver is tuned and its band-width of reception.

From the study of intensities of atmospherics from lightning at known distances, it has been found that the equivalent power of a flash (i) is sensibly independent of the geographical area in which the thunderstorm occurs, and has a value of about 2 kw. for a receiver tuned to 1,000 kc./s., and with a band-width of 20 kc./s., and (ii) is inversely proportional to the square of the frequency within the range 10 kc./s.-1,000 kc./s. (the band-width being maintained constant).

It is interesting to use this result to estimate the "total peak radiated power" of the flash, i.e. the maximum rate of dissipation of energy in the form of electro-magnetic radiation in the "radio" portion of the spectrum. It is necessary to make some assumption as to what happens at the lower frequencies. The most tractable assumption is that the power falls to zero at a critical frequency V_0, which we shall take as 300 c/s., this

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* A "source" of atmospherics is a term introduced by Munro and Huxley to denote a well-defined area over which atmospherics arise, which is of linear dimensions of about 100 km. It is a thunderstorm, or a group of thunderstorms which behave as one entity.

RADIO RESEARCH BOARD ANNUAL REPORT—(Continued)

being the reciprocal of the period of a single pulse as found by Appleton, Watt, and Herd. With this assumption, integration leads to a value of 10^5 kw. for the total peak radiated power. The peak current in a lightning flash has been variously estimated. If the value of 3 x 10^5 amps. is assumed, the effective radiation resistance comes out at 10^{-3} ohm.

The range of intensities* of individual atmospherics coming from a single source has been studied ((12) p. 34, (13) pp. 22, 41). It is found that the distribution of logarithms of the intensities is a normal probability distribution, and that 90 per cent. of the atmospherics usually lie within a range of 4 to 1. The range varies slightly with different sources, and appears to be slightly less for 1,000 kc/s. receiver frequency than for 100 kc/s. This relatively small range has led to considerable simplification in the determinations of the mean intensities of sources, i.e., the mean intensity of atmospherics from a source, which have been used in the deduction of equivalent power.

3. Properties of Sources.

(i) Mean Intensities.—A map, on which points at which lightning flashes give the same mean intensity at the observing station are connected to form "iso-intensity" contours, can be used to determine by interpolation the portion of a source from single station observations, the procedure being somewhat analogous to that used by astronomers in the case of the Cepheid variable stars. Owing to the relatively small range of individual intensities, a few intensity observations suffice for each source.

(ii) Extent.—From carefully selected directional observations, the average extent has been found to be about 10^4 sq. km. ((13) p. 51). Meteorological observers give the area of a thunderstorm as of the order 100 sq. km., but cases are reported of simultaneous occurrence of thunderstorms over an area of the order of 10^4 sq. km. From the number of sources observed in a year's observation in each of several areas and the isobront map for these areas, an independent estimate of the extent of the source can be obtained. The values obtained are of the order of 10^5 sq. km. The discrepancy is probably due to the migration of thunderstorms to which reference will be made later.

(iii) Activity and Duration.—The average activity of sources ranges from less than 10 flashes per minute for sources in Tasmania, to over 40 for north-west Queensland. The mean durations of land sources are about 6 hours for all latitudes, but for sea sources the mean is about 10 hours, and some sea sources persist for days. In agreement with direct observations on thunderstorms, the average mid-point in the life of a source is about 4 p.m.

(iv) Movement.—As mentioned previously, sources are frequently of a migratory type, moving with velocities of the order 50 km/hr. ((13) p. 51). This point will be considered later in more detail.

4. Thunderstorm Areas of the World.

Some information regarding the distribution of world centres of atmospherics was derived from directional observations by Munro and Huxley during a voyage from England to Australia via Suez ((12) p. 19), and this has been confirmed and extended by the records of the atmospheric recorder at Canberra. The most prolific world centre is situated in tropical Africa, the centres next in importance being in the Malay Archipelago and North Australia. Brooke's isobront map, based on reports of meteorological observers, confirm these results.

5. Distribution in Australia.

Some light on the detailed distribution of thunderstorms in eastern Australia has been thrown by atmospherics directional observations from Canberra, Melbourne, and Toowoomba. The correspondence obtained with the isobronts deduced by Barkley* from 10 years' meteorological observations is as close as would be expected in view of the limited period of the atmospherics observations.

6. Interference with Broadcast Reception.‡

Preliminary estimates of the degree of interference with broadcast reception under various circumstances have been made, based on a new definition of degree of interference, viz., the average annual period for which a broadcast listener at a specified place, listening to a signal of specified amplitude, receives more than a specified number of "interfering" atmospherics per minute. Previous estimates of interference have always been based on noise level conception; these have been shown to be somewhat misleading.

The present estimates are based on the provisional conclusion from experiments that an atmospheric interferes seriously with a broadcast programme when its "peak field intensity" is twice the field strength of the broadcast signal. The equivalent power of a lightning flash (for a specified receiver) being known, and the attenuation of the radiation being obtainable from published data, then for a specified locality, with a broadcast signal of specified field strength and wavelength, a "region of interference" can be determined. Lightning flashes within this region will, on the average, give interfering atmospherics, while flashes outside this region will not. Owing, however, to the appreciable range of radiated powers for a given thunderstorm, thunderstorms from without this region will contribute somewhat to the interference, and allowance must be made on this account.

From the distribution of thunderstorms obtained by isobront maps and atmospherics source data, and the activity and durations of these sources, estimates of degree of interference can then be made. Typical results are for (a) Victoria, with signal field strength 0.5 mV/m., wavelength 400 metres, there are 95 hours in the year for which more than 3 interfering atmospherics per minute will occur; (b) for south-east Queensland the corresponding figure is 250 hours. In general, for high signal amplitudes, the degree of interference contours, correspond closely with the isobronts, while for very low signal amplitudes they correspond nearly to parallels of latitude.

7. Meteorological Aspects.†

As mentioned previously, some sources, particularly those south of latitude 35°, show clear evidence of motion. Northern land sources, on the other hand, often appear to be stationary. Meteorologists are accustomed to classify thunderstorms into two types, heat and frontal, the first of which originate from local surface heating, while the second originate in or near a front or frontal zone separating two different air masses. Such fronts are known usually to move with velocities of the order 30-50 km/hr. (although almost stationary fronts are not unknown). A study of the meteorological conditions associated with the sources of atmospherics have enabled many sources to be classified as heat or frontal—in particular, migratory sources all appear to be associated with fronts (as would be expected). The proportion of heat sources increases as the latitude decreases; the thunderstorms of north-west Queensland seem to be mostly heat ones. This conclusion is confirmed by an examination of meteorological observers' thunderstorm reports.

In the region below 35° latitude, in late spring and early summer, nearly all sources, if not all, appear to be associated to some degree with fronts, and are consequently of the migratory type, moving roughly from west to east from the Bight to the Tasman Sea. This is interesting in view of the fact that the regularity of movement of fronts and weather phenomena generally in this region constitutes the basis of weather forecasting for Victoria and Tasmania. The area in this region which is effectively kept under observation by a cathode ray direction-finder is very large, amounting as it does to some millions of square miles.

8. Sea Sources.

The atmospherics observations have shown that the number of sea sources per annum for each 5° "square" (i.e., of latitude and longitude) is comparable with the number of land sources for a square in the same latitude. For the northern part of the Tasman Sea there are rather fewer sea sources than on land, but for the portion of it east of Victoria there is an excess of sea sources.

For obvious reasons sea thunderstorms have been relatively little studied, and it is interesting to summarise the information concerning them given by the atmospherics observations.

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* The intensity is measured by the oscillograph deflection. with a receiver sensitivity adjusted so that a single-frequency test signal gives a constant deflection.

* Of the Commonwealth Meteorological Bureau.

‡ A summary of Ref. 13. Paper 2. (pp. 43-60).

† The data referred to in this section are mostly unpublished.

RADIO RESEARCH BOARD ANNUAL REPORT—(Continued)

The durations of atmospherics from sea sources are almost invariably long, usually of the order of a second; in fact, "sea" atmospherics can usually be distinguished from "land" by this characteristic. As mentioned previously, the average total life of a sea source is also of greater duration than of land. The hours of commencement and ending, and also the hour of greatest activity, are less regular than in the case of land sources. A sea source may continue for days with very slight changes in position, extent, and activity—an example of a sea source persisting over a week has been obtained.

The uniformity of the sea's surface and the comparative independence of the sources on the degree of isolation suggests that sea sources would be almost all of the frontal type. While the meteorological observations tend to confirm this in many cases, the stationary position of many long-lived sources is difficult to reconcile with this usual behaviour of fronts.

9. Aviation.

The ability of cathode ray direction-finders to register rapidly the bearings of thunderstorms may have an application to aviation, particularly for night-flying. The movement of sources has been followed in detail on the occasions of two notable flights; in one case an active thunderstorm was situated near, but not on, the route, and in the other case a thunderstorm nearly led to disaster.

4. Publications.

The following publications have been issued during the past year as a result of the Board's investigations:—

(a) Publications of the Council for Scientific and Industrial Research.

1. **Bulletin** 87.—"Radio Research Board: Report No. 6." (1) "On the Rotation of the Plane of Polarisation of Long Radio Waves," by A. L. Green, M.Sc., Ph.D., and G. Builder, Ph.D. (2) "A Field Intensity Set," by A. L. Green, M.Sc., Ph.D., and H. B. Wood, B.Sc., B.E. (3) "Measurements of Attenuation, Fading, and Interference in South-Eastern Australia, at 200 Kilocycles per Second," by G. H. Munro, M.Sc., and A. L. Green, M.Sc., Ph.D. (4) "A Frequency Recorder," by D. F. Martyn, Ph.D., A.R.C.Sc., and H. B. Wood, B.Sc., B.E.

2. **Bulletin** 88—"Radio Research Board; Report No. 7." (1) The Propagation of Medium Radio Waves in the Ionosphere," by D. F. Martyn, Ph.D., A.R.C.Sc., (2) "The Characteristics of Downcoming Radio Waves," by D. F. Martyn, Ph.D., and A. L. Green, Ph.D. (3) "The Influence of Electric Waves on the Ionosphere," by V. A. Bailey, M.A., D.Phil., and D. F. Martyn, Ph.D. (4) Long Distance Observations of Radio Waves of Medium Frequencies," by D. F. Martyn, Ph.D., R. O. Cherry, M.Sc., and A. L. Green, Ph.D.

3. **Bulletin** 89.—"Radio Research Board: Report No. 8." (1) "Simultaneous Observations of Atmospherics with Cathode-Ray Direction-Finders at Toowoomba and Canberra," by G. H. Munro, M.Sc., and H. C. Webster, M.Sc., Ph.D., and A. J. Higgs, B.Sc. (2) "Atmospheric Interference with Reception," by W. J. Wark, M.Sc.

(b) Other Publications.

1. "Dispersion and Absorption Curves for Radio Wave Propagation in the Ionosphere according to the Magneto-Ionic Theory," by D. F. Martyn, Ph.D., A.R.C.Sc. **Phil. Mag., 19:** 376, 1935.

2. "The Interaction of Radio Waves," by V. A. Bailey, M.A., D.Phil., and D. F. Martyn, Ph.D., A.R.C.Sc. **Wireless Engineer,** March, 1935.

3. "The Interaction of Radio Waves," by V. A. Bailey, M.A., D.Phil., and D. F. Martin, Ph.D., A.R.C.S. **Nature, 135:** 585, 1935.

4. "A Temperature Compensated Dynatron Oscillator of High Frequency Stability," by J. H. Piddington, B.Sc., B.E., **J. Inst. Eng. Aust., 6:** 1934.

5. "The Amplification of Transients," by G. Builder, Ph.D. **Wireless Engineer, 12:** 246, 1935.

6. "A Graphical Solution of Simple Parallel-Tuned Circuits," by G. Builder, Ph.D. **J. Inst. Eng. Aust. 6:** 1934.

7. "A Multi-Range Push-Pull Thermionic Voltmeter," by G. Builder, Ph.D. **J. Inst. Eng. Aust., 6:** 1934.

8. "The Amplification of Programme Transients," by G. Builder. **J. Inst. Eng. Aust. 6:** 1934.

5. Acknowledgments.

Once again, acknowledgment is due to a number of organisations and individuals for the valuable co-operation they have furnished. The help of the Postmaster-General's Department and of the Universities of Melbourne and Sydney has been continued on the previous lines. The Department of Defence, too, has afforded help in several ways, notably by the loan of apparatus and the accommodation of equipment at Laverton (Victoria), and Liverpool (New South Wales). The Commonwealth Solar Observatory at Mt. Stromlo, and the Watheroo Magnetic Observatory of the Carnegie Institution are also co-operating most helpfully in connection with the work on atmospherics. The Commonwealth Meteorological Bureau has also furnished meteorological data at all times, and towards the end of the period under review, arranged to co-operate in a thorough test of the possible value of the Board's atmospheric work from a meteorological point of view.

6. References.

1. Cherry and Martyn. "Radio Research Board Report 4," Paper 2, Coun. Sci. Ind. Res. (Aust.), Bulletin 63, 1932.
2. Baker and Green. "Radio Research Board Report No. 3," Coun. Sci. Ind. Res. (Aust.), Bulletin 60, 1932.
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4. Green and Builder. "Radio Research Board Report No. 6," Paper 1, Coun. Sci. Ind. Res. (Aust.), Bulletin 87, 1935.
5. Appleton. **Proc. Phys. Soc. 42:** 321, 1930.
6. Builder and Green. "Modulation-frequency-change Technique for Ionospheric Measurements." In Press.
7. T. L. Eckersley. **J. Inst. Elec. Eng. 57:** 992, 1929.
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10. Radio Research Board Second Annual Report. **J. Coun. Sci. Ind. Res. 3:** 156, 1930.
11. J. H. Piddington. **J. Inst. Eng. Aust. 7:** 53, 1935.
12. "Radio Research Board Report No. 5," Coun. Sci. Ind. Res. (Aust.), Bulletin No. 68.
13. "Radio Research Board Report No. 8," Coun. Sci. Ind. Res. (Aust.), Bulletin No. 89.
14. **Nature. 134:** 880, 1934.
15. "Radio Research Board Report No. 10," Coun. Sci. Ind. Res. (Aust.), Bulletin No. ? (In Press.)

Tariff Board's Report

Tariff Revision—Wireless Receiver Parts and Accessories

REPORT COMPLETED 28th JUNE, 1935—ORDERED TO BE PRINTED 4th DECEMBER, 1935.

ON 2nd March, 1933, the Minister for Trade and Customs referred to the Tariff Board for inquiry and report, in accordance with section 15 (1) (d) of the Tariff Board Act 1921-1929, the question of the necessity for the rates of duty imposed by the Customs Tariff Proposals of 13th October, 1932, on the goods covered by the following sub-items of those proposals, viz.:—Item 180(e) (1), (2), (4), (7), (8), (9), (10), (11), (12), (13), (14), (15), (16), (18), (19), (20), (21) and (24), Item 180 (m) and (n), imported into the Commonwealth of Australia.

On 8th September, 1933, the Minister for Trade and Customs referred to the Tariff Board for inquiry and report, in accordance with section 15 (2) (e) and section 15 (1) (d) of the Tariff Board Act 1921-1929 the following questions:—

(1) Whether appliances for use with radio sets installed in motor cars, for converting current from the car battery into current suitable for the plate supply of the valves of the radio set should be removed from the provisions of Tariff Item 434, and

(2) If so, what rates of duty should be levied on the above-mentioned appliances.

On 18th October, 1933, the Minister for Trade and Customs referred to the Tariff Board for inquiry and report in accordance with section 15 (2) (e) and section 15 (1) (d) of the Tariff Board Act 1921-1929 the following questions:—

(1) Whether rods of amorphous carbon or consisting principally of amorphous carbon with metal-sprayed ends for use in the manufacture of radio resistors should be removed from the By-law under Item 434, and

(2) If so, what rates of duty should be levied on the above-mentioned goods.

In pursuance of the Minister's references the Board has made the necessary inquiry and submits the following report:—

PRESENT ITEM AND RATES

Tariff Board Notes.—(1) The sub-items set out hereunder are those appearing in the Customs Tariffs 1933, but are identical with those appearing in the Customs Tariff Proposals of 13th October, 1932, and mentioned in the Minister's reference of 2nd March, 1933.

(2) With the exception of that under Item 434, the duties chargeable under the British Preferential Tariff, rates shown in the sub-items hereunder are subject to reduction in accordance with the Customs Tariff (Exchange Adjustment) Act 1933-1934.

	British Preferential Tariff		General Tariff
Item 180. Electrical and Gas Appliances viz.:—			
(e) Wireless Receivers, Parts, thereof, and Accessories therefor, viz.:—			
(1) Chargers, Battery, .4 ampere to 1 ampere, both inclusive, each	7s.	....	10s.
(2) Chargers, Battery, exceeding 1 ampere and up to and including 3 amperes .... each	21s.	....	30s.
(4) Condensers, Fixed Mica each	5d.	....	6d.
(7) Dials, Vernier .... each	10d.	....	1s. 3d.
(8) Dials, n.e.i. .... each	1½d.	....	2d.
(9) Eliminators, "A" Battery .... each	35s.	....	50s.
(10) Eliminators, "B" Battery .... each	27s. 6d.	....	40s.
(11) Eliminators, "BC" and "ABC" Battery, Power Packs, and similar devices, whether imported separately or incorporated in a wireless receiving set .... each	40s.	....	60s.
(12) Resistances, fixed, having a resistance value of 2 megohms and over .... each	4½d.	....	6d.
(13) Headphones .... each	2s. 6d.	....	4s.
(14) Jacks, Phone and Loudspeaker each	4d.	....	6d.
(15) Knobs .... each	1½d.	....	2d.
(16) Lightning Arrestors .... each	4d.	....	6d.
(18) Plugs, Phone and Loudspeaker each	3d.	....	4½d.
(19) Rheostats Potentiometers and Variable Resistances .... each	6d.	....	8d.
(20) Sockets, Valve .... each	3d.	....	4½d.
(21) Transformers, Audio and Radio each	1s. 9d.	....	2s. 6d.
Or as to all the goods covered by the above paragraphs the following rates if same return a higher duty, viz. .... ad. val.	35%	....	55%
(24) Parts, n.e.i. of wireless receivers, other than Cabinets .... ad val.	35%	....	55%
Electrical Appliances—			
(m) Registers or Meters, of the type which totals electrical impulses, such as those used in telephone exchanges for recording subscribers' calls, and in totalisators .... ad val.	40%	....	60%
Electrical Appliances—			
(n) Jacks, n.ei. .... ad val.	40%	....	60%

(British Preferential Tariff rates are subject to exchange adjustment in accordance with the Customs Tariff (Exchange Adjustment) Act, 1933.)

Item 434. Goods of the classes which may be prescribed by Departmental By-laws under Items 174, 404 or 415a, but which are for such use as, in the opinion of the Minister, does not justify the application of the rates of duty operating under such items, as prescribed by Departmental By-laws .... ad val.	5%	....	20%

Importations

The only articles dealt with by the Board for which separate statistics of importations are kept are battery eliminators and battery chargers. These statistics are given below.

Importations of appliances for converting battery current to plate current for motor car radio are included in the figures relating to importations of battery eliminators, and which are given below.

Importations of carbon rods are included in the figures relating to importations of "Carbon manufactures of all kinds," and as no dissection is possible these figures are not given.

The balance of the goods covered by this report are included under the statistical heading "Wireless parts, n.e.i." The figures under that heading are given below, but it must be remembered that they cover many parts not dealt with by the Board herein:—

Public Inquiry

In accordance with section 11 (4) of the Tariff Board Act 1921-1933 the matters referred by the Minister were made the subject of public inquiry at Melbourne on 6th March, 1935, and Sydney on 20th March, 1935.

Witnesses

The following witnesses appeared at the inquiry, tendered evidence on oath and were examined by the Board:—

Ernest Herbert Wyndham Westwood, general manager, Miniature Electric Company Proprietary Limited, developers of

(Continued on next page)

TARIFF BOARD REPORT—(Continued)

Article and Counry of Origin.	1930-31 No.	1930-31 £	1931-32 No.	1931-32 £	1932-33 No.	1932-33 £	1933-34 No.	1933-34 £
Statistical Item 534b—Battery Eliminators—								
United Kingdom	13	27	2	7	Not separately recorded		201	711
Other British	..	..	..	..			2	14
Germany	26	71	..	..			..	..
Netherlands	454	728	1	1			..	..
United States of America	69	230	181	83			4,364	4,114
Other Foreign	..	..	..	..			15	17
Total	562	1,056	184	91	207	489	4,582	4,856
Statistical Item 534c—Battery Chargers	110	229	13	148	37	64	..	5
Statistical Item 534d—Wireless Parts, n.e.i.—								
United Kingdom	..	30,058	..	10,299	..	8,073	..	9,242
Canada	..	43	..	737	..	2,131	..	933
Other British	..	347	..	133	..	56	..	29
Germany	..	14,059	..	5,547	..	2,693	..	891
Netherlands	..	21,323	..	1,367	..	631	..	307
United States of America	..	69,739	..	44,433	..	23,533	..	23,139
Other Foreign	..	518	..	492	..	190	..	69
Total	..	136,087	..	63,008	..	37,307	..	34,610

miniature electric machines for all kinds of applications, 106 Moor-street, Fitzroy, N.6.

David John Doughton, managing director, Condensers Proprietary Limited, manufacturers of fixed mica condensers and other radio appliances, 476 Latrobe Street, Melbourne.

John Peter Hoppe, manager, Van Cooth and Company Proprietary Limited, exporters, importers and manufacturers of radio parts and appliances, 247-249 William Street, Melbourne.

Leslie Edwin Cole, managing director, Hilco Transformers Proprietary Limited, manufacturers of transformers, 23-27 Villiers Street, North Melbourne.

Arthur George Warner, joint managing director of Radio Corporation Proprietary Limited, manufacturers of radios, 21 Sturt Street, South Melbourne, S.C.4.

William James Mills, manufacturer of carbon resistors, 187 Catherine Street, Leichhardt, New South Wales.

Herman J. Hoppe, managing director of Van Cooth and Company Proprietary Limited, exporters, importers and manufacturers of radio parts and appliances, 247-249 William Street, Melbourne.

Gordon Rich, manager, Simplex Radio, manufacturers of fixed mica condensers, 716 Parramatta Road, Petersham, New South Wales.

Stanley McKenzie Grime, president of the Radio and Telephone Manufacturers' Association—a section of the Chamber of Manufactures of New South Wales—and assistant manager of Amalgamated Wireless (Australasia) Limited, manufacturers of radios and radio parts.

Claude Plowman, managing director, Airzone 1931 Limited, manufacturers of radios, 16-22 Australia Street, Camperdown, New South Wales.

Hedley Vicars Howe, representing the Chamber of Manufacturers of New South Wales, 26 O'Connell Street, Sydney.

Frederick William Parkes Thom, director of Thom and Smith Limited, manufacturers of radio and electrical apparatus, 55 Dowling Street, East Sydney.

Evidence.*

A copy of the official transcript of evidence tendered at the inquiry is attached.

Summary of Evidence

Owing to the wide and varied range of goods covered by this report and the mixed interests of various witnesses, the summary of evidence usually supplied with the Board's reports is not included herein.

* Evidence not printed.

Tariff Board's Comments

Three separate matters are covered by this report, viz.:—

(1) Question of the necessity for the rates of duty imposed on certain wireless parts and accessories under various sub-items of Tariff Item 180 (e);

(2) Question of removal from by-law to Tariff Item 434 of appliances for use with radio sets installed in motor cars for converting current from the car battery into current suitable for the plate supply of the valves of the radio set; and

(3) Question of removal from by-law to Tariff Item 434 of rods of amorphous carbon, or consisting principally of amorphous carbon, with metal-sprayed ends.

The Tariff Board has, therefore, divided its comments under the following headings, viz.:—

(a) Necessity for Existing Duties. (Pages 6 to 23.)

(b) Motor Car Radio Current Converting Appliances. (Pages 23 to 25.)

(c) Carbon Rods. (Pages 25 to 27.)

(a) Necessity for Existing Duties.

Wireless receiving apparatus was first mentioned in the Customs Tariff in Tariff Proposals of 3rd September, 1925, when rates of duty of 35 per cent. (British Preferential Tariff) and 55 per cent. (General Tariff) were imposed on all kinds of such apparatus.

In 1928 the Tariff Board investigated the question of the duties on wireless receivers and parts, and following that investigation the Government, in Tariff Proposals of 21st November, 1929, imposed alternative fixed rate or ad valorem duties on each of a comprehensive list of parts of receivers as well as a duty of the same nature on complete receivers.

Of the 26 sub-items into which Tariff Item 180(e) was divided, sub-items (3), (5), (6), (17), (22), (23), (25) and (26) covering—

Choke coils for battery-eliminating devices,
Variable condensers.
Loudspeakers and parts thereof,
Power transformers, and
Complete receiving sets.

formed the subject of investigation by the Board in 1932. The Board made its report on those sub-items on 26th January, 1933, and following that report the sub-items mentioned were amended in the Tariff Proposals of 8th March, 1933.

The reference now being dealt with covers those sub-items not covered by the Board's report of 26th January, 1933.

The main points of general evidence submitted by witnesses in support of adequate protection to the local industry were as under:—

(Continued on next page)

TARIFF BOARD REPORT—(Continued)

(1) It is estimated that 140,000 receivers were sold in Australia in 1934, and as about 70 per cent. of the value of these represents Australian material and labour, some idea can be gained of the importance of the receiver-manufacturing industry to the Commonwealth.

(2) The industry has flourished under the protection enjoyed in the past, and large sums of capital are now invested in it.

(3) Australian wireless receivers are of good quality, and as up to date as those produced overseas.

(4) The industry is of national importance for defence purposes in that, in the event of war, large stocks of materials and trained personnel would be immediately available.

(5) The manufacture of parts is an integral part of receiver manufacture, the actual assembly of the receiver being a relatively small part of the whole. If the manufacture of parts was not adequately protected there would be practically no local industry, employment would recede to about 15 per cent. of its present amount and much manufacturing plant would be rendered idle.

(6) Imposition of prohibitive rates of duty would not injure any other Australian industry and, as there are now about 160 receiver manufacturers in the Commonwealth, competition would ensure reasonable prices to purchasers.

(7) Evolution in wireless receiving apparatus has rendered necessary a re-wording of the tariff sub-items now under consideration.

No evidence either in opposition to protection to the Australian industry or on behalf of United Kingdom producers was tendered.

Two main requests were submitted to the Board on behalf of local manufacturers, one by A. G. Warner, of Radio Corporation Proprietary Limited, South Melbourne, and the other by S. McK. Grime, of Radio and Telephone Manufacturers' Association, New South Wales.

A. G. Warner stated that he represented the following manufacturers, viz.:—

Essanay Manufacturing Company Proprietary Limited.
A. G. Healing Limited.
Radio Corporation Proprietary Limited.
Eclipse Radio Proprietary Limited.
Howard Radio Proprietary Limited.
Targan Electric Company Proprietary Limited.
Tilbury and Lewis Proprietary Limited.

He suggested as regards the goods covered by the Minister's reference—

(a) As regards—
180(e) (1) Battery Chargers, .4 ampere to 1 ampere, both inclusive.
(9) "A" Battery Eliminators.
(10) "B" Battery Eliminators.
(16) Lightning Arrestors.

that they be deleted from the tariff and the goods mentioned made dutiable as wireless parts, n.e.i., the reason being that these goods are now obsolete or very little used.

(b) As regards—
180(e) (13) Headphones.
(14) Jacks, Phone and Loudspeaker.
(18) Plugs, Phone and Loudspeaker.

that these goods are no longer extensively used in radio receivers and could be more appropriately classified under Item 180(a) as telephone appliances.

(c) As regards—
180(e) (15) Knobs.

that these should be classified as bakelite mouldings,

(d) As regards—
180(e) (4) Fixed Mica Condensers.
(12) Fixed Resistances.

no suggestion is submitted, the matter of the rates on these being left to the local manufacturers concerned.

(e) As regards—
180(e) (11) "BC" and "ABC" Battery Eliminators, Power Packs and similar devices.

that this sub-item be deleted and sub-item 180(e) (23), covering "power transformers and choke coils combined," be extended to cover these goods.

(f) As regards the balance of the sub-items covered by the Minister's reference, that they be amended to read (the rates requested being those considered necessary under present conditions)—

Item 180(e)—	British Preferential Tariff		General Tariff
(2) Chargers, Battery, exceeding 1 ampere and up to and including 5 amperes .... each	20s.	....	25s.
(7) and (8) Drives, Vernier or otherwise, with or without dials or escutcheons, for tuning radio receivers—			
(a) having a drive not exceeding five to one .... each	10d.	....	1s. 3d.
(b) having a drive exceeding five to one .... each	4s.	....	5s.
(19) Rheostats, Potentiometers and Variable Resistances .... each	6d.	....	8d.
(20) Sockets, valve .... each	2d.	....	3d.
(21) Transformers, Audio and Radio— each	1s. 9d.	....	2s. 6d.
(24) Parts n.e.i. of wireless receivers, other than cabinets .... ad val.	35%	....	55%

With reference to paragraph (d) of the above request Condensers Pty. Ltd. Melbourne, and Simplex Radio, Sydney requested that fixed mica condensers be dutiable at rates of each 4d. (British Preferential Tariff) and 5d. (General Tariff), and the local manufacturers of fixed resistances requested that the existing duties on those goods be maintained.

S. M. Grime stated that he appeared on behalf of the members of the Radio and Telephone Manufacturers' Association, a section of the Chamber of Manufacturers, New South Wales, and metal trades, &c., listed below, and after consultation with the representatives of the Victorian manufacturers—

Airzone (1931) Ltd.
Amalgamated Wireless (Australasia) Ltd.
Breville Radio.
Commonwealth Moulding Co. Ltd.
Ducon Condenser Pty. Ltd.
Efco Manufacturing Co. Ltd.
Electricity Meter Co. Ltd.
Harrison, G. A. & L.
International Radio Co. Ltd.
James Manufacturing Co. Ltd.
Kriesler (Australasia) Ltd.
Lekmek Radio Laboratories,
Metropolitan Electric Co. Ltd.
New Systems Telephone Pty. Ltd.
Raycophone Ltd.
Reynolds Ltd., R. W.
Simplex Radio.
Stromberg Carlson (A'sia) Ltd.
Slade, C. W.
Thom & Smith Ltd.
Wetless Electric Mfg. Co. Ltd.

He suggested that the existing tariff sub-items under review be replaced by others in conformity with the list set out hereunder:—

	British Preferential Tariff		General Tariff
1. Signal Frequency tuning units with or without variable condensers and tuning coils (constructed as part of or separate to receiver) .... each	34s 9d.	....	40s.
2. Variable tuning condensers complete with tuning dial and drive .... each	13s.	....	15s.
3. Variable Condensers .... per unit	3s.	....	3s. 6d.
(a) Stator or fixed plate assembly for variable condensers— per average unit	8½d.	....	10d.

(Continued on next page)

TARIFF BOARD REPORT—(Continued)

	British Preferential Tariff		General Tariff
(b) Rotor or moving plate assembly for variable condensers— per average gang	10d.	....	1s.
(c) Variable Condenser framework tub, or condenser element support .... per unit	2s. 2d.	....	2s. 6d.
(d) Moving or fixed plates for variable condensers .... per dozen	10d.	....	1s.
4. Power Units complete (for supplying filament and/or plate and/or bias potentials and/or current to radio receivers or electric acoustic apparatus) constructed as part of or separate to receiver .... per unit	30s. 5d.	....	35s.
(a) Power transformers for power units .... each	10s. 10d.	....	12s. 6d.
(i) Windings or coils for power transformers .... per unit	6s. 6d.	....	7s. 6d.
(ii) Laminations or stampings for magnetic circuit of power transformer per lb.	8½d.	....	10d.
(b) Filter or smoothing chokes for power units .... per unit	6s. 1d.	....	7s.
(i) Windings or coils for filter chokes .... per unit	3s.	....	3s. 6d.
(ii) Laminations or stampings for magnetic circuit or filter chokes .... per lb.	8½d.	....	10d.
(c) Filter or smoothing condensers (paper) ½ to 1 mf.			
Over 1 mf.			
5. Audio Transformers and audio Chokes .... each	3s.	....	3s. 6d.
(a) Windings or coils for audio transformer or audio chokes— per unit	1s. 3½d.	....	1s. 6d.
(b) Laminations or stampings for magnetic circuit of audio transformer or audio chokes per lb.	6½d.	....	8d.
6. R.F. Transformers or chokes and/or I.F. Transformers and Chokes each	2s. 2d.	....	2s. 6d.
(a) Windings or coils for R.F. or I.F. transformers or chokes per unit	10d.	....	1s.
(b) Capacitor assembly for R.F. or I.F. transformers and chokes per unit	10d.	....	1s.
7. Complete dials and drives for tuning devices .... each	3s.	....	3s. 6d.
(a) Ratio reducing drives for tuning devices .... per unit	2s. 2d.	....	2s. 6d.
(b) Dial or scale assembly for tuning drives .... per unit	10d.	....	1s.
8. Variable resistors and potentiometers—wire wound type .... each	2s. 2d.	....	2s. 6d.
(a) Resistance elements for variable resistors and potentiometers, wire wound type .... each	10d.	....	1s.
(b) Moving Element Contact Assembly .... per unit	7½d.	....	9d.
9. Fixed Resistors—			
(a) Wire wound type .... each	5d	....	6d.
10. "Trimmer," "vernier," or adjusting condensers for lining up R.F. and I.F. circuits, &c., assembled or unassembled .... per unit	10d.	....	1s.
11. (a) Fixed condensers mica dielectric up to 700 mmf. .... each	4d.	....	5d.
(b) Fixed condensers paper dielectric	As set out in Condenser Interests. September, 1934.		
(c) Fixed Condensers Electrolytic			
12. Switches—			
(a) Rotary Switches for tone selection, sensitivity control, circuit selection, &c. .... each	6½d.	....	8d.
(b) Battery Switches .... each	1s. 8½d.	....	2s.
(c) Power Switches			
(d) Wave range selector switches assembled or unassembled— per unit	1s. 3½d.	....	1s. 6d.
13. Pin jacks for loudspeakers 'phone pickup, &c., connexions .... each	3d.	....	4d.
14. Valve sockets (average type) .... each	5d.	....	6d.
(a) Contacts for valve sockets— per unit	4s. 4d.	....	5s.
15. Control Knobs .... each	3d.	....	4d.
16. Chassis, housings, bases or frameworks for receivers or power units per doz.	5d.	....	6d
17. Current limiting resistors for power circuits of transformerless receivers and/or power units .... each	1s. 8½d.	....	2s.
18. (a) Transformers for vibratory converters .... each	6s.	....	8s.
(b) Filters for vibratory converters— each	13s.	....	15s.
(c) Vibrator units for vibratory converters			
(d) Remote controls for automobile receivers (less flexible drives) .... each	17s. 5½d.	....	20s.
19. (a) Filters for Rotating Converters— each	13s.	....	15s.
20. Tuning Indicators .... each	1s. 3½d.	....	1s. 6d.
21. Special aerials such as for interference elimination and S.W. reception .... each	13s.	....	15s.
(a) Transformers for special aerials .... each	4s. 4d.	....	5s.
22. Interference Eliminating Filters—			
(a) For suppressing line electrical interference or—			
(b) For suppressing electrical interference at source such as in generators, &c. each	6s. 6d.	....	7s. 6d.
23. Cabinets or containers for radio and acoustic equipment—			
(a) Wooden cabinet type— each	£2 3s. 5d.	....	£2 10s.
(b) Metal type .... each	13s.	....	15s.
(c) Plastic Moulded Type each	13s.	....	15s.
24. N.E.I. .... ad val.	35%	....	55%

It will be seen that there is a wide divergence between the requests submitted by Mr. Warner and Mr. Grime. While Mr. Warner restricts those goods which require protection by fixed rates of duty to comparatively few lines and is content to leave the balance dutiable at ad valorem rates as Parts n.e.i., Mr. Grime requests a considerable extension of the sub-items providing fixed rate duties on wireless apparatus, including some lines such as variable condensers and cabinets which are not under reference to the Board, and further requests rates of duty under the British Preferential Tariff which, when they do not exceed the total Australian cost of production of the goods in question, approach closely thereto.

Mr. Grime, in supporting his request stated—

(a) We are now suggesting a revision of the existing tariff items relating to parts of wireless receivers, by removing some of the items which are not now in demand in our industry, and the addition of a number of items which are now used, and were not known, or perhaps were omitted when the present list was compiled seven years ago. We feel sure that the proposed amendments will not only cover the field better, but will simplify the classification of imports.

(b) That the industry has always made it clear that it was asking for prohibitive duties and that it was because that industry has enjoyed throughout its life protection amounting to practically prohibition that it has developed to its present position. Internal competition ensures reasonable selling prices.

When it was pointed out to Mr. Grime that, as regards the goods to which he desires protection by fixed rate duties

(Continued on next page)

TARIFF BOARD REPORT—(Continued)

be extended, Australian manufacturers had hitherto succeeded in securing the bulk of the local market under the ad valorem rates of duty provided in respect of "Parts n.e.i. of wireless receivers," viz., 26¼ per cent. (35 per cent. less exchange adjustment) (British Preferential Tariff) and 55 per cent. (General Tariff), he replied that while those rates had, until recently, provided more or less adequate protection, the existing position regarding the admission of wireless receivers from New Zealand was endangering the local industry.

The position is that under the **Customs Tariff (New Zealand Preference) Act** 1933-1934 wireless broadcast receiving sets not mounted in cabinets have, since 5th July, 1934, been admitted into the Commonwealth from New Zealand free of duty if, in the manufacture or production of such sets, not less than 50 per cent. of the factory or works cost consists of New Zealand labour or material. Mr. Grime states that Australian manufacturers do not object to these conditions applying to sets genuinely manufactured in New Zealand, as they can compete with such sets, but that he learned that a shipment of receivers had recently been landed in the Commonwealth under these conditions when they consisted wholly of British and foreign parts probably so cheaply priced that the cost of assembling, testing and packing amounted to 50 per cent. of the finished cost. In this way he claimed that a complete set of overseas parts, including loud speakers could be imported free of duty.

This position is, however, in respect of the duties on complete receivers, the question of the duty on which is not now before the Board. Even if the practice is likely to assume serious proportions, it cannot be advanced as an argument in support of high fixed rate duties on various parts, especially when such duties would apply to parts of whatever origin. Neither can it be seen that the granting of Mr. Grime's present request would remedy the position he puts forward and the remedy would appear to lie in negotiation between the Governments of the Commonwealth of Australia and the Dominion of New Zealand.

The existing sub-items under consideration were drafted in 1929. Since then important developments have taken place in the type and design of wireless receiving equipment and the Board is well aware of the necessity for revision of both the wording and rates in those sub-items. Many of the sub-items are obsolete or so seldom necessary as to be of little practical value. Witnesses generally agreed that these should be deleted from the Schedule. The Board is not convinced, however, that the many new sub-items requested by Mr. Grime are necessary or desirable. The goods to which he desires that protection by means of high fixed rates of duty be extended are being successfully manufactured in the Commonwealth under ad valorem rates of duty of 26¼ per cent. (British Preferential Tariff) and 55 per cent. (General Tariff), and under these rates local manufacturers have secured the bulk of the Australian market. Victorian manufacturers are satisfied with the existing protection on those lines and the Board, after full consideration of the case, is convinced that an extension of the specific duties is not justified.

Battery Chargers

Tariff sub-item 180 (e) (2) reads at present as under:—

	British Preferential Tariff	General Tariff
Chargers, Battery, exceeding 1 ampere and up to and including 3 amperes each	21s.	30s.
or ad val.	35%	55%

whichever rate returns the higher duty.

(Tariff Board Note.—When adjusted for exchange effect, the rate under the British Preferential Tariff would be about 15s. 9d. each or 26¼ per cent. ad valorem).

It was stated in evidence that owing to the decrease in the use of battery receivers in electrical areas the use of these chargers had fallen off but had revived somewhat with the installation of radio in motor cars whose charging rate is low, or where the battery is defective. It was therefore, requested that to meet this situation the sub-item be amended to cover chargers exceeding 1 ampere and up to 5 amperes with rates of each 20s. (British Preferential Tariff) and 25s. (General Tariff) under present conditions.

The Tariff Board, after consideration of local manufacturers' costs, overseas selling prices and the existing effective protection, is of opinion that adequate protection would be afforded by rates of duty of—

	British Preferential Tariff	General Tariff
Under present conditions .... each	15s.	24s.
or ad val.	30%	50%
whichever rate returns the higher duty.		
At par exchange .... each	20s.	29s.
or ad val.	45%	65%
whichever rate returns the higher duty.		

Fixed Mica Condensers

Tariff sub-item 180 (e) (4) reads at present as under:—

Condensers, Fixed Mica .... each	5d.	6d.
or ad val.	35%	55%

whichever rate returns the higher duty.

(Tariff Board Note.—When adjusted for exchange effect, the rate under the British Preferential Tariff would be about 4s. 6d. each or 26¼ per cent. ad valorem).

The case in favour of adequate protection on these goods was submitted by Mr. D. J. Doughton of Condensers Proprietary Limited, Melbourne, and Mr. G. Rich, of Simplex Radio, Sydney. These gentlemen requested that the rates of duty in question be amended to 4d. (British Preferential Tariff) and 5d. (General Tariff) under present conditions. Both witnesses submitted costs of production of three representative sizes. In all these cases the fixed rate duty requested under the British Preferential Tariff, although a reduction in the existing duty, amounted to more than the labour, factory overhead and general overhead costs combined, and in the case of the small condensers amounted to more than the total Australian factory cost. Furthermore, the metal foil used as one of the raw materials is admitted under by-law to Tariff Item 404 at rates of duty of free (British Preferential Tariff) and 15 per cent. (General Tariff), and, bakelite powder being unspecified, is free of duty from all countries.

It has been found that a duty of 3d. each under the British Preferential Tariff would provide a substantial measure of protection on the three sizes in respect of which United Kingdom f.o.b. prices were given and in addition local manufacturers would enjoy the protective effect of adverse exchange. The Tariff Board is of the opinion that a duty of this height should be sufficient to protect an industry which is not a big employer of labour and which can obtain much of its imported material free of duty.

The Tariff Board, therefore, finds that reasonable and adequate rates of duty on fixed mica condensers would be—

	British Preferential Tariff	General Tariff
Under present conditions .... each	3d.	4d.
or ad val.	30%	50%
whichever rate returns the higher duty.		
At par exchange .... each	3½d.	4½d.
or ad val.	45%	65%
whichever rate returns the higher duty.		

Dials, Vernier & n.e.i.

Tariff sub-items 180 (e) (7) and (8) read at present as under—

	British Preferential Tariff	General Tariff
(7) Dials, Vernier .... each	10d.	1s. 3d.
(8) Dials, n.e.i. .... each	1½d.	2d.
or as to the goods covered by these two sub-items the following rates if same return a higher duty, viz.:— ad. val.	35%	55%

It was stated in evidence relating to these sub-items that the general method of using dials, escutcheons and drives had completely changed since the sub-items were framed. Mr. Warner, in describing this change, stated—

Some five or six years ago the receivers were tuned by means of a large dial placed on the front of the cabinet in which, in many instances, vernier control was fitted. The present method is to fit a knob on to an escutcheon plate. Behind the escutcheon plate and inside the receiver, controlled by the knob and its shaft, is usually fitted an arrangement of gears or friction drives which rotates the variable

(Continued on next page)

TARIFF BOARD REPORT—(Continued)

condenser and thus tunes the receiver in the desired manner.

It is desirable, therefore, that the wording of the sub-items be amended to apply to apparatus now in use and that new rates of duty applicable to such apparatus be fixed.

From the evidence submitted to it the Board is of the opinion that it would be reasonable and desirable to supersede existing sub-items 180 (e) (7) and (8) with an item worded and providing rates of duty as under—

	Under present conditions B.P.T. s. d.	Under present conditions G.T. s. d.	At par exchange B.P.T. s. d.	At par exchange G.T. s. d.
(a) Complete dials for tuning devices, per unit	2 0	2 6	2 4	2 10
(b) Ratio reducing drives for tuning devices per unit	1 6	1 9	1 9	2 0
(c) Dial or scale assembly for tuning drives per unit	0 6	0 9	0 7	0 10
or as to the goods covered by the above sub-items the following rates if same return a higher duty—ad val	30 per cent.	50 per cent.	45 per cent.	65 per cent.

Fixed Resistances

Tariff sub-item 180 (e) (12) reads at present as under:—

	British Preferential Tariff	General Tariff
(12) Resistances, Fixed, having a resistance value of 2 megohms and over each	4½d.	6d.
or ad val.	35%	55%

whichever rate returns the higher duty.

(Tariff Board Note.—When adjusted for exchange effect, the rates under the British Preferential Tariff would be about 4d. each or 26¼ per cent. ad valorem).

Little evidence was tendered in support of the existing rates of duty on these goods and the information before the Board indicates that the fixed rates of duty now in force are higher than are required to protect the local industry or than are justified by the value of the goods in question.

In the opinion of the Tariff Board, reasonable and adequate rates of duty on these goods would be—

	British Preferential Tariff	General Tariff
Under present conditions .... each	2½d.	4d.
or ad val.	30%	50%
whichever rate returns the higher duty.		
At par exchange .... each	3d.	4½d.
or ad val.	45%	65%
whichever rate returns the higher duty.		

Rheostats, Potentiometers and Variable Resistances

Tariff sub-item 180(e) (19) reads at present as under—

	British Preferential Tariff	General Tariff
(19) Rheostats, Potentiometers and Variable Resistances .... each	6d.	8d.
or ad val.	35%	55%

whichever rate returns the higher duty.

(Tariff Board Note.—When adjusted for exchange effect, the rates under the British Preferential Tariff would be about 5d. each or 26¼ per cent. ad valorem.)

Mr. A. G. Warner, in giving evidence in respect of these lines, stated—

Most manufacturers make certain types of rheostats, potentiometers and variable resistances. Variable resistances of the type covered by this item are made in two forms—(1) By winding wire on a strip over which a wiping contact is rotated. (2) By a carbon resistance over which a similar contact is moved or rotated. The first type is manufactured in Australia; the second is not manufactured here. Generally speaking the carbon variable resistances are superior to the wire wound resistances, but are more difficult to make and more expensive. It appears to be the general practice in Australia for the more expensive model to be equipped with the carbon variable resistances which are imported from overseas. The wire wound resistances are used on the cheaper models. There is an enormous number of types of these three items, and so large is the variety that it is very difficult to compare costs.

In view of the fact that carbon type variable resistances are not manufactured in the Commonwealth, the Board considers that they should not be made subject to fixed rates of duty, but should be excluded from the sub-item now being considered, and automatically fall under the Item covering parts n.e.i. of wireless receivers at ad valorem rates of duty only. These ad valorem rates would prevent any undue competition between the carbon type resistances and the wire wound type which is produced in Australia.

As indicated above, it is difficult to make comparison of prices of overseas and local goods owing to the great variety of types of rheostats, potentiometers and resistances, but the Board is of the opinion that rates as set out hereunder would be necessary to adequately protect local manufacturers, viz.:—

	British Preferential Tariff	General Tariff
Under present conditions .... each	6d.	8d.
or ad val.	30%	50%
whichever rate returns the higher duty.		
At par exchange .... each	7½d.	9½d.
or ad val.	%45	65%
whichever rate returns the higher duty.		

Valve Sockets

Tariff sub-item 180(e) (20) reads at present as under:—

	British Preferential Tariff	General Tariff
(20) Sockets, Valve .... each	3d.	4½d.
or ad val.	35%	55%

whichever rate returns the higher duty.

(Tariff Board Note.—When adjusted for exchange effect the rates under the British Preferential Tariff would be about 2½d. per cent. or 26¼d. per cent. ad valorem).

Mr. Warner, of Radio Corporation Proprietary Limited, stated—

It is essential that a duty be retained on this item—both to protect the Australian manufacturer of valve sockets and also to prevent the importation of metal frames containing sockets for the manufacture of chassis. The cost of manufacturing these sockets varies among the better class manufacturers from 4d. to 7d., according to the number of holes in the particular type of socket. A few of the very cheap type sockets can be obtained at prices between 2d. and 3d. We attach considerable importance to adequate protection on this item.

He added that although local manufacturers do not avail themselves of all the existing protection, it could be reduced but little without detriment to the Australian industry, and requested that the fixed rates of duty, under present conditions, be fixed at each 2d. (British Preferential Tariff) and 3d. (General Tariff).

This request the Tariff Board regards as reasonable, and it therefore finds that reasonable and adequate rates of duty on valve sockets would be:—

	British Preferential Tariff	General Tariff
Under present conditions .... each	2d.	3½d.
or ad val.	30%	50%
whichever rate returns the higher duty.		
At par exchange .... each	3d.	4½d.
or ad val.	45%	65%
whichever rate returns the higher duty.		

Transformers, Audio and Radio

Tariff sub-item 180(e) (21) reads at present as under:—

	British Preferential Tariff	General Tariff
(21) Transformers, Audio and Radio, each	1s. 9d.	2s. 6d.
or ad val.	35%	55%

whichever rate returns the higher duty.

(Tariff Board Note.—When adjusted for exchange effect the rates under the British Preferential Tariff would be about 1s. 6d. or 26¼ per cent. ad val.).

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TARIFF BOARD REPORT—(Continued)

Mr. Warner, of Radio Corporation Proprietary Limited, stated in evidence—

Grouped under this Item of Transformers, Audio and Radio, are two very different types of transformers. The audio transformer contains a considerable amount of material, but is simple to manufacture; the radio transformer contains very little material, but is difficult to manufacture, and, as a rule, costs more in developmental work than all the other parts of a receiver put together.

The radio frequency transformer in particular is the part of the receiver. The development of these provides work for a number of Australian engineers, in addition to the ordinary manufacturing processes, and if the radio industry is to maintain its present technical staffs it is essential that adequate protection should be given to the trade of this Item. Failing this, the manufacture will become merely assembling parts around a radio frequency transformer which has been designed by British or American engineers. We consider that the present tariff is essential to protect the trade from dumping on both these items.

Costs of production of transformers produced by several Australian manufacturers, as well as the f.o.b. prices of American transformers, were submitted. From a perusal of these, the Tariff Board is satisfied that the maintenance of the fixed rate duties at existing levels would be justified, and therefore finds that the rates of duty on audio and radio transformers should be as under:—

		British Preferential Tariff	General Tariff
Under present conditions	each	1s. 6d.	2s. 6d.
	or ad val.	30%	50%
whichever rate returns the higher duty.			
At par exchange	each	2s.	3s.
	or ad val.	45%	65%
whichever rate returns the higher duty.			

"BC" and "ABC" Battery Eliminators and Power Packs.

Tariff Sub-item 180(e) (11) reads at present as under:—

		British Preferential Tariff	General Tariff
(11) Eliminators "BC" and "ABC" Battery, Power Packs and similar devices, whether imported separately or incorporated in a wireless receiving set	each	40s.	60s.
	or ad val.	35%	55%
whichever rate returns the higher duty.			

(Tariff Board Note.—When adjusted for exchange effect the rates under the British Preferential Tariff would be about 35s. each or 26¼ per cent. ad val.).

Mr. Warner, of Radio Corporation Proprietary Limited, in dealing with the goods covered by this sub-item stated—

This Item could not safely be deleted from the Tariff because a power pack and its associated rectifying equipment is still used in the modern receiver, and if it were possible to import these at a very low rate of duty—possibly from some country dumping their end of season supplies—the radio trade in Australia would be very adversely affected.

He then suggested that Sub-item 180(e) (23) which covers "Power Transformers and Choke Coils combined" at fixed rates of each 15s. (British Preferential Tariff) and 25s. (General Tariff), be enlarged to cover the goods now being considered as under:—

		British Preferential Tariff	General Tariff
Combined Power Transformer and Choke, or any device for eliminating "AB" or "BC" and/or "ABC" batteries, such as power packs and similar devices, whether imported separately or incorporated in a wireless receiving set	each	15s.	25s.
	or ad val.	35%	55%
whichever rate returns the higher duty.			

Mr. Warner pointed out that this suggestion, if adopted, would result in a very material reduction in the existing duties on these goods, and that he was aware that all Australian manufacturers did not agree that his proposal would provide adequate protection. He expressed the opinion that his suggestion would just give bare protection especially as it allowed the associated filtering appliance to enter with the power transformer.

The question of the duties under Sub-item 180(e) (23) on "Power Transformers and Choke Coils combined" is not included in the Minister's reference now being dealt with. In the interests of improved Tariff classification, however, the Tariff Board considers that Mr. Warner's suggested sub-item should be adopted as suitable for present conditions. This will not result in any material alteration in the duties at present levied on the goods covered by Sub-item 180(e) (23), but should exchange, Australia on London, become more favourable, the rates of duty would be increased.

Under all the circumstances, and after a scrutiny of local manufacturers' costs of production and the selling prices of overseas products, the Tariff Board is of the opinion that Sub-item 180(e) (11) and (23) should be combined in a sub-item reading as under—

Combined Power Transformer and Choke, or any device for eliminating "AB" or "BC" and/or "ABC" batteries, such as power packs and similar devices, whether imported separately or incorporated in a wireless receiving set,

and that the goods covered by this sub-item should be made dutiable at rates as under—

		British Preferential Tariff	General Tariff
Under present conditions	each	15s.	25s.
	or ad val.	30%	50%
whichever rate returns the higher duty.			
At par exchange	each	18s.	28s.
	or ad val.	45%	65%
whichever rate returns the higher duty.			

Parts n.e.i. of Wireless Receivers, other than Cabinets

Tariff Sub-item 180(e) (24) reads at present as under—

		British Preferential Tariff	General Tariff
(24) Parts n.e.i. of wireless receivers, other than cabinets—	ad val.	35%	55%

(Tariff Board Note.—The effective rate under the British Preferential Tariff, after adjustment for exchange effect, is 26¼ per cent.)

Little evidence was tendered in respect of this sub-item. It was stated that the public no longer buys parts to assemble into receivers, but purchases complete receivers. On the other hand, receiver manufacturers either manufacture parts or usually buy parts of Australian manufacture, and reasonable comparisons of the costs of Australian and overseas parts could not be submitted.

The Tariff Board in its findings regarding electrical machinery, appliances and apparatus has generally recommended that reasonable and necessary protection is afforded by rates of—

		British Preferential Tariff	General Tariff
Under present conditions	ad val.	30%	50%
At par exchange	ad val.	45%	65%

It is considered that similar rates should be provided by the sub-item now under review. Under present conditions this will result in a slight increase in the effective rate now operating under the British Preferential Tariff and a slight reduction in the rate under the General Tariff but, should exchange Australia on London return to par, the rates under both columns would be higher than the existing rates.

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TARIFF BOARD REPORT—(Continued)

Other parts covered by the Minister's reference

These are—

Item 180(e) (1) Chargers, Battery, exceeding 1 ampere and up to and including 3 amperes
(9) Eliminators, "A" Battery.
(10) Eliminators, "B" Battery.
(13) Headphones.
(14) Jacks, Phone and Loudspeaker.
(15) Knobs.
(16) Lightning Arresters.
(18) Plugs, Phone and Loudspeaker.
180(m) Registers or Meters, of the type which totals electrical impulses, such as those used in telephone exchanges for recording subscribers' calls, and in totalisators.
(n) Jacks, n.e.i.

As regards the parts mentioned above and covered by Item 180(e), the evidence shows that they are either obsolete or so little used that a separate Tariff Sub-item is not justified. The Tariff Board, therefore, recommends that Sub-items (1), (9), (10), (13), (14), (15), (16) and (18) of Item 180 (e) be deleted, and that any goods now covered by them, and which may be imported in future, be made dutiable as "Parts n.e.i. of wireless receivers."

The goods covered by Sub-items (m) and (n) of Tariff Item 180, are now dutiable at rates of 30 per cent. (40 per cent. less exchange adjustment) (British Preferential Tariff), and 60 per cent. (General Tariff). No evidence having particular reference to these sub-items was tendered to the Board. The rates of duty generally found by the Board to provide adequate protection on electrical machinery and apparatus, viz., at present 30 per cent. (British Preferential Tariff) and 50 per cent. (General Tariff), and at par exchange 45 per cent. (British Preferential Tariff) and 65 per cent. (General Tariff), are reasonably close to the effective rates now operating under Sub-items 180 (m) and (n), although slightly higher than the rates provided for conditions of par exchange.

The Board does not consider that any interest would be materially affected by the imposition on the goods covered by Sub-items 180 (m) and (n) of the rates of duty applying to electrical machinery and apparatus generally, and is of the opinion that reasonable and adequate protection would be provided in respect of those goods were they made subject to rates of duty as under:—

		British Preferential Tariff	General Tariff
Under present conditions	ad. val.	30%	50%
At par exchange	ad val.	45%	65%

General

It will be seen that the adoption of the Board's findings will considerably reduce the number of Sub-items in Tariff Item 180 (e), as the Board has confined alternative fixed rates and ad valorem duties to comparatively few of the more important parts of wireless receivers. In doing this the Board has followed closely the request of the Victorian receiver manufacturers. The parts, specific reference to which in the Item the Board proposes to delete, will automatically become dutiable at ad valorem rates as "Parts n.e.i. of wireless receivers." This will necessitate a re-drafting of the whole of Tariff Item 180(e).

As all the sub-items of Tariff Item 180(e) were not referred to it, the Board can recommend duties varying with the protective effect of exchange, only in respect of those sub-items referred to it. It is, nevertheless, desirable that the rates throughout the Item should be varied for exchange effect. While the protective effect of exchange will vary with the numerous items dealt with herein, the Board has calculated that effect to be generally equivalent to an ad valorem duty of 15 per cent., and has varied its rates accordingly.

It will be found that the Board in its findings at the end of this report, in recommending a redrafted item, has grouped those sub-items which it has dealt with herein, and suggested no alteration in the rates applying to the remaining sub-items.

(b) Motor Car Radio Current Converting Appliances

At the present time the following goods, viz.:—

Appliances for use with radio sets installed in motor cars for converting current from the car battery into current suitable for the plate supply of the valve of the radio set.

are admitted under Departmental By-law to Tariff Item 434, which provides rates of duty of 5 per cent. (British Preferential Tariff) and 20 per cent. (General Tariff). This concession has operated as on and from 12th August, 1932. The Minister has now referred to the Board the questions as to whether the appliances should be removed from the Departmental By-laws, and, if so, what rates of duty should be imposed thereon.

It was explained in evidence that the appliances in question are usually of two types—

(a) a rotary converter installed in the body of the car, or

(b) a vibrator or interruptor fitted into the radio receiver.

The only witness who appeared in favour of the removal of these appliances from the By-laws was E. H. W. Westwood, representing the Miniature Electric Co. Proprietary Limited, Fitzroy, Victoria, and the main points of his evidence were—

1. His company manufactures the motor for the rotary or motor type of appliance the balance being fitted by the radio manufacturer. As there are no practical difficulties in making this type of apparatus, any factory manufacturing small motors could make it. Local manufacturers should be protected, and he requests that rates of duty of 30 per cent. (British Preferential Tariff) and 50 per cent. (General Tariff) be imposed at present with an additional 30 per cent. for exchange adjustment.
2. Adequate protection should be granted to local manufacture because of the employment it would give, the local materials it would use and its value for defence purposes in equipping cars, small boats, aeroplanes, etc.
3. Overseas manufacturers have many advantages over Australian manufacturers in cost of materials, wages, &c., longer working hours, less rigid labour conditions, &c.
4. His company has manufactured and supplied a considerable number of the motors in question, the quality being good and giving satisfaction to users. It is now ready to launch out on bulk supply.
5. The price of his company's motor to wholesale buyers is £7 less 40 per cent.
6. The rotary type of appliance in which his company's motor is used, although considerably dearer than the vibrator type as to first cost, is more reliable than the latter type and obviates the use of valves required in the latter.

Two witnesses appeared in opposition to removal from By-law under Item 434 of the appliances in question. The main points of the evidence tendered by these witnesses were as under:—

By A. G. Warner, of Radio Corporation Proprietary Limited, Melbourne—

1. In the United States of America, where the greatest number of car radio receivers are sold, at least 90 per cent. of them use the vibrator type of appliance.
2. The vibrator type of appliance is extremely difficult to manufacture. His company has tried to make them, but without success.
3. None of the big car manufacturers instal rotary appliances with their car radios. In the early days some were used because of faults in the vibrator type, but those faults have since been rectified.
4. Although the vibrator type requires a valve and the rotary type does not, the former type requires less filtering, has desirable features from the service point of view and is less cumbersome.
5. The vibrator type costs 8/- to land in Australia, whereas the rotary type costs about £2/15/-, and could be used only on high-priced radio sets. It does not seem reasonable to penalise an article which will do the work

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TARIFF BOARD REPORT—(Continued)

efficiently and cost only 8/- in order to promote the use of an article costing about £3 and doing the same work.

By F. W. P. Thom, representing Thom and Smith Limited, Sydney—

1. Although the bulk of the demand is for vibrator type apparatus, the rotary type is superior.
2. No Australian producer has ever approached his company to sell the appliances under review, although it is well known in the trade as a user of these goods.
3. His company had one appliance manufactured locally, and this, although efficient, was bulky and cost £5, whereas imported rotary appliances cost £3/5/9 landed.
4. If the appliances in question be removed from By-law and local manufacturers adequately protected, the result will be to make car radios very expensive, particularly those using rotary current rectifying appliances.

S. McK. Grime, of Amalgamated Wireless (Australasia) Limited, stated that his company recently imported rotary type appliances at a cost of £2/6/3 each.

The only evidence tendered regarding local manufacture was on behalf of a manufacturer of motors for rotary type appliances, and it would appear that this manufacturer is supplying but a small proportion of the Australian demand, although the witness presenting the evidence stated that the company was ready to embark on bulk supply. Furthermore, the selling price of the Australian article is greatly in excess of the landed cost of the imported rotary appliance.

The great bulk of the Australian demand is for the vibratory type appliance, as to which no evidence of any serious attempt at local manufacture was tendered, and which costs only a fraction of the price of the rotary type.

To remove the appliances in question from the By-laws under Tariff Item 434 and provide rates of duty which would adequately protect the local manufacture of the rotary type would—

(a) materially increase the cost of imported rotary type appliances to users and probably compel many users who would prefer the rotary type to take the vibrator type;

(b) lead to an increase in the cost of vibratory type appliances which supply the bulk of the demand and as to which no evidence of commercial manufacture in the Commonwealth was tendered.

Under the circumstances the Tariff Board recommends that no action be taken to remove from the By-laws to Tariff Item 434 the following, viz:—

Appliances for use with radio sets installed in motor cars for converting current from the car battery into current suitable for the plate supply of the valves of the radio set.

(c) Carbon Rods

At the present time the following goods, viz.:—

Rods of amorphous carbon or consisting principally of amorphous carbon, with metal-sprayed ends, for use in the manufacture of radio resistors,

are admitted under Departmental By-law to Tariff Item 434, which provides rates of duty of 5 per cent. (British Preferential Tariff) and 20 per cent. (General Tariff). This concession has operated as on and from 26th April, 1933. The Minister has now referred to the Board the question as to whether the rods in question should be removed from the Departmental By-laws, and, if so, what rates of duty should be imposed thereon.

No evidence in opposition to removal of the rods in question from the By-laws was tendered at the public inquiry, although the International Radio Company Limited, Sydney, importer of the rods, forwarded a letter to the Board subsequent to the public inquiry, setting out its views.

The main case in support of removal of the rods from By-laws was submitted by W. J. Mills, Leichhardt, New South Wales. This witness stated that—

1. He has for three years carried out intensive research in the carbon section of the radio industry, particularly resistors, and is now supplying in increasing quantities fixed carbon resistors made entirely from Australian materials.
2. He has supplied complete resistors with satisfaction to several of the largest receiver manufacturers in Australia, and, although now meeting only approximately 10 per cent. of the Commonwealth demand, could supply all requirements in a reasonable time. He estimates the Australian requirements at approximately 2,000,000 per annum.
3. Imported metal-sprayed rods are almost completely manufactured resistors, requiring only the addition of a pair of wires and a coat of paint to complete, neither of which have any real bearing on the functioning of the resistor.
4. The rods admitted under the By-law do not conform to the wording thereof, as the percentage of carbon therein is extremely small.
5. While he can compete with imported resistors under the duty payable thereon, he cannot successfully compete with other local producers, who take advantage of the unfair position created by the By-law.
6. He is of the opinion that the rods in question should be made dutiable at the rates of duty payable on "Parts n.e.i. of wireless receivers." (Tariff Board Note.—The witness, in a letter to the Board, subsequent to the inquiry, stated that fixed rate duties would be preferable.)

Mr. Mills also produced a letter from Metal Coatings Limited to show that the number of rods sprayed by them with metal ends had fallen off considerably since the issue of the By-law under notice, and stating that the company had capacity to treat 100,000 resistors per week.

J. P. Hoppe and H. J. Hoppe tendered evidence on behalf of Van Gooth and Company Proprietary Limited, the main points of their evidence being—

1. They support the evidence of Mr. Mills except as to the the protection required.
2. Their company, after the expenditure of a considerable sum in preparatory work, is about to commence the production of carbon resistors.
3. About 80 per cent. of the raw materials used by the company will be of Australian origin.
4. Fixed rate duties of each 2½d. (British Preferential Tariff) and 3d. (General Tariff) should be imposed on the rods under review.

Carbon, being amorphous carbon or consisting principally of amorphous carbon which has been subjected to no other process of manufacture than the formation into plain rods, is at present admitted under Tariff Item 415a (2) at rates of free (British Preferential Tariff) and 15 per cent. (General Tariff). These rods could, then, be imported and sprayed locally, as it has been shown that Metal Coatings Limited has capacity to so treat the total Commonwealth requirements of fixed carbon resistors.

The difference of 5 per cent. between the rates of duty under Item 415a (2) and the rates under Item 434, the item under which sprayed rods are admitted, provide a small margin of protection to the spraying process, but, in the opinion of the Board, not sufficient to be adequate.

Furthermore, the rods themselves are now being produced in Australia by one manufacturer entirely from Australian materials, and another manufacturer is about to commence production using 80 per cent. Australian materials. This extension of Australian manufacture is, in the opinion of the Board, worthy of adequate protection. Protection on the completed resistor is provided under Tariff Item 180 (e), but the evidence shows that, as long as the By-law now under consideration remains in force, that protection is being lessened.

The Board, is, therefore, of the opinion that the By-law in question should be cancelled.

Were the rods covered by the By-law not admitted under Tariff Item 434 they would be dutiable under Tariff Item 181 (c) as "carbon manufactures." The Board, in a report dated 29th April, 1935, reported to the Minister on the question of the necessity for the rates of duty provided under Tariff Item 181 (c), and in that report submitted findings as to what it regarded to be reasonable and adequate duties on carbon manufactures of all kinds.

The rates of duty embodied in those findings would, if adopted, provide reasonable and adequate protection to the

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TARIFF BOARD REPORT—(Continued)

Australian manufacturers of carbon rod similar to that now admitted under Item 434.

The Board, therefore, recommends that—

Rods, of amorphous carbon or consisting principally of amorphous carbon, with sprayed metal ends, for use in the manufacture of radio resistors.

be removed from the Departmental By-laws to Tariff Item 434, and made dutiable at the rates provided under Tariff Item 181 (c) on "Carbon manufactures of all kinds."

Tariff Board's Findings

1 The Tariff Board recommends that the numbering and wording of the sub-items of Tariff Item 180 (e) be amended to read as under—

Item 180. Electrical and Gas Appliances, viz.:—

(e) Wireless Receivers, Parts thereof, and Accessories therefor, viz.:—

(1) Chargers, Battery, exceeding 1 ampere and up to and including 5 amperes.
(2) Condensers, Fixed Mica.
(3) (a) Complete Dials for tuning devices.
(b) Ratio Reducing Drives for tuning devices.
(c) Dial or Scale Assembly for tuning devices.
(4) Resistances, Fixed, having a resistance value of 2 megohms and over.
(5) Rheostats Potentiometers and Variable Resistances other than Carbon Type Variable Resistances.
(6) Sockets, Valve.
(7) Transformers, Audio and Radio.
(8) Combined Power Transformers and Chokes or any device for eliminating "AB" or "BC" and/or "ABC" batteries, such as power packs and similar devices, whether imported separately or incorporated in a wireless receiving set.
(9) Wording as in existing sub-item 180 (e) (3).
(10) Wording as in existing sub-item 180 (e) (5).
(11) Wording as in existing sub-item 180 (e) (6).
(12) Wording as in existing sub-item 180 (e) (17).
(13) Wording as in existing sub-item 180 (e) (22).
(14) Parts n.e.i. of wireless receivers, other than Cabinets.
(15) Wording as in existing sub-item 180 (e) (25).
(16) Wording as in existing sub-item 180 (e) (26).

2. As regards sub-items 180 (e) (1) to (8) and (14) as set out in paragraph 1 of these findings, the Board finds—

(a) That under existing conditions but without primage duty, reasonable and adequate rates of duty would be—

	British Preferential Tariff	General Tariff
Item 180 (e)—		
(1) Chargers, Battery, exceeding 1 ampere and up to and including 5 amperes .... each	15s.	24s.
(2) Condensers, Fixed Mica .... each	3d.	4d.
(3) (a) Complete dials for tuning devices .... per unit	2s.	2s. 6d.
(b) Ratio Reducing Drives for tuning devices .... per unit	1s. 6d.	1s. 9d.
(c) Dial or Scale Assembly for tuning devices .... per unit	6d.	9d.
(4) Resistances, Fixed, having a resistance value of 2 megohms and over .... each	2½d.	4d.
(5) Rheostats Potentiometers and Variable Resistances other than Carbon Type Variable Resistances .... each	6d.	8d.
(6) Sockets, Valve .... each	2d.	3½d.
(7) Transformers, Audio and Radio each	1s. 6d.	2s. 6d.
(8) Combined Power Transformers and Chokes or any device for eliminating "AB" or "BC" and/or "ABC" batteries, such as power packs and similar devices, whether imported separately or incorporated in a wireless receiving set .... each	15s.	25s.
Or as to all the goods covered by paragraphs (1) to (8) of sub-item (e) the following rates if same return a higher duty, viz. ad val.	30%	50%
(14) Parts n.e.i. of wireless receivers, other than Cabinets .... ad val.	30%	50%

(b) That if the rate of exchange, Australia on London, were now at par and primage duty non-existent, the reasonable and adequate rates of duty would be—

	British Preferential Tariff	General Tariff
Item 180 (e)—		
(1) (As in finding (2) (a) above) each	20s.	29s.
(2) " " " each	3½d.	4½d.
(3) (a) " " " per unit	2s. 4d.	2s. 10d.
(b) " " " per unit	1s. 9d.	2s.
(c) " " " per unit	7d.	10d.
(4) " " " each	3d.	4½d.
(5) " " " each	7½d.	9½d.
(6) " " " each	3d.	4½d.
(7) " " " each	2s.	3s.
(8) " " " each	18s.	28s.
Or as to all the goods covered by paragraphs (1) to (8) of sub-item (e) the following rates if same return a higher duty, viz. ad val.	45%	65%
(14) (As in finding (2) (a) above) ad val.	45%	65%

(c) That if the rates mentioned in (2) (a) be adopted, provision be made for their increase by adding to them for each reduction of one in the percentum rate of exchange, one twenty-fifth of the difference between the rates shown in (2) (a) and the corresponding rates shown in (2) (b).

3. As regards the goods covered by sub-items (m) and (n) of Tariff Item 180, the Tariff Board finds—

(a) That under existing conditions but without primage duty, reasonable and adequate rates of duty would be—

	British Preferential Tariff	General Tariff
Item 180—		
(m) Registers or Meters, of the type which totals electrical impulses, such as those used in telephone exchanges for recording subscribers' calls and in totalisators ad val.	30%	50%
(n) Jacks n.e.i. .... ad val.	30%	50%

(b) That if the rate of exchange, Australia on London, were now at par and primage duty non-existent, the reasonable and adequate rates of duty would be—

	British Preferential Tariff	General Tariff
Item 180—		
(m) As above .... ad val.	45%	65%
(n) As above .... ad val.	45%	65%

(c) That if the rates mentioned in (3) (a) be adopted, provision be made for their increase by adding to them for each reduction of one in the percentum rate of exchange, one twenty-fifth of the difference between the rates shown in (3) (a) and the corresponding rates shown in (3) (b).

4. The Tariff Board recommends that no action be taken to remove from the By-laws to Tariff Item 434 the following, viz.:

Appliances for use with radio sets installed in motor cars for converting current from the car battery into current suitable for the plate supply of the valves of the radio set.

5. The Tariff Board recommends that—

Rods, of amorphous carbon or consisting principally of amorphous carbon, with sprayed metal ends, for use in the manufacture of radio resistors,

be removed from the Departmental By-laws to Tariff Item 434 and made dutiable at the rates provided under Tariff Item 181 (c) on "Carbon manufactures of all kinds."

M. B. SYNAN, Acting Chairman, Tariff Board.
H. E. GUY, Member, Tariff Board.
W. S. KELLY, Member, Tariff Board.
WALTER J. ROSE, Member, Tariff Board.

Melbourne, 28th June, 1935.

Australian Radio Tariff Schedule

In accordance with Customs Tariffs, 1933, and Customs Tariff Proposals No. 3 of November 28th, 1935.

In the following Schedules the first duty is British Preference Tariff and the second General Tariff.

In addition to the rates of import duty shown hereunder, primage duty is payable on goods covered by certain items as follows:—

Tariff Items.	Primage Duty. B.P.T.	General
Item No. 180 (e)	5%	10%
,, ,, 180 (g) (1) and (3)	5%	10%
,, ,, 180 (1)	5%	10%
,, ,, 181 (a) (2)	10%	10%
,, ,, 404	Free	4%
,, ,, 404a	Free	4%
,, ,, 415a	Free	4%

The import duty on goods admissible at the British Preferential Tariff rate under Tariff Items Nos. 180 (g) (1) and (3) is subject to a deduction in accordance with the Customs Tariff (Exchange Adjustment) Act, 1933, and in this connection Section 5 of that Act reads as follows:—

"5. The duties of Customs (other than primage duty and duty imposed by the Customs Tariff (Industries Preservation) Act 1921-1922 or any Act amending or in substitution for that Act) which would, but for the provision of this Act, be payable on goods to which protective duties apply and which are admissible under the British Preferential Tariff and which are entered for home consumption on or after the fifth day of October, One thousand nine hundred and thirty-three, shall be varied in accordance with the following provisions:—

(a) Whenever at the date of exportation of any such goods Australian currency is depreciated to the extent of not less than sixteen and two-thirds per centum in relation to the currency of the British country from which those goods are imported, a deduction from the amount of duty payable on those goods in accordance with any law of the Commonwealth for the time being in force imposing Duties of Customs (other than primage duty and duty imposed by the Customs Tariff (Industries Preservation) Act 1921-1922 or any Act amending or in substitution for that Act) or in accordance with Customs Tariff proposals shall be made of—

(i) one-fourth of that amount of duty; or

(ii) twelve and one-half per centum of the value for duty, whichever is the less; and

(b) Whenever at the date of exportation of any such goods Australian currency is depreciated to the extent of not less than eleven and one-ninth per centum and less than sixteen and two-thirds per centum in relation to the currency of the British country from which those goods are imported, a deduction from the amount of duty payable on those goods in accordance with any law of the Commonwealth for the time being in force imposing Duties of Customs (other than primage duty and duty imposed by the Customs Tariff (Industries Preservation) Act 1921-1922 or any Act amending or in substitution for that Act) or in accordance with Customs Tariff proposals shall be made of—

(i) one-eighth of that amount of duty; or

(ii) six and one-quarter per centum of the value for duty whichever is the less."

180 (e) Wireless Receivers, Parts Thereof, and Accessories Therefor, viz. :

1. **Chargers,** Battery, exceeding 1 ampere and up to and including 5 amperes, each 15/- (British), 26/6 (General).

And in respect of paragraph (1)—For each £1 by which the equivalent in Australian currency of £100 sterling is less than £125 at the date of exportation—an additional duty of, each 2.4d.

2. **Condensers,** fixed mica, each 3d.—4¼d.

And in respect of paragraph (2)—for each £1 by which the equivalent in Australian currency of £100 sterling is less than £125 at the date of exportation—an additional duty of, each .02d.

3. Articles for tuning devices, viz.:—

(a) Dials, complete, per unit, 2/-.—2/8.

And in respect of sub-paragraph (a)—for each £1 by which the equivalent in Australian currency of £100 sterling is less than £125 at the date of exportation—an additional duty of, per unit .16d.

(b) Dial or Scale Assembly, per unit, 6d.—9½d.

And in respect of sub-paragraph (b)—for each £1 by which the equivalent in Australian currency of £100 sterling is less than £125 at the date of exportation—an additional duty of, per unit, .04d.

(c) Drives, ratio reducing, per unit, 1/6.—1/10½.

And in respect of sub-paragraph (c)—for each £1 by which the equivalent in Australian currency of £100 sterling is less than £125 at the date of exportation—an additional duty of, per unit, .12d.

4. **Resistances,** fixed, having a resistance value of 2 megohms and over, each 2½d.—4¼d.

And in respect of paragraph (4)—for each £1 by which the equivalent in Australian currency of £100 sterling is less than £125 at the date of exportation—an additional duty of, each .02d.

5. **Rheostats,** potentiometers and variable resistances other than carbon type variable resistances, each 6d.—8¾d.

And in respect of paragraph (5)—for each £1 by which the equivalent in Australian currency of £100 sterling is less than £125 at the date of exportation—an additional duty of, each .06d.

6. **Sockets,** valve, each 2d.—4d.

And in respect of paragraph (6)—for each £1 by which the equivalent in Australian currency of £100 sterling is less than £125 at the date of exportation—an additional duty of, each .04d.

7. **Transformers,** audio and radio, each 1/6.—2/9.

And in respect of paragraph (7)—for each £1 by which the equivalent in Australian currency of £100 sterling is less than £125 at the date of exportation—an additional duty of each, ¼d.

8. **Combined power transformers** and chokes or any device for eliminating "AB," "BC" or "ABC" batteries, such as power packs and similar devices, whether imported separately or in corporated in a wireless receiving set, each 15s.—26s. 6d.

And in respect of paragraph (8)—For each £1 by which the equivalent in Australian currency of £100 sterling is less than £125 at the date of exportation—An additional duty of, each 1½d.

or, as to all the goods covered by paragraphs (1) to (8) of sub-item (E) the following rates if same return a higher duty viz.: ad val. 30 per cent.—57½ per cent.

And for each £1 by which the equivalent in Australian currency of £100 sterling is less than £125 at the date of exportation—An additional duty of, ad val. .6 per cent.

9. **Choke coils** suitable for use in connection with battery eliminating devices, each 5s.—10s.

10. **Condensers,** variable, of capacities exceeding .0001 microfarad, but not exceeding .001 microfarad—

With gang or drum control—per each condenser contained therein, 1s. 6d.—3s.

Without gang or drum control, each 1s. 6d.—3s.

11. **Condensers,** variable, midget, of .0001 microfarad capacity or less, each 1s.—1s. 6d.

12. **Loudspeakers** and Parts thereof:—

(a) Loudspeakers including transformers, each 10s.—12s. 6d.

(b) Parts of loudspeakers imported other than in complete loudspeakers, viz.:—

(1) Field Coils, each 2s.—3s.

(2) Field Coil Cores, each 9d.—1s. 3d.

(3) Field Coil Housings, each 1s.—1s. 6d.

(4) Cones with or without voice coils, each 1s. 3d. —1s. 9d.

(5) Cone Housings, each 1s. 9d.—2s. 3d.

(6) N.E.I., other than transformers, ad val. 35 per cent.—55 per cent.

Provided however, that in the case of combinations of any of the abovementioned parts duty shall be payable on such combinations as though the parts were imported separately.

13. **Transformers,** power, each 10s.—15s.

or as to all the goods covered by paragraphs (9) to (13) of sub-item (e) with the exception of the goods covered by clause (6) of sub-paragraph (b) of paragraph (12) the following rates if same return a higher duty, viz.:—35 per cent.—55 per cent.

14. **Headphones:** Parts n.e.i. of wireless receivers, other than cabinets—ad val. 30 per cent.—57½ per cent.

And in respect of paragraph (14)—For each £1 by which the equivalent in Australian currency of £100 sterling is less than £125 at the date of exportation—An additional duty of, ad val., .6 per cent.

15. **Wireless Receiving Sets** wholly assembled, partly assembled, or unassembled, excluding cabinets, valves, loudspeakers, headphones, batteries or any device for eliminating batteries—

Per valve socket excluding sockets for valves forming part of any battery eliminating device—12s. 6d.—25s. or ad val. 35 per cent.—55 per cent.

whichever rate returns the higher duty.

Provided—(1) In the absence of valve sockets the sets shall be charged duty at the above rates on the basis of the number of valves for which they are constructed or designed.

(2) In the instance of sets constructed or adapted for use with multiple purpose valves, the sets shall be charged duty equal to that payable on sets having an equal number of unit stages using unit function valves.

16. **Wireless Receiving Sets** and Gramophones combined, excluding cabinets, valves, loudspeakers, headphones, batteries or any device for eliminating batteries, each 20s.—25s.

And in addition per valve socket excluding sockets for valves forming part of any battery eliminating device, 12s. 6d.—25s. or as an alternative to the cumulative fixed rates provided above, ad. val., 35 per cent.—55 per cent.

whichever rate returns the higher duty.

Provided—(1) In the absence of valve sockets the combined sets shall be charged duty at the above rates on the basis of the number of valves for which they are constructed or designed.

(2) In the instance of combined sets constructed or adapted for use with multiple purpose valves, the combined sets shall be charged duty equal to that payable on combined sets having an equal number of unit stages using unit function valves.

180 (g) Storage Batteries and Parts Thereof, viz. :

Storage Batteries

1. **Storage Batteries** for wireless receiving sets, whether imported separately or incorporated in or forming part of a wireless receiving set, ad. val., 50 per cent.—70 per cent.

2. **Storage Batteries** suitable for use in motor vehicles (other than motor cycles) otherwise than for propulsion purposes, whether imported separately or incorporated in or forming part of any goods covered by sub-item (d) of item 359, ad val., 50 per cent.—70 per cent.

3. Composition parts including containers for storage batteries for wireless receiving sets and fc: storage batteries suitable for use in motor vehicles (other than motor cycles) otherwise than for propulsion purposes, per lb., 2d.—2½d. and ad val., 40 per cent.—60 per cent.

Dry Batteries

1. **Dry Batteries and Dry Cells** of all descriptions, whether imported separately or incorporated in any article or appliance, per lb., 2d.—5¼d. or ad val. 25 per cent.—48¾ per cent.

whichever rate returns the higher duty.

And in respect of sub-item (1)—For each £1 by which the equivalent in Australian currency of £100 sterling is less than £125 at the date of exportation—An additional duty of, per lb., ..02d.—.02d. or ad val., .4 per cent.—.5 per cent., whichever is applicable.

Valves

181 (a)

2. Valves for wireless telegraphy and telephony including rectifying valves, each, 2s. 3d.—3s. 6d. or ad val., 20 per cent. —40 per cent., whichever rate returns the higher duty.

NOTE.—Valves of the type covered by this item, if produced in Australia are subject to an Excise Duty of 2s. each.

Division XVI.—Miscellaneous

404. Materials and Minor Articles, of a class or kind not commercially produced or manufactured in Australia, for use in the manufacture of goods within the Commonwealth, as prescribed by Departmental By-laws. Ad. val. Free and 15 per cent.

Resistance alloys in the form of wire, bars, rods, sheets, or strips. Jet insulating beads. Porcelain insulating beads of sizes less than ¾ inch diameter by ¾ inch long over all measurements. Cotton covered copper wire finer than 30 gauge (I.S.W.G.) Insulating tubes except: Tubular cotton covered braiding or sleeving. Bakelised paper. Porcelain Hard Rubber.	For use in the manufacture of all kinds of electrical apparatus and appliances.

Metal rectifying elements for the manufacture of battery eliminators for wireless receiving sets.

Speaker units for the manufacture of magnetic type loud speakers.

Permanent magnets for the manufacture of loud speakers.

Battery cables (not including terminals) consisting of several flexible cords contained in one braided cover Woven antenna, i.e., aerial tape without terminals. Cotton covered loop antenna wire for inside aerials, under security.	For the manufacture of wireless receiving sets.

Record changing devices imported unassembled, excluding pick-ups 12 inch turntables and motors, for use in the manufacture of combined radio gramophone sets.

Bright cold rolled steel strip 3½ ins. x $\frac{3}{16}$ ins. under security for manufacture of Loud Speaker Housings.

Plain aluminium sheets for all purposes.

415a (2) Manufactures for use in the development of an Australian industry of a class or kind not commercially manufactured in Australia—ad val., Free—15%.

Insulating boards of a quality or kind which the Minister of Customs is satisfied is not being made in Australia.

Copper braid (made of wire of gauges finer than No. 30 I.S.W.G.) Copper Cable (stranded, made of wire of gauges finer than No. 30 I.S.W.G.)	For use in electrical apparatus and appliances.

Cotton covered flat laid cords with terminals affixed thereto, for use in radio head sets.

Standard signal generators Beat frequency and low frequency oscillators.	Being instruments for testing radio equipment.

Carbon being amorphous carbon or consisting principally of amorphous carbon which has been subjected to no other process of manufacture than the formation into plain blocks or plain rods.

Carbon being synthetic graphite or consisting principally of synthetic graphite which has been subjected to no other process of manufacture than the formation into plain blocks or plain rods.

Radio Valve Importations Into Australia

January to December 1935

New South Wales

	U.K.	Canada	Germany	Holland	U.S.A.	Total
Quantity—						
January	5,030	250	—	11,548	21,487	38,315
February	2,347	—	—	225	24,095	26,667
March	7,674	5,350	—	11,819	125,366	150,209
April	19,643	—	267	7,891	60,139	87,940
May	39,352	36	—	12,545	69,166	121,132
June	20,856	—	—	9,741	78,499	109,096
July	14,428	6,006	64	3,177	59,549	83,224
August	11,920	—	40	6,634	37,315	55,909
September	9,710	—	2	4,836	26,313	40,861
October	15,551	—	12	3,494	43,853	62,910
November	6,126	12	—	10,849	31,425	48,428
December	1,435	—	—	48,246	48,793	98,474
	154,072	11,654	385	131,005	626,000	923,165
			Plus 54 miscellaneous as below			923,219
Value—						
January	£1,658	£39	—	£4,917	£3,044	£9,658
February	1,172	—	—	100	3,030	4,302
March	2,391	691	—	6,126	13,377	22,585
April	7,026	—	79	2,713	9,013	18,831
May	16,228	—	9	6,876	7,264	30,377
June	9,339	—	—	2,785	9,854	21,978
July	2,811	799	20	1,179	6,298	11,107
August	3,387	—	13	3,780	4,661	11,841
September	4,378	—	7	1,789	3,005	9,179
October	5,831	—	3	1,426	4,268	11,528
November	5,310	228	—	4,340	4,271	14,149
December	761	—	—	15,370	6,317	22,445
	60,292	1,757	131	51,401	74,402	187,980
			Plus £13 miscellaneous as below			187,993

N.S.W. imported from Austria in May, 1935, 5 valves, value £4.
N.S.W. imported from France in May, 1935, 5 valves, value £1.
N.S.W. imported from Japan in May, 1935, 23 valves, value £5.
N.S.W. imported from Japan in November, 1935, 16 valves, value £2.
N.S.W. imported from Japan in December, 1935, 5 valves, value £1.

Victoria

	U.K.	Canada	Germany	Holland	U.S.A.	Total
Quantity—						
January	11	—	—	32	5,248	5,291
February	27	—	12	35	9,397	9,471
March	20	—	3	3	9,219	9,245
April	4,220	—	—	5,713	28,942	38,875
May	24,478	—	—	11,802	27,755	64,035
June	7,061	—	—	7,664	12,492	27,217
July	1,312	1,650	6	5,384	12,100	20,452
August	14,601	—	—	3,084	10,337	28,022
September	7,233	—	4	—	4,783	12,020
October	6,700	—	3	1,736	5,980	14,419
November	3,069	1,200	—	4	10,451	14,724
December	755	—	—	606	16,743	18,104
	69,487	2,850	28	36,063	153,557	261,875
			Plus 128 miscellaneous as below			262,003

1935 VALVE IMPORTATIONS—(Continued)—

Value—	U.K.	Canada	Germany	Holland	U.S.A.	Total
January	£84	—	—	£189	£556	£829
February	137	—	8	266	920	1,331
March	38	—	—	14	911	963
April	2,013	—	—	3,526	2,984	8,523
May	11,884	—	—	8,190	2,731	22,805
June	3,406	—	—	3,870	1,261	8,537
July	633	224	3	3,526	1,101	5,487
August	6,791	—	—	2,553	1,019	10,363
September	4,068	—	1	—	441	4,510
October	3,252	—	45	639	572	4,508
November	1,807	274	—	42	1,278	3,401
December	943	—	—	188	2,417	3,548
	35,056	498	57	23,003	16,191	74,804
			Plus £9 miscellaneous as below			74,813

Victoria imported from Sweden in January, 1935, 6 valves, value £3.
Victoria imported from Japan in July, 1935, 100 valves, value £4.
Victoria imported from Japan in October, 1935, 4 valves, value nil.
Victoria imported from Japan in December, 1935, 18 valves, value £2.

Queensland

	U.K.	Canada	Germany	Holland	U.S.A.	Total
Quantity—						
January	35	—	—	—	5	40
February	—	—	—	2	1	3
March	4	—	—	4	225	233
April	1,509	—	—	2,500	7	4,016
May	1,887	—	—	—	12	1,899
June	10	—	—	—	—	10
July	—	—	—	2	—	2
August	578	—	—	—	91	669
September	190	—	—	—	12	202
October	38	—	—	—	—	38
November	112	—	—	—	48	160
December	6	—	—	—	—	6
	4,369	—	—	2,508	401	7,278
			Plus 5 miscellaneous as below			7,283
Value—						
January	£94	—	—	—	£2	£96
February	—	—	—	£9	1	10
March	20	—	—	94	24	138
April	642	—	—	1,490	5	2,137
May	506	—	—	—	2	508
June	18	—	—	—	—	18
July	—	—	—	5	—	5
August	1,260	—	—	—	73	1,333
September	674	—	—	—	11	685
October	335	—	—	—	—	335
November	73	—	—	—	9	82
December	1	—	—	—	—	1
	3,623	—	—	1,598	127	4,348
			Plus £3 miscellaneous as below			4,351

Queensland imported from Italy in January, 1935, 5 valves, value £3.

South Australia

	U.K.	Canada	Germany	Holland	U.S.A.	Total
Quantity—						
January	9	—	—	—	—	9
February	6	—	—	—	15	21
March	—	—	—	—	27	27
April	—	—	—	—	—	—
May	—	—	—	—	—	—
June	7	—	—	—	—	7
July	—	—	—	16	6	22
August	70	—	—	6	22	98
September	57	—	—	2	12	71
October	—	—	—	—	—	—
November	—	—	—	—	—	—
December	60	—	—	—	9	69
	209	—	—	24	91	324
			Plus 4 miscellaneous as below			328

1935 VALVE IMPORTATIONS—(Continued)—

	U.K.	Canada	Germany	Holland	U.S.A.	Total
Value—						
January	£2	—	—	—	—	£2
February	10	—	—	—	3	13
March	—	—	—	—	9	9
April	—	—	—	—	—	—
May	—	—	—	—	—	—
June	22	—	—	—	—	22
July	—	—	—	317	1	318
August	135	—	—	9	18	162
September	356	—	—	7	2	365
October	—	—	—	—	—	—
November	—	—	—	—	—	—
December	85	—	—	—	4	89
	610	—	—	333	37	980

Plus £34 miscellaneous as below 1,014

South Australia imported from Netherlands East Indies in March, 1935, 4 valves, value £34.

Western Australia

	U.K.	Canada	Germany	Holland	U.S.A.	Total
Quantity—						
January	78	—	—	—	—	78
February	8	—	—	—	—	8
March	84	—	—	—	6	90
April	106	—	—	—	—	106
May	13	—	—	—	—	13
June	386	—	—	—	12	398
July	—	—	—	—	5	5
August	120	—	—	11	—	131
September	365	—	—	—	9	374
October	143	—	—	34	18	195
November	19	—	—	12	925	956
December	267	—	—	—	12	279
	1,579	—	—	57	987	2,633
Value—						
January	£22	—	—	—	—	£22
February	2	—	—	—	—	2
March	82	—	—	—	2	84
April	56	—	—	—	—	56
May	7	—	—	—	—	7
June	176	—	—	—	2	178
July	—	—	—	—	1	1
August	18	—	—	152	—	170
September	545	—	—	—	2	547
October	318	—	—	269	10	597
November	23	—	—	15	81	119
December	45	—	—	—	7	52
	1,294	—	—	436	105	1,835

Tasmania

	U.K.	Canada	Germany	Holland	U.S.A.	Total
Quantity—						
January	10	—	—	—	22	32
February	—	—	—	—	—	—
March	—	—	—	—	7	7
April	—	—	—	—	6	6
May	42	—	—	—	5	47
June	—	—	—	—	7	7
July	—	—	—	—	4	4
August	12	—	—	—	24	36
September	43	—	—	—	25	68
October	1	—	—	—	3	4
November	5	—	—	—	6	11
December	—	—	—	—	—	—
	113	—	—	—	109	222

1935 VALVE IMPORTATIONS—(Concluded)—

	U.K.	Canada	Germany	Holland	U.S.A.	Total
Value—						
January	£3	—	—	—	£9	£12
February	—	—	—	—	—	—
March	—	—	—	—	3	3
April	—	—	—	—	1	1
May	41	—	—	—	1	42
June	—	—	—	—	1	1
July	—	—	—	—	6	6
August	48	—	—	—	12	60
September	86	—	—	—	13	99
October	3	—	—	—	3	6
November	3	—	—	—	2	5
December	—	—	—	—	—	—
	184	—	—	—	51	235

Commonwealth

	U.K.	Canada	Germany	Holland	U.S.A.	Total
Quantity—						
January	5,173	250	—	11,580	26,762	43,765
February	2,388	—	12	262	33,508	36,170
March	7,782	5,350	3	11,826	134,850	159,811
April	25,478	—	267	16,104	89,094	130,943
*May	65,772	—	36	24,347	96,938	187,093
June	28,320	—	—	17,405	91,010	136,735
July	15,740	7,656	70	8,579	71,664	103,709
August	27,301	—	40	9,735	47,789	84,865
September	17,598	—	6	4,838	31,154	53,596
October	22,433	—	15	5,264	49,854	77,566
November	9,331	1,212	—	10,865	42,855	64,263
December	2,523	—	—	48,852	65,557	116,955
	232,839	14,468	449	169,657	781,035	1,195,471

Plus 11 miscellaneous as below 1,195,482

	U.K.	Canada	Germany	Holland	U.S.A.	Total
Value—						
January	£1,863	£39	—	£5,106	£3,611	£10,619
February	1,321	—	£8	375	3,954	5,658
March	2,531	691	—	6,234	14,326	23,782
April	9,737	—	79	7,729	12,003	29,548
May	28,666	—	9	15,066	9,998	53,739
June	12,961	—	—	6,655	11,118	30,734
July	3,444	1,023	23	5,027	7,407	16,924
August	11,639	—	13	6,494	5,783	23,929
September	10,107	—	8	1,796	3,474	15,385
October	9,739	—	48	2,334	4,853	16,974
November	7,216	502	—	4,397	5,641	17,756
December	1,835	—	—	15,558	8,745	26,141
	101,059	2,255	188	76,771	90,903	271,191

Plus £78 miscellaneous as below 271,269

Australia re-imported into N.S.W. in January, 1 valve, value £22.
Australia re-imported into N.S.W. in May, 1 valve, value £6.
Australia re-imported into N.S.W. in August, 5 valves, value £2.
Australia re-imported into N.S.W. in October, 4 valves, value £48.

Radio Apparatus Importations into Australia

JANUARY TO DECEMBER, 1935

New South Wales

Value	Battery Eliminators £	Parts N.E.I. £	Radio Sets £	Total £
January	222	3,499	108	3,829
February	8	2,031	142	2,181
March	180	5,287	706	6,173
April	72	3,349	556	3,977
May	673	6,796	468	7,937
June	247	5,168	696	6,111
July	183	1,837	634	2,654
August	144	2,006	612	2,762
September	155	2,091	906	3,152
October	14	1,818	767	2,599
November	9	1,794	303	2,106
December	5	1,491	655	2,151
	1,912	37,167	6,553	45,632

Victoria

Value	£	£	£	£
January	144	344	74	562
February	267	750	34	1,051
March	35	370	218	623
April	—	438	55	493
May	54	660	170	884
June	68	268	122	458
July	215	279	50	544
August	2	275	32	309
September	5	261	160	426
October	64	334	283	681
November	4	288	32	324
December	18	397	409	824
	876	4,664	1,639	7,179

Queensland

Value	£	£	£	£
January	1	46	9	56
February	—	664	—	664
March	—	137	11	148
April	2	55	4	61
May	—	38	26	64
June	—	24	20	44
July	—	—	5	5
August	—	62	—	62
September	—	57	43	100
October	—	2	11	13
November	—	16	39	55
December	—	277	2	279
	3	1,378	170	1,551

6 Battery Chargers—value £10, were imported into Queensland in December, 1935.

1 Battery Charger—value £1, was imported into Tasmania in December, 1935.

South Australia

Value	Battery Eliminators £	Parts N.E.I. £	Radio Sets £	Total £
January	—	12	3	15
February	26	10	46	82
March	4	7	14	25
April	—	14	—	14
May	28	2	—	30
June	42	38	—	80
July	—	5	4	9
August	—	17	—	17
September	2	111	58	171
October	—	3	—	3
November	—	—	—	—
December	—	29	—	29
	102	248	125	475

Western Australia

Value	£	£	£	£
January	—	73	40	113
February	—	13	11	24
March	—	93	21	114
April	—	103	32	135
May	—	—	4	4
June	—	225	50	275
July	—	26	5	31
August	—	170	—	170
September	—	591	8	599
October	3	649	21	673
November	—	73	—	73
December	—	6	—	6
	3	2,022	192	2,217

Tasmania

Value	£	£	£	£
January	—	21	40	61
February	—	—	—	—
March	—	—	1	1
April	2	2	4	8
May	—	3	5	8
June	—	20	5	25
July	—	—	—	—
August	4	4	7	15
September	2	3	9	14
October	—	—	—	—
November	1	3	7	11
December	—	—	—	—
	9	56	78	143

Commonwealth

Value	£	£	£	£
January	367	3,995	274	4,636
February	301	3,468	233	4,002
March	219	5,894	971	7,084
April	76	3,961	651	4,688
May	755	7,499	673	8,927
June	357	5,743	893	6,993
July	398	2,147	698	3,243
August	150	2,534	651	3,335
September	164	3,114	1,184	4,462
October	81	2,806	1,082	3,969
November	14	2,174	381	2,569
December	22	2,200	1,070	3,293
	2,905	45,535	8,761	57,201

6 Battery Chargers—value £43, were imported into New South Wales in June, 1935.

4 Battery Chargers—value £194, were imported into New South Wales in December, 1935.

Important Australian Statistics

Sub-Section 1.—Population and Vital Statistics

AREA AND POPULATION.

States and Territories	Area Square Miles	Population Estimated 30th September, 1935 Males	Females	Persons	Population Capital Cities, 31st Dec., 1934
N.S.W.	309,432	1,340,730	1,309,050	2,649,780	1,249,040
Victoria	87,884	910,201	929,515	1,839,786	1,000,000
Queensland	670,500	508,201	461,907	970,108	304,930
South Australia	380,070	292,908	292,227	585,135	313,778
West. Australia	975,920	236,998	209,742	446,740	208,448
Tasmania	26,215	115,796	112,768	228,564	60,500
Northern Territory	523,620	3,542	1,647	5,189	1,600
F.C.T.	940	5,110	4,358	9,468	7,500
Total	2,974,581	3,413,486	3,321,284	6,734,770	3,145,796

ESTIMATED INCREASE OF POPULATION.

Adjusted in accordance with the revised results of the Census of the 30th June, 1933.

States and Territories	1932	1933	1934	First Nine Months of— 1934	1935
New South Wales	25,432	21,796	22,684	13,742	13,577
Victoria	9,821	11,096	13,011	9,978	2,296
Queensland	9,391	9,946	10,466	10,421	10,611
South Australia	2,216	3,386	1,617	823	841
West. Australia	2,641	3,948	2,346	2,006	4,130
Tasmania	2,143	1,502	-663	-4,302	-2,883
Northern Territory	-61	32	126	213	245
F.C.T.	-357	689	-61	-74	276
Total	51,226	52,395	49,526	32,807	29,093

NOTE.—Minus sign (-) denotes decrease.

BIRTHS, DEATHS AND MARRIAGES.

Births—Number.

States and Territories	1932	1933	1934	First Nine Months of— 1934	1935
New South Wales	44,895	44,195	43,335	32,552	33,291
Victoria	27,464	28,392	27,828	20,892	20,619
Queensland	17,367	17,150	17,360	12,995	13,319
South Australia	8,521	8,900	8,459	6,368	6,094
West. Australia	7,965	7,874	7,801	5,895	6,060
Tasmania	4,491	4,553	4,470	3,377	3,261
Northern Territory	79	74	88	64	65
F.C.T.	151	131	134	100	107
Total	110,933	111,269	109,475	82,243	82,816

Deaths—Number.

New South Wales	21,343	22,322	23,474	17,783	18,801
Victoria	16,805	17,456	18,648	13,960	14,062
Queensland	7,813	8,354	8,192	6,153	6,806
South Austraia	4,957	4,904	5,403	4,136	3,931
West. Australia	3,715	3,790	4,076	3,119	3,111
Tasmania	2,022	2,192	2,345	1,717	1,814
Northern Territory	73	61	60	46	54
F.C.T.	29	38	31	24	33
Total	56,757	59,117	62,229	46,938	48,612

Marriages—Number.

New South Wales	17,362	18,399	20,210	14,559	16,231
Victoria	11,744	12,668	13,862	10,139	11,018
Queensland	6,415	6,471	7,635	5,536	6,007
South Australia	3,636	3,973	4,310	3,074	3,441
West. Australia	2,904	3,374	3,682	2,712	2,929
Tasmania	1,508	1,629	1,678	1,216	1,329
Northern Territory	22	28	30	16	32
F.C.T.	43	53	58	40	52
Total	43,634	46,595	51,465	37,292	41,039

Principal Crops—Australia.

AREA UNDER CROPS.

	1931-32	1932-33	1933-34
	Acres	Acres	Acres
Grain—			
Wheat	14,741,313	15,765,504	14,901,271
Oats	1,085,489	1,027,262	1,373,921
Maize	269,448	228,260	303,761
Hay	2,634,680	2,727,408	3,080,680
Sugar Cane	325,737	307,281	328,839
Total area under all crops	21,166,900	22,408,489	22,454,327

Total Production.

	1931-32	1932-33	1933-34
	Bushels	Bushels	Bushels
Grain—			
Wheat	190,612,188	213,926,981	177,337,803
Oats	15,194,680	16,159,628	16,922,031
Maize	7,062,383	5,066,321	7,494,080
Hay	3,167,459	3,571,047	3,582,748
Sugar Cane	4,213,453	3,703,188	4,898,040
Cane Sugar	603,735	532,594	666,145

Wool (as in the Grease) Produced.

	Season Ended 30th June 1932	1933	1934
	lb.	lb.	lb.
N.S.W. (a)	503,275,416	533,710,404	486,152,493
Victoria	159,721,916	170,807,900	161,146,436
Queensland	184,716,462	185,833,546	169,989,516
South Australia	67,021,312	75,727,946	79,288,903
West Australia (b)	77,985,741	81,307,832	85,118,808
Tasmania	14,700,000	15,200,000	14,200,000
Northern Territory	35,000	35,000	35,000
Total	1,007,455,847	1,062,622,628	995,931,156

(a) Including F.C.T.; (b) For year ended previous 31st December.
NOTE.—The production of wool for the season ending 30th June, 1935, is estimated at 1,031,000,000 lb.

Estimated Gross Value of Production.

	1930-31 £'000	1931-32 £'000	1932-33 £'000	1933-34 £'000
Agricultural	70,500	74,489	75,562	70,732
Pastoral	69,499	61,540	64,851	94,924
Dairy, Poultry and Bee Farming	43,067	41,478	39,622	40,306
Forestry and Fisheries	8,313	7,703	8,470	9,605
Mining	15,361	13,352	15,583	17,608
Manufacturing (a)	112,966	106,456	114,136	121,757
Total	319,706	305,018	318,224	354,932

(a) These amounts differ from those given in the following tables, owing to the inclusion in those tables of certain products which in this table are included with Dairy Farming and Forestry.

MANUFACTURING INDUSTRIES.

Percentage of Each Item of Outlay on Value of Total Output, 1933-34.

Particulars	N.S.W.	Vic.	Q'land.	S. Aust.	W. Aust.	Tas.	Total
	%	%	%	%	%	%	%
Wages (a)	18.85	21.06	16.48	20.14	21.38	21.83	19.52
Fuel & Light	3.84	2.83	2.29	3.61	4.98	6.86	3.40
Materials used	56.60	56.43	65.40	58.69	52.74	48.20	57.50
Margin for profits and miscellaneous expenses and charges	20.71	19.68	15.83	17.56	20.90	23.11	19.58
Total Output	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Per cent. of Wages on value of Production	47.65	51.70	51.01	53.41	50.56	48.56	49.92

(a) Exclusive of amounts drawn by working proprietors.

NOTE.—Production figures for 1934-35 are not available.

Manufacturing Industries.

AVERAGE AMOUNT OF SALARIES AND WAGES PAID PER EMPLOYEE (a)

Year	N.S.W.	Vic.	Q'land.	S. Aust	W. Aust.	Tas.	Total
1931-32—	£	£	£	£	£	£	£
Males ..	225.99	200.27	204.08	191.61	213.43	192.28	210.26
Females ..	98.74	94.43	81.61	81.21	92.20	83.11	94.18
1932-33—							
Males ..	213.72	193.84	201.02	188.62	208.05	188.75	202.37
Females ..	95.78	89.71	81.08	79.62	89.05	79.24	90.58
1933-34—							
Males ..	206.98	191.45	208.23	185.58	206.27	182.05	199.32
Females ..	91.88	88.54	82.77	78.43	86.43	81.41	88.69

(a) Exclusive of working proprietors and amounts drawn by them.

Manufacturing Industries.

AVERAGE NUMBER OF MALES AND FEMALES EMPLOYED, 1933-34.

Sex	N.S.W.	Vic.	Q'land.	S. Aust.	W. Aust.	Tas.	Total
Males ..	111,653	100,959	32,248	23,743	12,930	7,716	289,249
Females	42,408	55,375	7,835	5,743	3,233	2,066	116,660
Masculinity (a) ..	263	182	412	413	400	373	248

(a) Number of males per 100 females.

Manufacturing Industries.

	1931-32	1932-33	1933-34
	No.	No.	No.
Number of Establishments ..	21,657	22,330	23,297
Hands Employed	336,658	370,727	405,909
	£	£	£
Salaries and Wages Paid (a) ..	55,931,818	59,416,436	64,444,660
Value of Plant, Machinery Land and Buildings	228,119,701	226,386,729	227,714,293
Value of Materials Used	161,199,245	175,148,548	189,827,264
Value of Production	110,981,830	119,203,148	129,091,915
Value of Output	281,645,785	304,797,868	330,134,060

(a) Exclusive of amounts drawn by working proprietors.

MOTOR VEHICLES REGISTERED IN AUSTRALIA, 1934-35.

State and Territories	Registrations: Motor Cars	Commercial Vehicles	Motor Cycles	Total	Drivers' and Riders' Licences Issued
New South Wales (b)	164,483	56,055	22,777	243,315	341,255
Victoria	140,483	37,487	24,968	202,938	260,288
Queensland	65,261	27,985	7,807	101,053	(a) 125,550
South Australia ..	42,815	14,450	8,903	66,168	93,258
West. Australia ..	30,341	16,279	6,597	53,217	63,539
Tasmania	12,900	3,010	3,881	19,791	23,475
Northern Territory	303	182	31	516	773
Federal Capital Territory	1,098	273	81	1,452	2,080
Total	457,684	155,721	75,045	688,450	910,218

(a) Certificates of competency (State Transport Act, 1932).
(b) Number of vehicles on the road.

Saving Banks (a).

AMOUNT OF DEPOSIT.

	30/6/33	31/12/33	30/6/34	31/12/34	30/6/35
	£'000	£'000	£'000	£'000	£'000
New South Wales ..	72,308	72,504	75,714	76,167	77,906
Victoria	67,814	67,861	69,971	70,375	72,019
Queensland	23,453	24,054	24,834	25,809	26,197
South Australia ..	22,515	22,813	23,438	23,556	24,208
West Australia ..	10,064	9,978	10,399	10,539	10,929
Tasmania	5,865	5,855	6,039	6,198	6,430
F.C.T.	225	224	237	228	230
Northsrn Territory ..	38	42	44	50	53
Total	202,282	203,331	210,676	212,922	217,972

Average Per Head of Population (b).

	30/6/33	31/12/33	30/6/34	31/12/34	30/6/35
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
New South Wales ..	27 16 0	27 14 9	28 17 7	28 17 10	29 9 2
Victoria	37 5 1	37 3 10	38 4 10	38 5 11	39 3 8
Queensland	24 14 11	25 6 9	25 18 6	26 17 10	27 1 3
South Australia ..	38 15 1	39 3 0	40 3 7	40 6 3	41 7 1
West. Australia ..	22 18 7	22 13 2	23 10 5	23 16 1	24 10 5
Tasmania	25 15 4	25 4 6	26 9 10	26 15 7	28 2 3
F.C.T.	25 3 1	24 4 5	25 8 10	24 15 11	24 15 2
Nth. Territory ..	7 18 1	8 13 8	8 19 10	10 4 4	10 9 6
Total	30 10 2	30 10 11	31 11 0	31 15 0	32 8 3

(a) Includes Commonwealth Savings Bank.
(b) Averages are based on population at the end of the respective quarters.

BASIC WEEKLY WAGE RATES FIXED BY COMMONWEALTH COURT OF CONCILIATION AND ARBITRATION FOR EACH CAPITAL CITY. (a).

Capital	1st March, 1935	1st June, 1935	1st Sept., 1935	1st Dec., 1935
	s. d.	s. d.	s. d.	s. d.
Sydney	68 0	68 0	68 0	70 0
Melbourne	66 0	66 0	66 0	66 0
Brisbane	62 0	62 0	62 0	64 0
Adelaide	65 0 (64 0)	65 0	65 0	67 0
Perth	68 0	68 0	68 0	68 0
Hobart	69 0 (68 0)	69 0	69 0	69 0
Weighted Average—Six Capitals ..	66 0	66 0	66 0	68 0

(a) " C " Series Index Nos.—Commonwealth Arbitration Court's " Restoration " wage of the 17th April, 1934. Rates in brackets represent amount actually being paid after graduated deductions made.

(b) The family unit associated with this wage consists of man, wife and two children.

BASIC WEEKLY WAGE RATES FIXED BY STATE INDUSTRIAL TRIBUNALS.

State	Basic Wage: Males	Basic Wage: Females	Date of Operation	Family Unit (for Male Rate)
	£ s. d.	£ s. d.		
N.S.W.	(a) 3 8 6	1 17 0	1/5/35	Man, wife and child
Victoria	(b)	(b)	(b)	(b)
Queensland ..	3 14 0	1 19 0	1/7/31	Man, wife and three children
South Aust. ..	(c) 3 6 0	(d) 1 11 6	..	Man, wife and three children
West. Aust. ..	(e) 3 10 6	1 18 1	1/7/35	Man, wife and two children
Tasmania ..	(b)	(b)	(b)	(b)

(a) Plus child allowances. (b) None declared, but follow Federal rates to a large extent. (c) Judgment dated 21st October, 1935. (d) Judgment dated 4th December, 1931. (e) Metropolitan Area. Basic wage for Goldfields Areas and other portions of State, exclusive of the S.W. Land Division—Males, £4 4s. 4d.; Females, £2 5s. 6d.; Agricultural Areas and S.W. Land Division—Males, £3 11s. 2d.; Females, £1 18s. 5d.

Taxation—Commonwealth & State, per Head.

	Year Ended 30th June. 1933	1934	1935
	£ s. d.	£ s. d.	£ s. d.
Taxation by Commonwealth Government (a):—			
Customs and Excise	5 13 0	4 19 11	5 2 11
Other	(c) 3 2 4	(c) 3 10 1	(c) 3 6 7
Total	8 15 4	8 10 0	8 9 6
Taxation by State Govts. (b) ..	5 8 11	5 13 3	5 3 7
Total Taxation (a)	14 4 0	14 3 1	13 12 11

(a) Based on mean population of Commonwealth for each financial year. (b) Based on aggregate population of the six States, mean for each financial year. (c) Inclusive of Sales Tax, £1 5s. 9d. per head in 1931-32; £1 8s. 5d. in 1932-33; £1 6s. 2d. in 1933-34, and £1 5s. 4d. in 1934-35; also Flour Tax, 3s. 9d. per head in 1933-34, and 2s. 5d. in 1934-35.

STATISTICS OF BUSINESS CONDITIONS—AUSTRALIA.

Month	Retail Price Index Numbers, Food and Groceries, Six Capitals	Retail Price Index Numbers, Food, Groceries and Rent (all Houses), Six Capitals	Retail Price Index Numbers, Food, Rent (4 and 5 rooms), Clothing and Miscellaneous	Wholesale Price Index Numbers, (all groups), Melbourne	Wool Prices: Brokers' Realisation Price, Greasy Wool, all Centres (a)	Wool Prices: Greasy Merino—Standard Average, Sydney (b)	Wheat—Shippers' Price, f.o.r. Williamstown	Price of Butter (export parity)	Price of Gold (export parity)
					Pence per lb.	Pence per lb.	Pence per bushel	Shillings per cwt.	£A per oz.
Average for 1928.. ..	1,000	1,000	1,000	1,000	—	(c) 18.5	(c) 61.88	(c) 154	4.248
1928-29 ..	—	—	—	—	16.44	(c) 16.5	(c) 56.50	(c) 158	4.248
1935—									
January ..	809	796	817	814	9.95	9.4	32.75	88	8.753
February ..	807			810	9.52	8.7	34.38	94	8.809
March	804			805	9.35	8.6	36.38	78	9.055
April	803	799	820	806	10.14	9.5	39.44	79	8.902
May	810			814	10.82	10.6	38.88	83	8.801
June	815			818	10.23	11.1	36.88	92	8.718
July	822	814	830	825	8.20	(11.6)	34.81	96	8.693
August ..	830			836	8.00	(11.4)	36.81	103	8.656
September ..	836			834	12.27	12.1	40.50	123	8.700
October ..	836	816	831	836	12.84	12.4	44.56	131	8.742
November ..	829			825	14.23	12.9	40.38	112	8.720
December ..	821			815	14.38	13.0	41.44	97	8.707

(a) Average prices realised for all greasy wool of whatever type or quality marketed during the month.
(b) Compiled by the New South Wales Government Statistician. (c) Unweighted average price.
NOTE.—Wool prices in brackets are nominal.

Statistics of Business Conditions—Australia—*Continued.*

Month	Building Permits—Capital Cities and Suburbs: Number of New Buildings and Dwellings	Value of New Buildings, Dwellings and Alterations and Additions	Bank Clearings, Six Capitals (excluding Treasury Bills Transactions) (b)	Savings Bank Deposits, Australia	Bankruptcies (a) Australia: Number	Gross Liabilities	Sterling-dollar Exchange Rates (average of Daily Rates)
Average for 1928.. ..	—	—	(d) 43,947	213,000	(c)	(c)	4.866
1935.	Number	£'000	£'000	£'000		£'000	$ to £ stg.
January	880	1,404.6	31,051	213,175	95	160	4.895
February	933	1,291.3	37,111	213,374	150	340	4.875
March	994	1,793.7	36,154	213,509	221	520	4.776
April	951	1,512.5	33,988	213,946	163	312	4.835
May	1,142	2,226.3	36,539	214,698	177	439	4.890
June	1,097	1,650.2	38,800	217,972	92	271	4.936
July	1,295	2,174.9	36,271	218,424	155	185	4.956
August	1,283	1,877.4	32,983	219,416	143	234	4.971
September	1,190	1,740.8	36,204	220,020	99	165	4.933
October	1,240	1,914.4	40,600	221,059	119	194	4.908
November	1,111	1,701.3	41,423	221,670	118	171	4.926
December	837	1,129.0	43,092	220,525	112	144	4.929

(a) Sequestrations, Compositions and Deeds of Arrangement. (b) Average of four or five weekly periods ending the last Monday in each month. (c) Not available. (d) Weekly average for year.

Wireless Control in Australia

Wireless activities in Australia, as in all other countries, are under Governmental control. With wireless transmission recognising no national boundaries it is obvious that some form of control is necessary. Consequently the various nations of the world work together under a form of agreement—the International Tele-communication Convention and its Regulations—to ensure freedom from interference.

IN the Commonwealth, the Postmaster-General's Department administers the required control and supervision under the powers of the Wireless Telegraphy Act and Regulations. The Act places the responsibility on the Postmaster-General of conducting wireless services or licensing other people to do so. Therefore, no person is permitted to erect, establish or maintain apparatus capable of transmitting or receiving wireless signals unless he is in possession of a license from the Postmaster-General. The Wireless Telegraphy Regulations published herein set out the detailed conditions under which licenses are obtained.

There are various types of licenses covering the activities of the different classes of services. The licenses issued by the Postmaster-General's Department are:—

Coast Station	Broadcast Listeners'
Ship Station	Portable
Land Station	Experimental Station
Broadcasting Station	Aircraft Station

and

Special Licenses covering such services as the Beam Service, and other services for which specific licenses are not provided.

With the exception of Broadcasting Station Licenses and Special Licenses, the applicant meets with scarcely any difficulty, provided that the required conditions are complied with. The name of the license generally indicates the type of service to be covered which, with the exception of Broadcasting Station Licenses, refer mainly to commercial wireless-telegraph or wireless-telephony services.

It is very important, however, for all persons contemplating the installation of wireless apparatus to obtain full particulars from the Senior Radio Inspector in each State.

The issue of Broadcasting Station Licenses is a matter of greater complexity because of the number of such licenses is necessarily limited by technical considerations. In accordance with an International agreement only a certain number of broadcasting frequencies or wave-lengths is available for broadcasting services if interference, both national and international, is to be avoided. In the interests of listeners it is essential that the wave-lengths of the different stations have a minimum frequency separation compatible with the performance of average broadcast receivers. Consequently the obligation rests on the Department, and it is viewed very seriously, to see to it that the stations are properly placed within the spectrum of frequencies comprising the broadcast band. And as the first demands on these frequencies must necessarily come from the national stations, it follows that only a limited number of broadcasting channels or wave-lengths are left for the stations established by private enterprise, known as Commercial Broadcasting Stations. Therefore, the grant of such a license gives to the licensee something of a monopoly and consequently the Department must select very carefully from the applicants those to whom licenses are to be granted, keeping in view the essential factor that service to listeners must be the paramount consideration.

Inspection of Stations

When licenses are granted, regular inspections are made by officers of the Department in order to ensure that the conditions of the license are complied with. Those conditions may be referred to shortly as the stipulated service to be given and adequate precautions to be taken to avoid interference with other services.

Operators' Certificates of Proficiency

Under the international and local wireless laws, the Department stipulates the conditions pertaining to the issue of Operators' Certificates of Proficiency. These certificates are issued, after appropriate examinations have been passed, to candidates who desire to operate particular types of stations; the examination being conducted with the object of allowing the candidates to demonstrate their possession of the required knowledge of proficiency.

Examinations are held periodically for the following certificates:—

First Class Commercial Operator's Certificate of Proficiency in Radiotelegraphy and Radiotelephony;
Second Class Commercial Operators' Certificate of Proficiency in Radiotelegraphy;
* Third Class Certificate of Proficiency in Radiotelegraphy.
* Third Class Certificate of Proficiency in Radiotelephony;
Broadcast Operator's Certificate of Proficiency;
Amateur Operator's Certificate of Proficiency.
* These Certificates are now issued in lieu of Limited Certificates of Proficiency in Radiotelegraphy and Radiotelephony.

Interested persons should communicate with the nearest Senior Radio Inspector for full details.

Broadcast Listeners' Licenses

This is the type of license which in recent years has obviously become the most popular one owing to the progress of the broadcasting services. There are several differences between this type of license and the others. Broadcast listeners are not required to sign any document as in other cases and the license fee is on a different basis. In all other cases the license fee is a nominal amount, sufficient to defray the administrative costs incurred by the Department.

In the case of Broadcast Listeners' Licenses, however, the fee includes not only the administrative costs but also an amount forming a method of payment for the services which the listener receives, which may be described as a subscription to the service. Only a small portion of the license fee covers the administrative costs, the far greater part being what might be termed the subscription fee.

The annual fee of 21/- for Broadcast Listeners' Licenses applies to all listeners situated within an area of about 250 miles from a National Broadcasting Station; that area is known as Zone 1. Outside that area, in Zone 2, the annual fee is 15/- per annum.

The license fee is divided between the Australian Broadcasting Commission which receives 12/- for the provision of programmes, and the Postmaster-General's Department, which retains the balance for:—

(a) the provision of the technical services of the National Broadcasting Stations (installation, erection and operation);
(b) the inter-connecting telephone circuits between the various National Stations;
(c) other technical services, including the investigation of radio inductive interference and research; and
(d) administrative costs in connection with the issue and recording of licenses.

WIRELESS CONTROL IN AUSTRALIA—(Contd.)

Despite the obligation on listeners to obtain a license, it is unfortunately necessary for the Department to maintain a permanent staff in each State for the purpose of locating unlicensed listeners. When these listeners are detected they are brought before the Police Magistrates and during the year 1935 there were more than 900 convictions for this offence.

Payment of Listeners' License Fees By Postage Stamps

Provision may be made for the payment of broadcast listeners' license fees by purchasing postage stamps and affixing them to cards which are provided for the purpose. The following notes, printed on the back of the card, state the conditions under which the Department permits license fees to be paid in this manner:—

Postage stamps not otherwise used or defaced, of an individual face value of 6d. or more, when affixed in the spaces provided on this card, will be accepted at any Post Office License Issuing Office in partial or full payment for a new listener's license or for the renewal of an existing license.

Stamps to the value of more than 21/- should not be affixed to this card.

This card does not take the place of a listener's license, and, even if it contains stamps to the value of a license, it is illegal to use a receiving set until the actual license has been obtained.

If, after certain stamps have been affixed, the owner of this card does not wish to purchase a broadcast listener's license, the stamps so affixed will be re-purchased at the G.P.O. in any State, but a discount of 10 per cent. (minimum 2d., maximum 2/-) will be charged.

No wireless set may be used until the user is actually in possession of a Broadcast Listener's License.

Free Broadcast Listeners' Licenses for the Blind

Broadcast listeners' licenses are issued free to any blind person over the age of 16 years. These licenses are granted to—

(a) blind pensioners;
(b) blind soldiers in receipt of a pension;
(c) any other person over the age of 16 years on production of a Certificate from a qualified medical practitioner stating that he or she has no useful vision.

Forms of application may be obtained from the Senior Radio Inspector.

Radio Inductive Interference

The department endeavours to give as much service as possible to broadcast listeners and one of these services which has received special attention during recent years is that of the investigation of radio inductive interference. This form of disturbance to broadcast reception has unfortunately increased, with the introduction of receivers obtaining their power from the house lighting system and the Department has energetically extended its activities in combating the nuisance. Specially qualified Radio Inspectors in each State undertake the investigation of complaints received from groups of listeners in different localities. The investigations have been responsible for considerable success in determining the cause of the interference and in almost every case it is possible for the Inspectors to demonstrate the method of eliminating or reducing the interference by the installation of suppressors.

The installation of the suppressing equipment is obviously not a responsibility of the Department. The cause can be diagnosed, the curative measures to be taken can be demonstrated and it only remains for the owners of the offending electrical equipment to take the necessary steps to instal the suppressors. While in many cases the Department gladly records the co-operation which has been afforded by electric authorities and private owners of offending equipment, it is unfortunate that in some cases the desired co-operation has not been forthcoming.

Radio dealers can be of great assistance in this connection, particularly in country districts where they are familiar with the conditions and have business or other contacts with the listeners and the owners of electrical equipment. By a recognition of a reasonable community spirit, the co-operation could be fostered by the tactful action of radio dealers, whose interests, of course, would be served by listeners generally being more satisfied with their broadcasting services.

The Department is anxious to hear from listeners who are experiencing any trouble in connection with radio inductive interference and invites them to inform the Department of their conditions by filling in a Wireless Reception Questionnaire Form, obtainable from any Post Office, and sending it completed to the Senior Radio Inspector. In every case the Senior Radio Inspector communicates with the complainant and it is pleasing to note that in most cases a satisfactory result has followed.

The technical staff of the Department has been considerably augmented to deal with complaints from listeners, and equipment of the most modern design has been provided to enable the source of the interference to be speedily located.

Many towns in the Commonwealth have been made interference free by the co-operative efforts of machine owners, power supply authorities and in some cases the listeners themselves, in conjunction with the Department's experts, by arranging for offending appliances and devices to be fitted with an appropriate suppressor.

Demonstrations by Radio Dealers

A broadcast listener's license obtained by a radio dealer in respect of a particular address does not entitle the dealer to demonstrate or in any other way use a receiver in the home of a prospective buyer. This is a point which many dealers have overlooked. The Department, however, has always endeavoured to assist radio dealers in the conduct of their business, recognising that the radio trade has a very important part to play in the development of broadcasting.

It is recognised that the dealers must give demonstrations away from their shops and the Department grants the concession of allowing these demonstrations to be conducted without the obligation of obtaining a license. The conditions under which these special arrangements can be made may be learned by consultation with the Senior Radio Inspector. Generally, it is the practice to permit a demonstration period of three days in the metropolitan area and one week in country districts.

The Department has been reluctantly compelled to take action against several dealers who failed to comply with its conditions covering the demonstration of receivers. In some instances receivers were seized and forfeited to the Commonwealth.

Radio Inspectors' Addresses

The addresses of the Senior Radio Inspectors in each capital city are as follows:—

Sydney: Mr. W. T. S. Crawford, Haymarket Post Office Chambers, 635 George Street, 'phone B040.

Melbourne: Mr. J. M. Martin, Treasury Gardens, C.2, 'phone Central 5551.

Brisbane: Mr. T. Armstrong, General Post Office, Phone BY 8371.

Adelaide: Mr. H. W. Harrington, Commonwealth Offices, Post Office Place, Adelaide; 'Phone Central 6100.

Perth: Mr. G. A. Scott, General Post Office, Phone: B 6023.

Hobart: Mr. E. J. G. Bowden, Telephone Buildings, Harrington Street, 'Phone: (Prefix not used in Hobart) 5081.

Full particulars relating to Departmental Wireless Matters can always be obtained from any of the Senior Radio Inspectors listed above.

Communication Services of the Postmaster-General's Department in Australia

AUSTRALIA is a land of vast distances with a few widely separated rather densely populated areas of small extent and extensive territories carrying extremely small densities of population.

The area of the Continent is roughly 3 million square miles and its present population is about 6½ millions, 3¼ millions of whom are resident in the six State capital cities. The average distribution of the remainder is therefore less than two per square mile. To traverse the boundaries of the Continent one would have to travel 12,000 miles. A mental picture of these conditions is helpful in forming a conception of the nature and magnitude of the problem of providing comprehensive communication services. The problem is mainly one of economics resulting from the necessity to maintain long lines of communication—postal, telegraphic and telephonic—for the transaction of comparatively small volumes of business. Almost anything may be achieved if the cost need not be counted.

The Post Office has managed to establish mail services of so extensive a character that it is doubtful whether there is any locality permanently inhabited by so few as two or three white people which is not systematically served with letter delivery. Neither the telegraph nor telephone can claim to be so far-reaching, but as will appear later their ramifications are remarkably extensive.

The internal postal system depends upon scheduled despatches over 27,000 miles of railway and in addition makes use of 5,000 independent road services to localities which have not railway facilities. These road services are maintained under contract conditions and cover 130,000 miles of route. The frequency of the journeys varies in the aggregate from once daily to once a week with a comparatively small percentage extending to once a fortnight or slightly more. It will be realised, therefore, that the journeys during a year would total many millions of miles. Over the road routes mail matter is conveyed by motor vehicle, horse-drawn vehicle, on horse-back, pack-horse, and occasionally by camel. For many miles in the outlying parts roads are not available and somewhat indefinite tracks point the way.

Coastal vessels sailing over the entire circuit of the Continent are also used in the regular transportation of mails. A weekly air-mail service was inaugurated in December, 1934, to link up with the Imperial Airways Service between London and Singapore.

The air-mail services, including the Darwin-Singapore section, cover roughly 14,500 miles of route, the journeys over which total 2,572,000 miles per annum.

MAIL steamers provide a weekly mail service in each direction between Australia and the United Kingdom, these ships running to schedule so that they may effect connection with railway services and air services at various places both at the terminal ports and at intermediate calling places. Letters are landed at Fremantle and conveyed by rail to Adelaide (1,698 miles), Melbourne (2,181 miles), Sydney (2,771 miles), and Brisbane (3,384 miles).

The articles of mail matter posted in the Commonwealth total about 1,000,000,000 per annum and the incoming items from overseas which require distribution over the whole Continent reach over 43,000,000 per annum.

At the end of January, 1936, 550,468 telephones were in use in Australia, of which 224,667 were connected to exchanges situated outside the telephone networks of the State capital cities. Approximately 240,000 telephones are served by automatic exchanges.

Nearly 440,000,000 local and 33,000,000 trunk line calls are completed annually through 6,200 telephone exchanges.

About 2¾ million miles of wire are in use for telephone purposes. The aerial lines are supported on approximately 25,000,000 insulators attached to three million poles.

The capital value of telephone assets and buildings is about £44,000,000.

With the opening of the telephone service between the mainland and Tasmania, there is almost a nation-wide telephone system, which penetrates into practically every settled portion of the Commonwealth. Now a resident in Wiluna, in Western Australia, may converse by telephone with Cloncurry in Queensland, over approximately 5,500 miles of telephone wire, which probably is a world's record in land line telephony.

Direct radio telephone services are established from Australia to the United Kingdom, to New Zealand and to Java. There are few places in the world to which it is impossible to telephone from Australia. Out of a total of 33 million subscribers in the world 93 per cent. are in countries accessible to Australian subscribers and in addition it is possible to telephone to passengers aboard transatlantic liners whilst on their journey between England and the United States.

The telegraph service is conducted from 10,000 offices interconnected by 300,000 channel miles of circuit. It deals with 15 million telegrams per annum. Like the telephone service it has been completely modernised and uses every device which will aid in securing speedy and accurate service with lessened cost. Automatic direct printing telegraph apparatus is used extensively and long distance circuits, such as Perth to Sydney (2,770 miles), are equipped with this system. The typing of a message on a typewriter keyboard in Perth results in an almost simultaneous replica being produced in Sydney.

Carrier circuits which are derived by impressing a continuous train of moderately high frequency electrical oscillation on a metallic circuit have been established extensively for both telephone and telegraph purposes with great benefits from the technical, traffic and economic aspects. The various technical methods of providing for the simultaneous transmission of a number of messages over one metallic circuit have been exploited to the utmost. As a case in point, over one pair of wires between Sydney and Melbourne 36 telegrams are transmitted by machine printing system simultaneously with a telephone conversation. If the traffic offering were sufficient to warrant more carrying capacity the output could be increased to 88 telegrams and one simultaneous telephone conversation.

Pictures of high quality are also transmitted over 600 miles of circuit between Melbourne and Sydney and it is possible for a photograph of, say, a Melbourne Cup to be available in Sydney within about an hour of the running of the race.

Broadcasting services also are of an extensive character. They are divided into two groups. One comprises the national service—Government owned—the programmes being supplied by the Australian Broadcasting Commission and the technical services by the Post Office, the other consisting of licensed stations operated by private enterprise. There are eight national stations in the capital cities and seven in the country areas. Several additional country stations, or regional stations as they are known, are in course of construction. The network is designed to provide extensive coverage and on completion of the scheme will service effectively about 95 per cent. of the total population.

The land-line telephone circuits have been equipped to make them suitable for broadcasting transmissions, and any desired grouping of broadcasting stations can thus be arranged for the simultaneous radiation of any particular programme. From the Rockhampton station in Queensland to the Perth station in Western Australia the circuit distance is 3,800 miles and on several occasions programmes have been simultaneously broadcast at these extreme distances with many other of the intermediate broadcasting stations transmitting the same programme at the same time.

The privately-owned group consists of 68 broadcasting stations which are distributed in the more densely populated areas of the Commonwealth. Frequently, by mutual arrangements amongst the managements of a number of these stations, extensive simultaneous broadcasting is effected. In a recent instance there were no less than 54 privately-owned stations simultaneously transmitting by means of the Post Office telephone trunk system.

RATES OF POSTAGE

Within the Commonwealth and to Lord Howe Island, Norfolk Island, Papua, the Territory of New Guinea, and the following islands in the Pacific, viz.: Bismarck Archipelago (New Britain, New Ireland, New Hanover, Admiralty Islands, etc.), Nauru, Bougainville, and Buka (Solomon Islands).

Letters and Letter-Cards—2d. per oz.

Postcards—1½d. each.

Second-Class Matter—(a) Commercial Papers, Patterns, Samples, and Merchandise, 1d. per 2 oz.; (b) Printed Matter (comprising Printed Papers, Circulars and Catalogues, and Books, Periodicals and Newspapers not registered at a General Post Office), 1d. per 4 oz.

NOTE.—Commercial Papers include partly printed routine communications as prescribed, and formal documents such as accounts, invoices, etc.

Printed Matter includes wholly printed communications such as acknowledgments of the receipt of correspondence, orders or remittances, and notifications of the despatch of goods, etc., also catalogues containing samples of material subject to prescribed conditions.

Permit Mail, i.e., large quantities of circular letters posted in sealed envelopes under permit previously obtained—Printed matter rate plus spcial fee of ½d. per article.

Third Class Mail Matter (comprising books, periodicals and Newspapers registered at a General Post Office for transmission as such)—1d. per 6oz.

Beyond the Commonwealth.—Letters and Letter-Cards. To places within the British Empire, and to New Hebrides, Banks and Torres Islands—2d. per oz.

To all other places—3d. first oz., 2d. each additional oz.

Postcards—To places within the British Empire and to New Hebrides, Banks and Torres Islands—1½d. each.

To all other places—2d. each.

Commercial Papers—To New Zealand and the islands annexed thereto, and Fiji—1d. per 2 oz.

To all other places—1d. per 2 oz., with a minimum of 3d.

Printed Matter—To places within the British Empire, and to New Hebrides, Banks and Torres Islands—1d. per 4 oz.

To all other places—1d. per 2 oz.

Newspapers—To New Zealand and the islands annexed thereto, and Fiji—1d. per 6 oz.

To the United Kingdom and Irish Free State:

via France or America—1d. per 4 oz.

via All Sea Route—1d. per 6 oz.

To all other places Printed Matter Rates apply.

Samples—To places within the British Empire, and to New Hebrides, Banks and Torres Islands—1d. per 2 oz.

To all other places—1d. per 2 oz., with a minimum of 2d.

Merchandise—To New Zealand and the Islands annexed thereto, and Fiji only—1d. per 2 oz.

Small Packets (transmissible to certain countries only)—2½d. per 2 oz., with a minimum of 6d.

Postal Notes—1/- to 2/6, 1d.; 3/- to 4/6, 1½d.; 5/- to 7/6, 2d.; 10/- to £1, 3d.

The Use of the Long Distance Telephone Service for Broadcasting Purposes

DURING 1935 unprecedented demands were made on the Postmaster-General's Department for the use of trunk line channels for the transmission of programmes for simultaneous broadcasting from two or more stations, and the facilities which were made available in this connection no doubt enhanced substantially the value of the programmes. Since 1932 there has been an increase of over 372 per cent. in the total number of transmissions over trunk lines for broadcasting purposes in any one year, and the progressive growth in the past four years is shown by the following figures:—

Year ended	No. of transmissions over trunk lines
December, 1932	2,118
December, 1933	3,478
December, 1934	7,679
December, 1935	9,997

This particularly heavy demand for trunk line facilities for broadcasting purposes has occurred during a time when normal trunk line business was also increasing substantially, and exceptional measures have had to be taken in an endeavour to cope with both classes of business.

Telephone trunk line channels are normally designed for two-way telephone speech, but when required for broadcasting the characteristics of these circuits must be completely changed to permit of the highest quality transmission in one direction only of both speech and music. To make these circuit changes for an extensive hook-up, a special and highly skilful staff must be provided at several points along the route where the delicate repeater apparatus has to be suitably adjusted.

The preparation of circuits for broadcasting purposes must be controlled by experienced technical officers from specified points known as "zone controls." The work entailed is of a most involved and complex character and, as all types of programmes are relayed, including music and speech, it is important that the transmission characteristics of the telephone channels used should be of the highest possible quality and free from any distortion.

In order to ensure high quality transmissions special arrangements have been made to install channels on important routes which will be satisfactory for broadcasting relay purposes, and, as the popular time for the relay of a programme of special appeal or interest is naturally in the evening when there is a considerable amount of trunk line business offering, because of the application of the reduced night rates, it is often difficult to divert from normal use the channels which are required on behalf of the broadcasting interests.

Of the 9,997 relays which were arranged in 1935, 2,094 involved broadcasting stations in two States, 978 went to stations in three States, 631 to four States, and 346 to five States. The remaining 5,948 relays concerned only stations in the States of origin. The total period for which trunk line channels were occupied for programme transmissions during 1935 exceeded 16,000 hours.

Prior to 1935 the maximum number of broadcasting stations connected together for a simultaneous transmission was 47, but on one occasion last year 67 stations were linked up, involving the use of 12,500 miles of telephone trunk lines.

The diversity of the broadcast items relayed over trunk lines is illustrated by specifying the nature of programmes which have already been covered, viz:—

Musical programmes, including. Symphony Concerts, String quartettes, Choral Concerts, Choral Championships, Operas, Children's Concerts.

Descriptions of sporting events: Cricket Matches, Races, Tennis Tournaments, Football Matches, Boxing Contests, Rowing Events, Bicycle Races.

Talks on a wide variety of subjects: Speeches, Election Results, Debates, Musical Comedies, Plays, Revues, Vaudeville Entertainments.

Descriptions of: Floods, Important aeroplane flights, Funeral services, Royal Jubilee celebrations, the Royal Tour in Australia.

Welcomes to distinguished visitors: The Bells of Bethlehem, Carillon Bells, Consecration of an Archbishop, Opening of new radio stations, Weddings, New Year Greetings, Empire Broadcasts, Lyre Bird Calls, Tours of Australia by telephone.

The busiest periods for interstate broadcasting relays occur on Saturday afternoons and Sunday evenings. Descriptions of sporting events form the main attraction on Saturday afternoons, but the programmes relayed on Sunday evenings cover a very wide range of subjects, including news sessions, talks on various subjects, musical programmes, and radio dramas.

The total mileage of trunk line channels utilised in 1935 for actual programme transmissions exceeded 4,000,000 miles, whilst approximately the same mileage was involved in the channels utilised for the preparation of the transmission channels and for the monitoring of the relays.

The Department appreciates the desire of advertisers and broadcasting organisations to reach the maximum audience practicable, and, in considering the development of the long distance telephone system, is making provision to meet all reasonable demands which might be made in this direction.

In the submarine cable between the mainland and Tasmania, the development of broadcasting made it desirable to include a channel suitable for transmitting programmes in either direction between broadcasting stations situated on the mainland and in Tasmania. The use of this channel will overcome certain disabilities experienced in the past by Tasmanian listeners and will enable them to participate to a greater and more efficient degree in the programmes arranged by mainland stations.

Technical Progress in Australian Broadcasting

An account of the activities of the Postmaster-General's Department in the Radio Broadcasting Field in Australia.–

Introduction

THE Australian system of broadcasting is unique in that it allows for a National undertaking and private enterprise to function side by side. The success of the arrangement may be gauged from the fact that there are 800,000 licensed listeners and a license density which is exceeded by five other countries.

The National Service is financed from listeners' license fees and is intended to supply satisfactory reception of at least one National Station throughout the Commonwealth. The commercial stations rely on advertising for their revenue, and operate under licenses granted by the Postmaster-General.

TECHNICAL ACTIVITIES WITH THE NATIONAL SERVICE.

General:

THE Postmaster-General's Department has important functions in connection with the technical aspect of broadcasting. It provides the technical services for the National stations, and, as the Department administering the Wireless Telegraphy Regulations, it controls the operations of the commercial stations.

The Department's activities, in so far as the National Service is concerned, include the following:—

(a) Provision, maintenance and operation of the technical equipment at the stations and studios;

(b) Provision of the necessary networks of lines for the simultaneous transmission of programmes through the various stations;

(c) The investigation of developments in other parts of the world, so that no new features are overlooked which can, with profit, be adapted to Australian conditions.

Development:

The basic plan prepared in 1929 had as its aim the provision of stations so distributed throughout the Commonwealth that fading-free service day and night is given to over 90% of the population. This population is approximately seven millions, extending over an area of three million square miles.

The plan provides for over 30 stations, of which 15 have been installed. Six stations are in course of construction.

Technical development work is continually carried on so that the newest and most efficient methods and apparatus are made available to the National Broadcasting Service. Developmental work on aerial design has also been proceeding, and one of the new regional transmitters, now in course of erection, will be fitted with a new type of radiator which will possess novel mechanical and electrical features.

Frequency Allocation:

The frequencies allotted by the International Tele-communication Convention for broadcasting purposes lie within the band 550 to 1500 Kc/s. (545 — 200 m.), and in certain cases between 160 and 224 Kc/s (1875 and 1339 m.). Australia has utilised the former band, and 91 channels are available for the National and the Commercial stations within this band. The allocation of these channels requires very careful consideration to prevent mutual interference between channels and to avoid the heterodyne interference from broadcasting stations in Japan, China, New Zealand and other countries. The consideration of station locations must of necessity take full account of the geographical situation as well as the power and the frequency to be employed.

On 1st September, 1935, a revised frequency plan for Australia was brought into operation. The alteration in station frequencies was carried out without a hitch, and has since given satisfaction to listeners throughout the Commonwealth.

Station Sites:

The preparatory work for the next step in the basic plan was advanced considerably during the past year. Using a portable transmitter and measuring equipment the results of field strength measurements at possible sites were obtained and studied in conjunction with other related data in the selection of sites to give the maximum possible service area. Work in the field has defined the sites for four additional regional transmitters and has given the best location for the sites of new transmitters for Melbourne and Sydney.

Operation and Maintenance of National Stations and Studios

Station Equipment:

THE increase in the number of country regional transmitters taking common programmes from the Capital City studios has introduced complicated branching and switching problems. The Control Room equipment has been modernised to include the number of branching amplifiers required, and special attention is now being given to the design of apparatus which will facilitate the changeover of regional transmitters to the various studios.

Audition equipment, complete with talk-back facilities, has been installed in all studios to assist rehearsals and the dramatic productions of studio plays.

Investigation work on the various types of microphones available has been completed, and standardisation is now proceeding on the lines of moving coil microphones for outside broadcasts and general service, and the ribbon type for dramatic plays. It is common practice now to carry out debates between two persons located in different States, and to produce composite programmes such as the St. David's Day Celebration in which speeches and items are relayed direct from other States and fed into the special control position in one of the Capital City studios.

(Continued on next page)

TECHNICAL PROGRESS IN AUSTRALIAN BROADCASTING—(Contd.)

It will be seen that the facilities to effect the smooth changeover from point to point, separated by many hundreds of miles, as well as the organisation of the programme to include switching times and cue words has become of great importance. The fact that programmes of these types can be successfully produced is a tribute to the co-operation which exists between the officers of the Australian Broadcasting Commission and the Postmaster-General's Department.

Outside Broadcast Equipment:

The portable equipment used during the Royal Tour proved such a success that an installation is now available in each of the States. This equipment employs 4 input microphones, each of which is individually controlled and fed into an amplifier having a gain of 90 db. This amplifier in turn can be operated with special branching amplifiers so that a standby channel is at all times available. Very effective use was made of this equipment during the broadcast of the operas in Melbourne, when one branching channel was fed to a loud speaker operating in a specially treated room at the outside broadcast point. This is an innovation in Australia and contributed a great deal to the aesthetic value of the broadcast, owing to the more effective control of the production and active co-operation with the musical producer. A further interesting addition to the outside broadcasting plant is the use of the ultra short-wave transceivers. This equipment consists of a portable transmitter and receiver located in the one unit and operated by keys. The equipment has been very useful in the description of mobile events, and is operated with the transmitter located in a conveyance in constant touch with the second installation operating as a receiver at some fixed point where the programme is picked up and fed into the line connecting that point with the studio. Its effectiveness was very clearly demonstrated in the description of the yachting events from Moreton Bay in Queensland. Acting on pre-arranged signals the equipments were reversed and the studio was put in direct touch with the mobile equipment for the issue of instructions.

Public Address Systems:

The Australian Broadcasting Commission purchased a public address system in several of the States for use at the various racecourses. At their request the operation and maintenance of this system was carried out by the Postmaster-General's Department.

Recorded Programmes:

The three main methods of recording programmes are known as:—

(a) the disc method;
(b) the steel tape method;
(c) the film method.

Investigation into the relative merits of each type has been completed, and during the past year a decision was reached to adopt for immediate use the disc and the steel tape methods. The Marconi Stille steel magnetic recorder was purchased and installed. This machine will record items of 30 minutes duration. After a complete investigation, special equalisers were designed and fitted to obtain high quality and the machine is now used by the musical directors to prove the tonal balance of symphony orchestras. The demand for methods of recording items of approximately 4 minutes' duration was so great that a Neumann disc recorder was installed in Melbourne and Sydney. This machine will cut and record a 4 minute programme on a specially prepared record, and can be immediately played back. This is a valuable adjunct to the steel tape with its recordings of 30 minutes' duration, and both machines were used extensively to record the ceremonies broadcast from England on the occasion of the death of the late King George V.

Maintenance:

The maintenance of studios and stations is carried out in accordance with a strict procedure designed to ensure that no part of the plant is overlooked and that breakdowns due to negligence shall not occur. This maintenance procedure has been carefully reviewed during the year, and a system of recording and analysing all interruptions to service has been developed. The causes of all faults are determined, and all recurring troubles are followed up, in an effort to remove from the plant any inherent weaknesses due to design or types of equipment.

Staff:

The Department has introduced a training scheme for mechanics who are employed in stations and studios. Juniors who are taken straight from school are given a thorough training for a period of 5 years in all branches of the technical side of telephone and radio work. Subsequently, before the trainee is employed as a mechanic in a studio or station, he is required to pass an examination testing his qualifications. It will be appreciated, therefore, that with such a method of staff recruitment a very high standard in personnel is ensured.

Permanent Programme Lines

THE lines connecting the Capital City regional transmitters with the associated studios are, in general, composed mainly of conductors in underground cables. The attenuation characteristic of such lines increases with frequencies, and it was formerly the practice to treat these lines with equalisers so that a flat characteristic between 35 and 5,000 cycles per second was obtained. In all cases the frequency band has now been extended, and Capital City permanent programme lines now transmit a frequency band from 35 to 10,000 cycles per second.

The transmitting stations situated in country districts are connected to the Capital City studios by means of open wire lines. It has been possible in many cases to keep these lines solely for broadcasting purposes and under these circumstances the open wire lines have been equalised to transmit a frequency band from 35 to 8,000 cycles per second. In other cases where carrier systems are superimposed on the lines the cut-off frequency of the line filters lies between 5,000 and 6,000 cycles. It has not been possible to progress with the conversion work in these cases.

Interstate Relay Lines

The past year has again witnessed a big increase in the demand for interstate lines for the transmission of programmes. The National Service daily operates a network of 5,000 miles and the licensed stations have shown an increasing tendency to demand programme channels from the Department. This demand has necessitated an increase in the plant.

Lines:

The programme channels have been divided into two classes, based on the frequencies transmitted. Carrier telephone lines are used on speech relays where the important consideration is intelligibility. The lines designed for transmitting musical programmes have a frequency band of 35 to 8,000 cycles per second. There is an increasing tendency to demand the latter type of line on account of its more faithful reproduction and the Department, therefore, provided two channels between Sydney and Brisbane, 4 channels between Sydney and Melbourne, and 4 channels between Melbourne and Adelaide.

It was formerly the practice, when transmitting a programme to Tasmania, for a mechanic at Devonport or at Hobart to operate a wireless receiver connected to a trunk line between the pick-up point and the 7ZL studio. On 25th March, a new submarine cable was brought into operation between Victoria and Tasmania, and henceforth all programmes between those points will be transmitted over the high quality programme channel operating on the cable between frequencies of 34 to 42 kilocycles. The initial tests, which have already been carried out on this channel, indicate that the quality is in line with all other high quality channels operated by the Department.

(Continued on next page)

TECHNICAL PROGRESS OF P.M.G.'S BROADCASTING ACTIVITIES

Short Wave Services

Transmitter:

During the year, the reports on the service area of 3LR Lyndhurst, Victoria, were examined. It was apparent that this station was giving excellent service to the centre of Australia and to the islands within the Pacific. Although the service was opened in 1934, it was felt that the power could be increased with advantage, and during the past year the equipment was redesigned to provide for 1 kilowatt being fed into the aerial.

The present hours of Station 3LR are Monday to Friday, 6.15 to 10.30 p.m., Saturday, 1.30 to 10.30 p.m., but it is hoped to give more extended transmissions in the future.

The station is intended primarily for service within Australia. It operates on a frequency of 9,580 kilocycles, and employs a horizontal doublet aerial fed from the transmitter by a transmission line. This aerial is partly directive, and its use accounts for the excellent results achieved in the centre of Australia and in the islands.

A considerable amount of work on propagation to overseas countries was carried out, particularly in co-operation with the British Broadcasting Corporation and the League of Nations short-wave station at Geneva. A special directive aerial of the rhombic type directed on Britain was used. This type of aerial has a gain over the vertical half wave type of 10 db. This gain represents a considerable increase in power, and is partly responsible for the fact that 3LR is heard so well in Great Britain, the Continent and America.

Receiver:

The Postmaster-General's Department also operates a short-wave receiving station at Mont Park, Victoria. The station commenced operation with one panel mounted receiver and one horizontal rhombic aerial, both of which had been designed and constructed by the Postmaster-General's Department. The success attained has increased the demands on the equipment to such an extent that two receivers are now regularly operated and a third receiver will shortly be maintained as a standby. The aerial systems have been extended to include a double horizontal rhombic, a number of vertical V aerials and a vertical half wave aerial. It has been found possible to operate the two receivers with a combination of aerials and so reduce the amount of fading experienced in the audio channel output. Work on other methods to eliminate fading and noise troubles is proceeding, and further improvement in the overseas radio broadcasting service should be made during the coming year.

Research

THE Department has met this need by gathering together in its Research Laboratories a group of physicists, engineers and other officers specially qualified for this type of work. In these laboratories any developments giving promise of being useful in this country are tested, and local problems arising in the engineering, operation or maintenance of radio systems are investigated.

Separate premises, providing 16,500 square feet of floor space, have been set aside to accommodate the Research Staff and to house its equipment, valued at approximately £27,000. Upwards of 50 officers are continually engaged on various problems relating to radio and the other engineering activities of the Department.

In addition to the main laboratories housed at 59 Little Collins Street, Melbourne, there are two field laboratories used mainly for radio investigations; one at Mont Park and the other at Lyndhurst, both in Victoria. This portion of the Department's organisation dealing with broadcasting also maintains close contact with the Radio Research Board, a course designed to ensure the maximum of mutual assistance and to avoid any overlapping.

The bulk of the technical problems met with in broadcasting are basically similar to problems met with in modern telephone engineering, and are susceptible to attack along the same lines and with the same equipment as the latter. The association of the radio research and investigation work with the work already being done by the Department in connection with its telephone and telegraph services has, therefore, avoided unnecessary duplication of expensive equipment, and brought to the radio work research facilities on a scale which would not otherwise have been possible.

Activities in Connection With Commercial Stations

AS the licensing and controlling authority, the Department is closely associated with the Commercial Stations. Applications for new stations, alterations or replacements to existing transmitters, and all other technical features of the stations call for the approval of the Department. In the interests of listeners these matters are carefully investigated in order to permit the broadcasters to develop the Commercial Service as far as conditions will allow throughout the various States.

The main limiting factor is the shortage of broadcasting channels (wavelengths) which, as already mentioned, are Internationally limited to a certain band. In order, however, to provide for additional stations where they are considered justified and where there is a prospect of the stations becoming a financial success for their owners, the Department has introduced a system, adopted in other countries, of sharing the channels between two or more stations. In certain areas where more powerful stations are justified on the basis of population and area to be served, clear channels are provided for those stations, while in other cases, where a comparatively local service is required, stations are allotted channels on the sharing principle.

The maintenance of the operating frequency of the stations is of great importance in the success of the Commercial Stations, particularly those on shared channels, and the Department gratefully records the co-operation which is afforded by the station owners in arranging for the installation of reliable equipment for this purpose. In order to help the stations in this matter, checks of the operating frequency are regularly made and the Department is providing additional equipment for its Radio Inspectors in the different Capital Cities so that the work may be more usefully carried out in the interests of the broadcasters and listeners.

Radio Inductive Interference

INTERFERENCE with broadcast reception caused by electrical appliances has developed in Australia, as in other countries, somewhat seriously. The Department was fully alive to this development and during the past five years has undertaken the work of investigation into the interference. Information concerning listeners' difficulties is invited by the Department, and questionnaire forms for the purpose are provided at Post Offices. All such complaints are investigated and, where necessary, Radio Inspectors visit the localities, carry out investigations with the object of locating the cause of the interference, and demonstrate to the people concerned methods of fitting suppressors whereby the interference may be reduced or eliminated.

A considerable amount of co-operation in this matter is given promptly by Electric Supply Authorities, radio dealers and Listeners' Leagues, with the result that the growth of the interference has been checked.

With the establishment of further stations, thereby ensuring a higher signal strength in the different localities, the menace of radio inductive interference becomes less serious, but, nevertheless, the Department is continuing its work of helping the broadcasters and listeners in this problem.

Australia's Radio Communication System

THE following notes, together with the map illustrating the wireless services on the next page, are included in this Annual with the purpose of giving our readers a specific idea of the ramifications of the Wireless communication services throughout Australia and those emanating from Australia.

A PERUSAL of the map will show that the main radio centre lies in Sydney and from there communication services go down to New Zealand by radio telephony, across to Lord Howe Island by radio telegraphy, over to Suva, direct to Noumea; another service goes to Nauru, also to Rabaul, and then a cross service from Rabaul to Nauru. The service from Rabaul also extends on to Truk Island.

Still another service goes to Port Moresby. From Cooktown the service connects across to Samarai.

From Sydney the service also goes to Darwin and Wyndham. From Darwin it goes across to Koepang and Singapore.

It will also be noticed that the British Telephony System and also the Java Telephone System to Bandoeng is operated from Sydney.

Then coastal communication from Sydney extends to Adelaide, Perth and Melbourne.

In Victoria the Fiskville and Rockbank Beam Centres communicate direct with England on the one hand and across to Canada on the other.

There is also a very well organised radio service between Melbourne, King Island, Hobart and Flinders Island.

It will therefore be seen that by the agency of wireless, both telephony and telegraphy communication from Australia, is available to most parts of the world.

A wireless telegram can be sent from Australia to any part of the world, to ships at sea, and to aeroplanes in flight. This is effected by a number of allied services which may be divided into the following principal categories:—

1. Overseas radio services to Europe and America.
2. Services to the Mandated Territories of New Guinea, Papua, and the Pacific Islands.
3. Service to ships.
4. Service to aircraft.

The overseas wireless telegraph services are operated by Amalgamated Wireless (Australasia) Ltd., and are maintained by high speed short wave transmitters situated at Fiskville, in Victoria. These transmitters are arranged to send highly concentrated waves to Grimsby in England and to Montreal in Canada, from which two points the messages are distributed throughout Europe and America respectively. Similarly, messages are gathered from various places to these two centres, and thence transmitted to Australia, where they are received at the Beam Wireless receiving station at Rockbank, Victoria.

The transmitters at Fiskville and the receivers at Rockbank are connected by landline to the Central Radio Offices in Melbourne and Sydney, so that the operation of keys in these offices causes messages to be transmitted from Sydney and Melbourne direct to Europe and America, the transmitters at Fiskville being remotely controlled by the apparatus in the Central Radio Offices of Amalgamated Wireless in those two capital cities. The incoming signals, although received at Rockbank, are automatically transferred to landlines and reproduced in both city offices without having been relayed in any way.

Huge Volume of Traffic

The transmitting apparatus used in the overseas telegraph service is capable of sending up to 1400 letters a minutes, in actual practice during rush periods often handling 1000 letters a minute for sustained periods. The volume of words handled annually totals over 12,000,000, and represents over 75% of the overseas telegraphic business of the community.

The aerial masts at these beam stations are 260 ft. in height, and are so arranged as to be capable of transmitting signals around the globe in either direction, so that the efficiency of the service is maintained during the hours of both daylight and darkness. The station employs an aerial feeder system to convey the high frequency current from the transmitting house to the aerial wires, and these feeder wires are run through copper pipes and so insulated and earthed as to make the entire feeder system electrically and mechanically efficient, and free from breakdown.

Pacific Island Service

The wireless telegraph services between Australia and the neighbouring Islands are now conducted by Amalgamated Wireless from Sydney, and afford direct communication with Fiji, Papua and New Guinea. About three-quarters of a million words a year are handled by this service, by means of which it is possible to reach the most outlying parts of these Islands. Messages destined for the Islands of the Western Pacific group are at present relayed through Suva Wireless Station, which is operated by Amalgamated Wireless (A/asia) Ltd., on behalf of His Majesty's Colonial Government.

Radio Girdle Around Australia

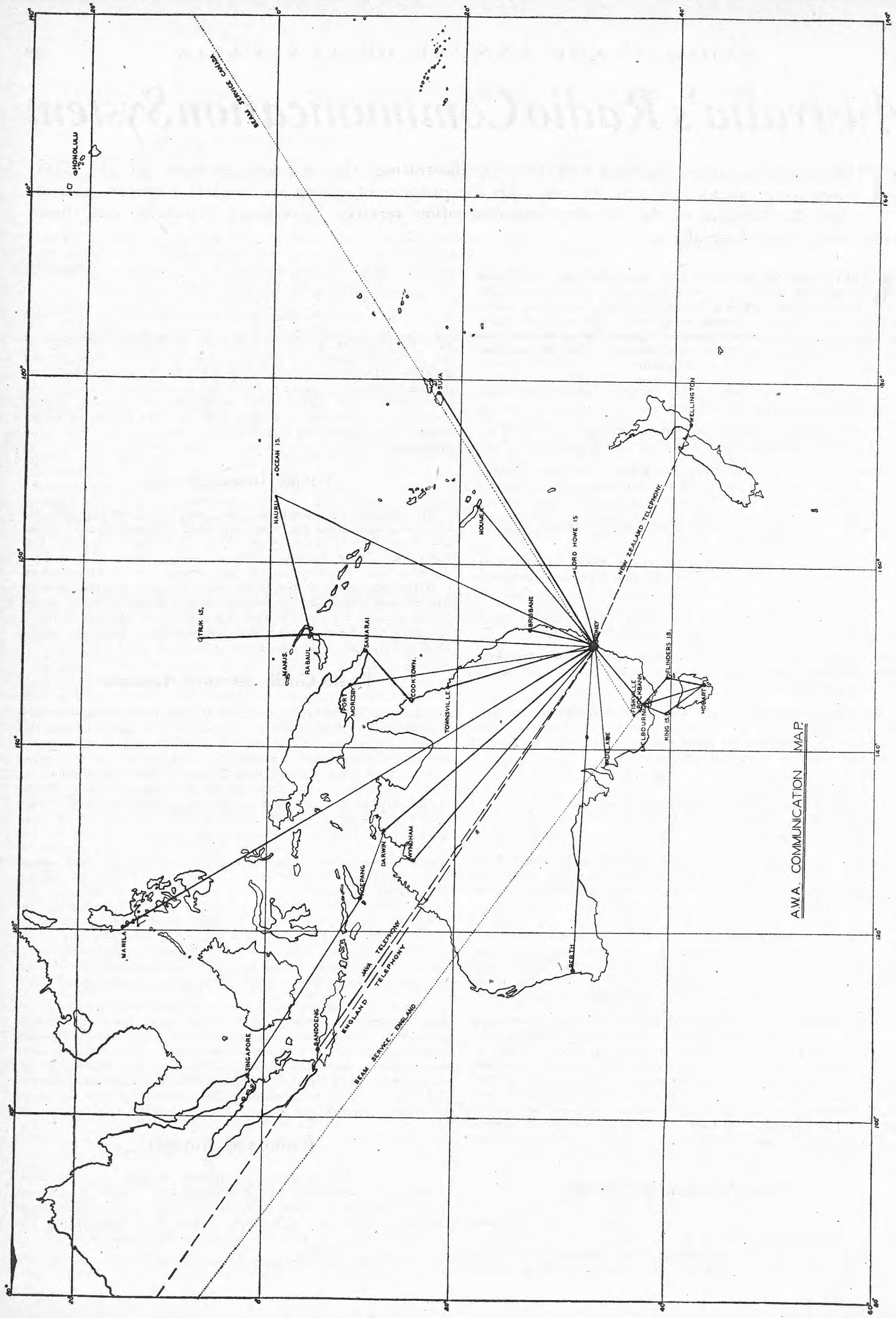
Amalgamated Wireless conducts the maritime wireless service by means of a chain of 19 stations situated at points around the coast of Australia. These stations conduct very comprehensive services to ships at sea, including the daily transmission of press news, official time signals, meteorological bulletins, weather reports, storm warnings, warnings of wreckage or other navigational dangers and the clearing of commercial and social traffic. The primary use of wireless between ship and shore is the safeguarding of life, and a continuous watch is maintained for distress signals, but to-day the application of this science to marine purposes has been extended to embrace not only equipment for the exchange of morse signals, but for direction finding (by means of which equipment the position of the ship can be ascertained at any time), echometers for determining the depth of water under the ship's keel, wireless telephony transmitting and receiving apparatus, enabling conversations to be carried on between ship and shore, lifeboat wireless equipment for use in emergencies, and automatic transmitting and receiving equipment which "keeps watch" when the operator is off duty.

In case of disaster, the automatic transmitter, started by the mere pressing of a switch (and having been previously set with the name of the ship and its position) sends out the distress signal and name and position of the vessel calling, thus releasing the operator for other duties. The automatic receiver is designed to pick up the S.O.S. signal only, and immediately causes a bell to ring, thus summoning the operator to take up watch for further signals.

Radio and Aircraft

With the increasing use of aircraft, a new need for communication by wireless has developed, and regular services are to-day maintained between aircraft in flight on the Bass Strait service, and the service between Sydney and Melbourne. The use of wireless in this connection is invaluable not only to

(Continued on page 91)



protect life, but for weather reports and as a guide to navigation, and for the latter purpose, a direction-finding station has recently been established at Essendon, in Victoria. Machines in flight take bearings from this station, and by this means can be guided home under the most adverse weather conditions.

Telephone Almost Anywhere

By means of the Overseas Wireless Telephone Service, it is possible for anyone in Australia within reach of a telephone to speak to any one of the thirty-five millions of telephone subscribers, or to any place where a telephone is installed, throughout Great Britain, Europe, America and New Zealand. It is even possible to speak from Australia to anyone on board the great trans-Atlantic liners on their voyages between America and Europe. The transmitting and receiving equipment for this service is operated by Amalgamated Wireless, and is linked to the internal telephone networks of each country, and by the establishment of this service, the peoples of the countries linked by it have been brought into even more close touch.

Another form of communication is made possible by the Beam Wireless Facsimile Service, established and operated by Amalgamated Wireless, which enables pictures to be transmitted and received by wireless between Australia and Great Britain and America. As an adjunct to the news service, or as a means of communicating commercial intelligence in the form of drawings or documents of any character, this service takes its place with the other wireless communication services in existence in Australia to-day.

In the A.W.A. short wave broadcasting transmitters VK2ME and VK3ME, there exists a means of communicating news about Australia to the outside world, and these stations play a prominent part in making the Commonwealth well and favourably known abroad. As reports show, these stations are regularly listened to in every country, and their usefulness as agents of goodwill for Australia is unquestionably great. They are located in Sydney and Melbourne respectively.

Australia – Overseas Beam Wireless Service

TO state that 93,528,016 words have been handled by Beam Wireless in Australia since the inauguration of the Beam system in 1927 is an indication of the magnitude of this service in relation to the business and social life of the community.

A more complete conception of the portance of Beam wireless is derived from a detailed study of its uses. Unlike many great experimental services, the Beam was a success from the day it was first opened, on 8th April, 1927. In the first year 1,331,410 words were exchanged between Australia and Great Britain, and in the following year the number was increased to 8,567,405. In 1934 the record of 12,991,266 words was reached, only to be beaten last year when the total was 13,693,449 words. "Words" in this connection means words paid for, not to speak of the millions made up by the check, prefix, office of origin, time lodged and so on. The establishment of the Beam, moreover made it possible to effect a decrease in the telegraphic rates between Australia and the outside world.

Beam Wireless was not a sudden creation. As far back as 22nd September, 1918, Mr. E. T. Fisk, Chairman of Amalgamated Wireless, received in Australia the first direct wireless messages transmitted from England, in furthering his advocacy of a direct wireless service, but over eight years elapsed before he had the satisfaction of opening such a service to the public.

So great was its success that a similar service between Australia and Canada, serving the North and South American continents was opened a year later.

The Beam Wireless transmitting centre in Australia is located at Fiskville close to Ballan about fifty miles west of Melbourne. There are three sets of transmitters. One is used for messages to London, whence they are distributed throughout the United Kingdom and Europe.

A second transmitting set communicates with Montreal in Canada. The third transmitter is used for the wireless despatch of pictures to either London or Montreal. It can also be used if occasion arises as a direct telegraph or telephone to London or Montreal.

Rockbank, about 18 miles from Melbourne, is the receiving centre for incoming Beam wireless messages. Both the transmitting and receiving stations are connected by special telegraph lines with the Beam wireless offices in Melbourne and Sydney.

Messages from Sydney and Melbourne city areas intended for transmission abroad are usually lodged at the Beam offices of Amalgamated Wireless in Sydney or Melbourne, or they are collected in the city by Beam messengers if the sender advises the Beam office.

Beam messages from other parts of Australia are lodged at any telegraph office, whence they are despatched over the telegraph lines and delivered to the Beam office in either Sydney or Melbourne. The constantly incoming stream of messages is handed over to expert telegraphists who sit before machines resembling typewriters and quickly translate the words into perforations on paper tape. The tape is then fed through a small instrument which causes the word impulses to be conveyed by means of the special telegraph lines to the transmitters at Fiskville. The time of despatch between Australia and England is a mere fraction of a second, the words being received in Great Britain as rapidly as they are passed through the Fiskville transmitters. From the British receiving station at Skegness they pass automatically over special lines to the overseas receiving centre of Cable and Wireless Ltd., in the heart of London where they are reproduced in Morse code characters on a tape from which they are transcribed by a telegraphist upon a typewriter. Thus the message is ready for delivery.

It will be seen that in the whole operation only two men are directly concerned, one being the telegraphist who prepares the tape for the transmitter and the other the telegraphist who reads the Morse tape record at the receiving end. All other phases in the transmission and reception of Beam wireless messages are entirely automatic.

The service between Australia and Canada is practically identical with that between Australia and Britain.

Beam Picturegram

Two years ago the Beam Telegraphic Service was supplemented by the Beam Picturegram. This enables the despatch and receipt between Australia and England of pictures of almost every description. The service is used mainly for the transmission of newspaper illustrations, photographs, architectural and engineering plans, fashion plates—even finger

(Continued on page 93)

AUSTRALIA-OVERSEAS BEAM SERVICE—(Continued)—

prints, Chinese writing and cheques. A very great saving in money was made recently when plans were "picturegrammed" from England to a cable steamer at Melbourne, thus enabling the vessel to proceed at once to the scene of a breakdown in a cable in the Indian Ocean. Much time would have been lost if the plans had been despatched by mail. Another interesting use of the picturegram service occurred at the time of the Melbourne Centenary Air Race, when sufficient photographs were sent by wireless to England to enable a film to be made showing many phases of the finish of the race.

The rate at which messages are transmitted is limited only by the mechanical restrictions of the automatic instruments used. A speed of about 180 or 200 words a minute is generally maintained, although 250 or more words can be achieved when necessary. Thus with Sydney and Melbourne both working, up to 500 words a minute may be leaving Australia. Or, to put it another way, the transmission methods used on the Beam may represent approximately the simultaneous work of seven expert telegraphists at Sydney and seven at Melbourne at a good average manual rate of operating.

The Beam Offices at Sydney and Melbourne at open for traffic day and night. The doors are but ornamental—they have never been closed since the inauguration of the service.

Amalgamated Wireless is proud of the fact that the whole of the staff necessary to inaugurate and maintain the highly technical and intricate Beam Wireless stations and highspeed telegraph controlling offices were recruited in Australia and the faith of those in charge of the great enterprise has been justified by its success.

Beam Transmitting Centre

Masts & Aerial Systems: Six stately latticed steel towers, each weighing 60 tons, rise to a height of more than 250 feet into the air, and support a delicate web of fine wires. The distance from mast to mast is 650 feet.

Three masts are used to support the two aerials and one common reflector connected to the London transmitters, and three for the aerial radiating to Montreal. The masts are 12 feet square, and are so strong that they are almost self-supporting. At its top, each mast carries a cross piece 90 feet long. The masts for each station are arranged in a line exactly at right angles to the direction on which the beam is to be projected.

The aerial system used in the Beam Wireless Stations is quite unlike the aerial of a broadcasting or a coastal radio station, because in addition to having to perform the ordinary duty of projecting the wave, it exercises the further function of concentrating it into a beam directed towards the desired receiving station.

Instead of being radiated broadcast all round the transmitter, signals are concentrated into one direction, which brings about greatly increased signal strength. Suppose the beam is 10 degrees wide. Then, instead of being radiated all round the aerial in the full 360 degrees of the circle, the energy of transmission will be concentrated into one thirty-sixth of the area it would otherwise cover. It follows, therefore, that the wave at any point along the path of the beam would be 36 times as strong as it would be if the beam were not employed.

Power House: A spectacle of a type which few people would expect to find in a wireless station confronts one on entering the power house. The actual energy to operate the wireless station is derived from three large, crude oil engines, each developing 150 brake horse power. The engines each have three cylinders, and each drives an electric generator which develops direct current at a pressure of 440 volts. The output of each of these generators is taken to a switchboard, and from there it is distributed to drive a series of other machines. A modern wireless transmitter uses valves which are essentially the same as the valves in a wireless receiving set, but much larger. Hence, a current is required to light the filaments, and another current is employed to operate the plate circuits of the valves. The filament current is really supplied from batteries, which are kept charged by a motor generator.

One of the most striking features of the power house is the exceedingly complete nature of the arrangements which have been provided to prevent breakdown of portion of the apparatus from interfering with the service. In the first place, there are three complete and independent engine driven generating units, and all the apparatus for filament supply and plate current supply is in triplicate.

The purpose of the transmitter is merely to produce an alternating current which can be fed to the aerial, but this current must alternate, or change its rate at a frequency which staggers the lay mind. It must generate currents which surge up and down aerial wires no fewer than 11,660,000 times and similar rates a second. The alternating current used in the ordinary domestic and commercial supply system changes its direction only 50 times a second.

The plate circuits of the main transmitting valves require a pressure of no less than 10,000 volts to operate them. Intricate and elaborate apparatus is needed to supply this pressure. Another electric motor, driven from one of the main generators operates an alternating current generator. The current delivered from this machine is passed into a transformer which steps up the voltage to a pressure considerably exceeding 10,000 volts. This high pressure current then passes into a rectifier. The rectifier consists of 16 valves, each about the size of a large football arranged in a rack and insulated on slabs of glass. Owing to the pressure employed all this apparatus is carefully shielded.

Beam Receiving Centre

The receiving building at Rockbank is much smaller than the transmitting building at Fiskville, mainly because the elaborate power system necessary for transmitting is not required to work the receiving equipment.

The masts and aerial systems at Rockbank are almost identical with those at the transmitting station.

Two lead-in systems from the aerials terminate in a small room where four specially constructed and scientifically shielded receivers are installed. One is for reception from Great Britain and the other for reception from Canada and telepicture and spare receivers. Each receiver employs no fewer than 24 valves, several of which are specially constructed for shortwave work.

Staff Quarters

All the resources of modern building practice have been employed to make the living quarters comfortable for the staff, who are engaged at the transmitting and receiving stations. The little villages, which have been built under the shadow of the masts at the two stations have been equipped with all the latest conveniences which can be obtained in the capital cities, and the buildings themselves have been designed by highly qualified architects.

At Fiskville there are eleven, and at Rockbank five bungalows for the married members of the station staff and their families, while large and well-equipped quarters for the bachelors are also provided at each station.

The buildings are fitted with electric light throughout, and provision is made for a supply of fresh water.

A full time school is maintained at Fiskville in a building provided by A.W.A. It is attended by the children of the Beam Station staff, and a number of other children from properties within several miles of the Station.

Institution of Radio Engineers (Aust.)

Head Office :
30 CARRINGTON STREET, SYDNEY
B 7188.

Melbourne Secretary :
c/o Technical College, Latrobe St. (Melbourne).

Patron :
His Excellency the Governor-General.
The Right Hon. Lord Gowrie, V.C., K.C.M.G., C.B., D.S.O.

Objects.

THE objects for which the Institution is founded are subject to Section 53 of the N.S.W. Companies Act, 1899, and are as follows: To promote the science and practice of radio telegraphy and radio telephony in all its branches and the usefulness and efficiency of persons engaged therein. To raise the character and status and advance the interests of the profession of radio telegraphy and radio telephony and those engaged therein. To increase the confidence of the mercantile and general community in the employment of recognised engineers and technical advisers by admitting to the Institution such persons only as shall have satisfied the Council of the Institution that they have a satisfactory knowledge of both the theory and practice of radio-telegraphy and radio telephony. To promote honourable practice, to repress malpractice and to settle disputed points of practice and to decide all questions of professional usage and etiquette among the persons engaged in the profession of radio telegraphy and radio telephony. To collect and circulate statistics and other information relative to radio telegraphy and radio telephony in all its branches. To provide for the delivery and holding of lectures, exhibitions, etc. To encourage the study of radio in all its branches and to improve and elevate the general and technical knowledge of persons engaged or about to be engaged in the profession of radio. To conduct examinations, to award prizes, distinctions, certificates, establish scholarships, etc. In general to do all such other lawful things that the Institution may think incidental or conducive to the attainment of the objects of the Institution.

Officers and Council, 1935-1936.

President: E. T. Fisk.
Deputy President: N. S. Gilmour.
Vice-Presidents: L. P. R. Bean and D. G. Wyles.
Hon. Treasurer: C. H. Norville.
Hon. Assistant Treasurer: C. Tyrrell.
Hon. Secretary: O. F. Mingay.
Hon. Assistant Secretary: K. H. M. Denny.
Councillors: W. T. S. Crawford, L. A. Hooke, A. S. McDonald, S. V. Colville, E. E. Tree, F. W. P. Thom, L. N. Schultz, R. Allsop, J. N. Briton, P. S. Parker, T. P. Court, R. J. W. Kennell.
Qualifications Board: A. S. McDonald (Chairman), D. G. Wyles, F. W. P. Thom, and W. T. S. Crawford.
Examinations Board: L. N. Schultz (Chairman).
Lectures and Papers Board: J. N. Briton (Chairman).
Social Committee: L. A. Hooke (Chairman).

Victorian Division Committee

Chairman: J. Malone.
Vice-Chairman: S. H. Witt, F. J. Henderson.
Hon. Secretary: R. R. Mackay.
Hon. Assistant Secretary: J. Dobbyn.
Hon. Treasurer: C. W. Evans.
Welfare Officer: R. K. Crow.
Councillors: F. G. Cresswell, W. Conry, F. Canning, R. Kendall, N. Hayes, R. R. Binnion, F. C. Draffin, C. W. Smith, G. F. Williams, J. Johnson, G. Apperley.
Qualifications Board: Convenor, S. H. Witt, N. Hayes, G. F. Williams.
Lectures and Papers Board: F. G. Cresswell, J. Dobbyn, F. J. Henderson, R. Kendall, J. Johnson, W. Conry.

Progress.

During the past 12 months the Institution of Radio Engineers (Australia) has continued to make progress. Over 60 new members of all grades were admitted while quite a number of applicants were requested to sit for examination. The Examination is held on the first Saturday in November of each year and applicants can obtain all particulars from the Hon. Secretary, Box 3120 G.P.O., Sydney.

World Radio Convention.

The Institution is proceeding to organise a World Radio Convention in Sydney early in 1938 to coincide with the Sesquicentenary Celebrations of the foundation of N.S.W. and Australia (150 years ago). This promises to be an outstanding function.

Interstate Branches.

The Institution is arranging for the formation of Branches in Brisbane, Adelaide and Perth as soon as circumstances permit.

Annual Award.

Commencing this year, 1936, the Institution will make three awards annually, one each to full member grade, one to Associates and one to juniors, for the most meritorious paper, lecture or thesis presented during the year.

Radio Society of Australia

RECOGNISING the need for the fullest development of radio and all its associated arts and sciences; also to encourage the intercourse of those persons interested in such development, the Institution of Radio Engineers (Aust.), being an institution established by radio engineers for the development of all branches of the science, art and industry of radio-electricity and radio communication, decided to form the Radio Society of Australia.

It is appreciated by the radio engineers that there are many persons interested in the development of radio and its associated arts and sciences in all or many phases, and yet who would not necessarily come within the scope of membership of such a technical body as the Institution of Radio Engineers. There are several thousands of people engaged in radio merchandising and broadcasting. There are also thousands of private citizens keenly interested in the national development of radio and allied arts and sciences. The medical profession is beginning to analyse the radio arts. In fact, the possibilities of the associated radio arts are so widespread and of national importance, as to warrant the formation of such a society.

The organisation and management of the Radio Society is under the direction of the Institution of Radio Engineers, whose President, Treasurer and Secretary occupy similar positions in the Society.

There are two grades of membership: Fellows and Members. The former shall, as a general principle, be leaders in the art, and the latter, all people interested in the development of radio and associated arts and sciences. The annual subscription for Fellows is £2/2/- and Members 21/-.

Society members have the right to attend all lectures, demonstrations, etc., conducted by the I.R.E., and to receive copies of paper, but have no voice or vote in the conduct of the affairs of the I.R.E.

Membership of the I.R.E. automatically carries membership of the Radio Society.

Victorian Radio Association

The Victorian Radio Association is a body representative of the Melbourne radio trade. The Head Office and place of meeting is at Shell Corner, 532 Bourke Street, Melbourne, where the Secretary, Mr. A. D. Broad is located.

Among other objects of the Association are:—

(a) To promote the welfare of members of the Association and to further their interests by modern scientific methods of co-operation and organisation.

(b) To inaugurate and carry out publicly for the popularisation of radio by advertising in approved directions and to adopt such other means of publicity as may seem expedient for educating the public to a better knowledge of the advantages of radio.

(c) To encourage the standardisation of radio material.

(d) To secure for members the benefits of any Act or Acts now passed or hereafter to be passed by the Legislature of the State of Victoria or by the Parliament of the Commonwealth of Australia relating to industrial or such other matters as may from time to time be determined by the Association in connection with the Radio Industry **and in general do** all such other lawful things as are incidental or conducive to the attainment of the objects for the benefit of members generally.

The activities of the Victorian Radio Association are divided up into several sections being:—

(1) Merchants' Section
(2) Manufacturers' Section
(3) Retailers' Section.
(4) Broadcasting Stations.
(5) Associate Members.

Radio interests in Victoria were originally served by the Electrical Federation of Victoria, the constitution of which then provided for a radio section. In 1928 Radio Interests were entirely divorced from Electrical interests and the Federation from that date has operated wholly as an electrical organisation. At the beginning of that year the Wholesale Radio Association (Victoria) was formed and functioned until 1931, when it evolved into the present Victorian Radio Association.

Since that date, the Association has fully justified its existence. Representing the principal radio houses in Victoria, it takes a lively interest in the problems that from time to time confront the industry. The Association is now the accepted channel through which the Victorian radio trade makes its voice heard. Seeking not to control the policies of individual members, it guides the industry along paths of established trade custom and brings about a recognition among radio traders of a high standard of business ethics as the essential foundation of a successful industry.

The Association has to its credit many notable achievements and has been successful in having beneficial legislation introduced and harmful legislation removed from the statute book.

Radio Shows—The Council of the Victorian Radio Association conducts the Annual Radio Exhibition held in Melbourne. The eleventh of these annual shows was held last year (1935).

The Association has proved its worth in acting as the "watch-dog" of the trade and protects its members' interests either by direct or indirect action as circumstances require. General and sectional meetings are held only when necessary, the Council meeting at frequent intervals to carry out the major part of the Association's work. In this way the valuable time of its members is saved.

The Council of the Association comprises:—President, R. Begg; Vice-President, K. Nicholls; Past President, A. F. Brash; Treasurer, A. S. Duke; and representatives of various sections of the association:—**Broadcasting Stations:** S. Morgan and T. W. Bearup; **Retailers' Section:** E. Williams and G. Sharwood; **Wholesalers' Section:** H. V. Prior and K. Nicholls; **Manufacturers' Section:** R. Walker and F. Henderson.

The Electrical & Radio Federation—Queensland

THE Electrical Federation of Queensland is formed for the purpose of promoting the welfare of members of the Federation and to further their interests by modern scientific methods of co-operation and organisation. To assist and further the interests of producers, suppliers and consumers of electrical energy, and of manufacturers, distributors, contractors, purchasers, and users of electrical commodities and appliances, and to promote and facilitate co-operative planning and inventions of various means and methods effective to this end. These are the general aims of such an organisation.

Council, 1935-36

President: L. G. Hinwood, Australian General Electric Limited, Adelaide Street, Brisbane — B 2151.
Vice-President: B. C. Percy, The Lawrence & Hanson Electrical Co. (Q'land) Ltd., Elizabeth Street, Brisbane — B 1407.
Past-President: R. F. Galloway, W. T. Henleys' Teleg. Works Co. Ltd., Elizabeth Street, Brisbane — B 1636.
Treasurer: P. S. Trackson, Trackson Bros. Pty. Ltd., Elizabeth Street, Brisbane — B 2804.
Secretary: E. C. Fernandez, 334 Queen Street, Brisbane — B 8626.
Merchants: J. L. Ferguson, Siemens (Aust.) Pty. Ltd., Charlotte Street, Brisbane — B 2468.
W. E. Peterman, Edward Street, Brisbane — B 5704.
Radio Traders: W. O. Barber, 129 Adelaide Street, Brisbane—B 6206. C. Binnie, Australian General Electric Limited, Adelaide Street, Brisbane — B 2151.
Australian Manufacturers: C. G. Faine, Electric Construction Co. of Aust. Ltd., Petrie Bight, Brisbane — B 2059.
Manufacturers Agents: T. H. Martin, T. H. Martin & Sons, Wilson House, 35 Charlote Street, Brisbane — B 4694.
P. H. Phillips, Clock House, Elizabeth Street, Brisbane—B 5774.

The Federation is represented on the Electrical Workers' Board by Mr. P. S. Trackson; on the Uniform Wiring Rules Committee by Messrs. P. S. Trackson and R. F. Galloway; on the Group Apprenticeship Committee by Mr. P. S. Trackson and on the Brisbane Chamber of Commerce by Mr. B. C. Percy.

Merchants' Section

Australian General Electric Limited, Norman Bell & Co. Pty. Ltd., J. R. Blane, J. B. Chandler & Co., Engineering Supply Co. of Aust. Ltd., Intercolonial Boring Co. Ltd., The Lawrence & Hanson Electrical Co. (Q'land) Ltd., Noyes Bros. (Sydney) Ltd., W. E. Peterman, Siemens (Australia) Pty. Ltd., Trackson Bros. Pty. Ltd., Warburton Franki (B) Ltd., W. T. Henley's Teleg. Works Co. Ltd., Williams Pty. Ltd.

Australian Manufacturers' Section

Electric Construction Co. of Aust. Ltd.

Radio Traders' Section

Australian General Electric Limited, W. O. Barber, Bush & Co., J. B. Chandler & Co., G. J. Grice Ltd., A. E. Harrold, E. V. Hudson Ltd., The Lawrence & Hanson Electrical Co. (Q'land) Ltd., J. D. S. Morrison, National Radio Co., Noyes Bros. (Sydney) Ltd., Trackson Bros. Pty. Ltd., Eclipse Radio Company.

Manufacturers' Agents' Section

V. J. Griffiths, H. Maddick, T. H. Martin, A. H. Hills, R. J. Norris, P. H. Phillips.

Radio Retailers' Association of N.S.W.

Registered Office :
Sixth Floor, Australia House, Carrington Street, Sydney.
'Phones : BW 6673 and B 2490

Office Bearers:

President : E. E. Tree.
Vice-Presidents : E. D. Huckell and Maxwell Cutts.
Hon. Secretary & Treasurer : T. F. Webb.
Hon. Assist. Secretary : C. D. Einsiedel.
Councillors : Messrs. R. W. Grills, R. C. Wright, M. G. Clay, J. A. Garey, M. Cutts, O. Sandel, J. H. Ross, J. Quirke, J. Manning.
Social Committee : E. Einsiedel, M. Cutts, A. W. Lutton, T. F. Webb, A. F. Norcliffe.

Subscription : 10/6 per annum. Entrance fee : 5/-.

Objects of the Association

To promote the welfare of members of the Association, and to further their interest by modern scientific methods of co-operation and organisation. To inaugurate and carry out publicity for the popularising of radio by advertising in approved directions and to adopt such other means of publicity as may seem expedient for educating the public to a better knowledge of the advantages, etc., of radio.

To provide a centre of information, instruction and advice on all matters pertaining to the business of members.

To establish, promote or assist in establishing or promoting, and to subscribe to, amalgamate with, or become a member of, any other Company, Association or Club, whose objects are similar or in part similar to the objects of this Association, or the establishment or promotion of which may be beneficial to this Association, provided that no subscription be paid to any other such company, association or club out of the funds of this Association except bona fide in furtherance of the objects of this Association.

To consider, originate, and promote reform improvements in the law; to consider proposed alterations and oppose or support the same.

To effect improvements in the administration of the law, and for the said purposes to petition parliament or take such other proceedings as may be deemed expedient.

To print or publish any newspapers, periodicals, books, programmes or leaflets that the Association may think desirable for the promotion of its objects.

Certificates and Badges : The Association reserves the right to grant, issue, authorise, modify, cancel or revoke certificates and badges of the Association.

The Association was formed in 1928 mainly for the purpose of eliminating undesirable trade practices and stabilising discounts. It is now endeavouring to secure the registration of qualified technicians and mechanics by legislation.

Both suburban and country membership has greatly increased during the past two years, among the benefits accruing have been the interchange of credit information, technical assistance, and advice, exchange of practical experience, co-operative advertising, the dissemination of up-to-date business practices and ideas, reciprocal servicing by members in adjacent districts, assistance in purchasing and visits to modern radio assembly plants and factories.

Monthly social gatherings are held at Australia House, also auto-picnics, fishing excursions, cricket matches, tennis tourneys, etc.

Metal Trades Employers' Association

HEAD OFFICE : FOURTH FLOOR,
7 WYNYARD STREET, SYDNEY
B 4052—B 2376

This Association is formed to encourage and develop metal working, manufacturing and allied industries, and to safeguard the interests of Australian producers. Formed in 1901 by a few of the leading engineering establishments. Covers such industries as the Automotive, Engineering, Electrical Manufacturing, Foundry, Sheet Metal, Stove Making, Structural, Ship Building, Wire-Working, etc., and is now the largest association of its type in Australasia. Constitutionally it is a voluntary association of manufacturers and workers of metal and producers of metal and allied products, the promotion of their several and mutual interests, governed by an annually elected Council, which consists of 16 members, elected by ballot among the whole of the membership, and a number up to 4 appointive Councillors, all of whom are actively engaged in the industry.

Executive Officers for 1935-36 :

President : J. Heine (John Heine & Son Ltd.)
Vice-Presidents : L. Napier Thomson (Andrew Thomson & Scougall Ltd), W. E. Clegg (Vickers-Commonwealth Steel Products Ltd.), T. M. Ritchie (Crompton Parkinson (Aust.) Ltd.).
Hon. Treasurer : R. J. Burns (Australian Iron & Steel Ltd.).
Councillors : J. F. Clack (Commonwealth Oxygen & Accessories Ltd), W. Courtney (Courtney & Bohlson Ltd.), A. Duly (Duly & Hansford), N. Fraser (Cockatoo Docks & Engineering Co. Ltd.), E. A. Horner (Amalgamated Wireless A/sia Ltd.), P. T. Kavanagh (Kavanagh & English Ltd.), J. H. Meiklejohn (Austral Bronze Co. Ltd.), R. J. Saunders (B. & S. Electrical Co. Ltd.), H. L. Spring (Metters Ltd.), C. W. Squires (Malleable Castings Ltd.), T. W. Thornley (W. Thornley & Sons Ltd.).
Secretary & Federal Advocate : W. C. Myhill.
Assistant Secretary & State Advocate : D. M. McDonald.
Tariff Officer : N. F. Miller.
Outdoor Officer : R. Bell.

The Radio and Telephone Manufacturers' Association

A Section of the Chamber of Manufactures of N.S.W.
12 O'Connell Street, Sydney, N.S.W.
BW 1844.

Formed 11th November, 1927.

President : C. Plowman (Airzone (1931) Ltd.).
Vice-Presidents : L. P. R. Bean (Stromberg-Carlson A/sia. Ltd.), and A. R. Persson (Ducon Condenser Pty. Ltd.).
Secretary : Percy S. Edwards.

The aims and objects of the Association are:—

(a) To render the maximum possible service to the trade in which its members are engaged.
(b) To assist the trade in its efforts to secure Tariff protection by co-ordinated effort.
(c) To promote closer relations and cordial co-operation in all branches of the industry.
(d) To advocate knowledge and learning in the science of business.
(e) To co-operate with other organisations in efforts towards economic advancement, standardisation and other activities.
(f) By means of committees of skilled and experienced men to investigate solutions of the innumerable financial, technical, and commercial problems that confront us.
(g) To focus the general and sectional activities of the Association on the essential problems of the industry.

Australian Valve Merchants' Association

Assembly Hall Building, 1 Jamieson Street, Sydney
Tel.: B 1046

Members

Amalgamated Wireless Valve Co. Ltd. ("Radiotron Valves).
Standard Telephones & Cables (A/sia) Ltd. ("Raytheon" Valves).
Neutrodyne Pty. Ltd. ("Hygrade" Valves).
Eastern Trading Co. Ltd. ("Ken-Rad" Valves).
Tyme Ltd. ("Sylvania" Valves).
Eclipse Radio Pty. Ltd. ("Tung-sol" Valves).
British General Electric Co. Ltd. ("Osram" Valves).
Eilbeck & Co. ("Arcturus" Valves).
W. G. Watson & Co. Ltd. ("Cossor" Valves).

Local Advisory Committees have been appointed in each State.

Chairman : A. P. Hosking. Secretary : S. G. Dwyer.

Objects

The objects of the Association are to promote, encourage, foster, develop and protect the interests of the public and all sections of the trade and to introduce such conditions of trading as in the opinion of the Association may be conducive to the aforementioned objects.

To safeguard consumers' interests by—

(a) Co-operating with manufacturers to maintain a high standard of quality, design and workmanship.
(b) Regulate prices to provide maximum value to the public and adequate return to traders.
(c) Protect dealers' interests by introducing conditions of sale on Association valves, which will embrace all potential channels and prevent unfair trading by price-cutting by any section of the trade.

Conditions for Sale of Valves for Use in Broadcast Receivers

It shall be a condition of sale that purchasers of Association valves shall be offered or given only such terms as may be authorised by the Association from time to time.

CLASSIFICATION OF PURCHASERS

Retailers

Definition.—Any individual firm or company having business premises trading on their own account as dealers in wireless apparatus and/or radio valves who carry a reasonable stock appertaining to such industries and who purchase such goods on their own order form for re-sale to users.

Note.—Any individual who is mainly employed by other persons does not come within this definition.

Wholesalers

Definition.—Firms or companies specified by the Association whose business includes the distribution of radio valves and/or wireless apparatus to the trade and who carry and maintain on their own account for purposes of distribution a reasonable stock of radio valves and who enter into specific obligations with the Association.

Standards Association of Australia

Established under the aegis of the Commonwealth and State Governments for the promotion of Standardisation and Simplified Practice.

Headquarters: Science House, Gloucester and Essex Streets, Sydney.
'Phone: B 1714.
Telegrams: "Austandard," Sydney.

BRANCHES

Victoria: Secretary Southern Section: R. O. Boyce, 61 Spring Street, Melbourne. 'Phone: F 5038.
Queensland:—Secretary: S. G. Palmer, Empire Chambers, Cnr. Queen & Wharf Streets, Brisbane. 'Phone: B 7467.
South Australia:—Secretary: R. M. Wigg, Alliance Building, Grenfell Street, Adelaide. 'Phone Cl. 6976.
West Australia:—Secretary: Lawson Gray, Chief Mechanical Engineers' Branch, W.A. Railways, Midland Junction, W.A. 'Phone MJ 161.
Tasmania:—Secretary: F. J. Carter, Premier's Department, Hobart. 'Phone: 5051.
F.C.T.:—Secretary: H. P. Moss, Works Branch, Department of the Interior, F.C.T. Branch, Canberra.
Newcastle and District:—Secretary: J. H. Nancarrow, Howard Smith Chambers, Watt Street, Newcastle. 'Phone: 477.

Objects

The objects for which the Association is established include:—

Prepare and promote the general adoption of standards relating to structures, commodities, materials, practices, operations, matters and things, and from time to time to revise, alter and amend the same.

Adopt such measures and take such steps and do all such things as may, in the opinion of the Council, be conducive to the promotion of cordial relations between the Association and persons interested in the objects of the Association.

Co-ordinate the efforts of producers and users for the improvement of materials, products, appliances, processes and methods.

Register in the name of the Association a Mark and to affix or license the affixing of such Mark to certain materials and to enforce and protect the use of such Mark and to oppose any proceedings or applications which may seem calculated directly or indirectly to prejudice the interests of the Association.

Procure the recognition of the Association in any foreign country or place.

Collect and circulate statistics and other information relative to standardisation in all its branches.

Provide for the delivery and holding of lectures, exhibitions, public meetings, classes and conferences calculated to advance directly or indirectly the cause of education in standardisation whether general or technical.

Establish, form, furnish, and maintain libraries, museums and laboratories for the purpose of furthering the practice of standardisation.

Communicate information to members on all matters affecting the practice of standardisation and to print, publish, issue and circulate such papers, periodicals, books, circulars, leaflets and other literary undertakings as may seem conducive to any of the objects of the Association.

Officers

Chairman: Sir George Julius, B.Sc., B.E., M.I.Mech.E., M.I.E. Aust.; **Vice-Chairman:** W. E. Wainwright, A.S.A.S.M., M.Aust.I.M.M., M.Am.I.M.M.; **Chief Executive Officer:** W. R. Hebblewhite, B.E., M.I.E.Aust.

The Standards Association was established 1st July, 1929, by an amalgamation of the Australian Commonwealth Engineering Standards Association (founded 1922) and the Australian Commonwealth Association of Simplified Practice (founded 1927), and has over 500 Committees, including over 4,000 technical experts

Of particular interest to the radio trade is the fact that the Association has an Electrical Committee with a Wireless Components and Accessories Sub-Committee and a Wiring Rules Committee.

Chairmen of Committees

Electrical Sectional Committee:
Northern Section (Sydney): Mr. W. S. Corner.
Southern Section (Melbourne): Mr. H. R. Harper.
Wireless Components and Accessories: Mr. M. J. Lacey.

Wiring Rules Sectional Committee:
Queensland Sub-Committee: Mr. W. Arundel.
N.S.W. Sub-Committee: Mr. V. J. F. Brain.
Newcastle Panel: Mr. W. A. Wilson.
Federal Capital Territory: Mr. H. P. Moss.
Victorian Sub-Committee: Mr. A. L. Hargrave.
Tasmanian Sub-Committee: Mr. G. H. Lofts.
South Australian Sub-Committee: Mr. W. Hobba.
Western Australian Sub-Committee: Mr. F. C. Edmondson.

A.R.M.P.A.L.

President
L. P. R. BEAN

L. C. HARGREAVES — Vice-President
FRANK F. KRAEGEN — Secretary-Accountant

Australian Radio Manufacturers Patents Association Ltd., 3rd Floor, Assembly Hall, Margaret Street, Sydney. 'Phone B 3388. Cables & Telegrams, "ARMPAL" Sydney.

Officers

President: L. P. R. Bean. **Vice-Presidents:** W. J. O'Brien and L. C. Hargreaves. **Councillors:** L. P. R. Bean, W. J. O'Brien, L. C. Hargreaves, A. L. C. Webb. **Secretary-Accountant:** Frank F. Kraegen (Chartered Accountant (Aust.)). **Special Accountant:** H. T. Woods (Chartered Accountant (Aust.)). **Deputy Special Accountant:** R. B. Woods (Chartered Accountant (Aust.))

Auditors: G. A. Blackett & N. B. Lewis (Chartered Accountants (Aust.)).

Technical Committee

C. H. Norville (Chairman), W. A. Syme, N. H. Buchanan, J. N. Briton, C. Slade, H. A. Warby.
Patent Attorneys: Messrs. T. C. Allen & Goddard.

Aims and Objects

The objects of this Association are to promote the manufacturing interests of its members and to mould the general body of Radio Manufacturers into a cohesive and single-minded Association.

Particularly to render a service to its members by giving them a complete knowledge of all patents, and to form a Buying Pool for the securing of overseas Patents direct.

ARMPAL is a co-operative Association and not a profit making concern, formed to protect its members against patent attacks.

The Electrical and Radio Association of N.S.W.

Assembly Building, Jamieson & Margaret Streets, Sydney—Telephone: B 7503-4.

President: Roy P. Godfrey (Godfrey Ltd.).
Senior Vice-President: J. Russell Greenwood (Anthony Hordern & Sons Ltd.).
Junior Vice-President: G. K. Dunbar (Australian General Electric Ltd.).
Honorary Treasurer: J. N. Parry (Electric Light & Power Supply Corp. Ltd.).
Executive: N. Best, P. L. Boswell, G. Davidson, G. K. Dunbar, R. P. Godfrey, J. R. Greenwood, A. Grundy, C. H. Jensen, A. E. Kaleski, J. N. Parry, L. G. Rickard, A. Waddell, W. J. J. Wing.

Sectional Chairmen

Section 1. Electrical & Radio Development Association (ERDA)—J. R. Greenwood.
Section 2. Electricity Supply Undertakings—A. N. Parry.
Section 3. Overseas Manufacturers—C. Crome.
Section 4. Australian Manufacturers—R. P. Godfrey.
Section 5. Direct Representatives—A. E. Kaleski.
Section 6. Indentors—P. L. Boswell.
Section 7. Merchants—N. Best.
Section 8. Retailers—J. R. Greenwood.
Section 9. Contractors—T. P. Johnson.
Section 10. Radio Manufacturers—W. J. J. Wing.
Section 11. Radio Direct Representatives—G. K. Dunbar.
Section 12. Radio Wholesale Houses—C. H. Jensen.
Section 13. Radio Retailers—A. Grundy.
Secretary: A. F. O. Brown.

Aims and Objects

1. To promote the trade interests of the members of the Association.
2. To assist and further the interests of producers, suppliers and consumers of electrical energy and of manufacturers, distributors, contractors, purchasers and users of electrical commodities and appliances, etc.
3. To encourage the use of standardised electrical material.
4. To secure for the persons, firms, companies, or corporations engaged in the manufacture or sale of electrical appliances, or employing electrical workmen, the benefits of the Industrial Arbitration Act, 1912, or any Act or Acts now passed or hereafter to be passed by the Legislature of the State of New South Wales or by the Parliament of the Commonwealth of Australia relating to industrial matters in connection with electrical workmen.
5. To originate and promote improvements in the laws connected with the electrical industry and to support or oppose alterations therein, and to effect improvements in administration in matters connected therewith.
6. To inaugurate and carry out publicity for the popularisation of electricity and electrical appliances and methods by the collection and distribution among members data relating to the electrical industry, and by advertising in approved directions the benefits of the use of electricity and to adopt such other means of publicity as may seem expedient for promoting the objects of the association and/or educating the public to a better knowledge of the advantages and use of electric energy and appliances.
7. To provide for and be a central medium of useful and/or confidential information available for members of the Association, and generally for the furtherance and promotion of their business interests.
8. To further the objects herein contained or any of them by action directly, indirectly or in co-operation with any other organised body or bodies having objects similar to those of the Association.

Date of Formation, etc.

The Association was formed nearly 25 years ago with the principal object of contesting wage claims then lodged by the Electrical Trades Union of Australia. These claims became the basis of an award which was probably the first electrical award made in the world. In those days and up to within three or four years ago the Association was known as the Electrical Employers' Association of New South Wales.

With the expansion of its services, however, this name was considered too restrictive and it was changed by omitting the word "employers." Although the Association retains more than an active interest in industrial matters, its sphere of usefulness has been so widened that it caters now for every section of both the electrical and radio industries.

Some of Its Services and Activities

The ordinary services and activities of the Association include:

1. Free advice to members as to their liabilities under Industrial Awards, Federal and State legislation, or any other matter affecting their interests individually or collectively.
2. Representation on the S.A.A. Wiring Rules Committees, the Electricians, etc. (State) Conciliation Committee, the Municipal etc. Councils (Electricians) Conciliation Committee, Electrical Apparatus Safety Board, and other public bodies legislating in the Electrical Industry.
3. The encouragement of amicable relations between the many sections of the Electrical and Radio interests and also between employer and employee.
4. Use of accommodation exclusively set apart for members at the rooms of the Association containing, telephone, writing equipment, reference library, local and overseas trade press, daily press and other conveniences.
5. A copy of the official journal "ERDA," containing authentic and informative articles from reliable sources, posted free each month.
6. Special and continuous activity towards stabilising and bettering conditions of the Electrical Trade, especially contracting.
7. A better service to the public—at least an implied warranty of standard in the work done by Association members, the maintenance of a high ethical standard in all business and trade relations.

The Association is divided into sections, and each section looks after its own interests. The Executive, that is, the principal Committee, comprises one representative from each section, so that it can be said to be truly representative.

The subscription rates vary according to the section, and it is possible for an electrical contractor or radio trader to be a member of the Association for as little as two guineas per annum, or roughly 10d. per week.

THE ELECTRICAL AND RADIO DEVELOPMENT ASSOCIATION

Assembly Building, Jamieson & Margaret Streets, Sydney—Telephone: B 7503-4.

The Electrical & Radio Development Association, or, as it is usually known by its initials, ERDA, is the Development Section of the Electrical & Radio Association of N.S.W., and its sole function is the dissemination of publicity and propaganda as to the advantages of electricity and radio.

The annual Electrical and Radio Exhibition, the Red Seal Plan, various trade social functions, etc., are examples of its work.

Chairman: J. Russell Greenwood (Anthony Hordern & Sons Ltd.)
Committee: F. Ainsworth (Lawrence & Hanson Elec. Co. Ltd.), E. P. Bennett (Hecla Electrics (Sydney) Ltd.), S. G. Cook (David Jones Ltd.), G. Davidson (Philips Lamps A/sia Ltd.), G. K. Dunbar (Australian General Electric Ltd.), R. P. Godfrey (Godfrey Ltd.), W. J. J. Wing (Amalgamated Wireless A/sia Ltd.), W. Wright (Standard Telephones & Cables A/sia Ltd.).
Secretary: Andrew F. O. Brown.

The Society of Radio Technicians

Objects of the Society

The Society has been established to do all or any of the following things for the purpose of attaining the Objects of the Society and observing and performing whatever may be required by law in order legally to carry out such objects:

(a) To promote and develop the Science of Radio Technique with respect to Radio Service and set and maintain standards of efficiency for those professionally occupied in the Service and Maintenance of Radio Broadcast Equipment.

(b) To procure the recognition of the Status of the Society by Government, Public, Local and other authorities.

(c) To provide for the regular delivery of Lectures, and for the reading and discussing of communications and papers bearing on Radio Technology or upon subjects relating thereto.

(d) to (m) Other objects generally applicable to such a Society.

Officers and Council

Patron, H. C. Trenam; President, T. P. Court; Vice-Presidents, E. J. T. Moore, L. N. Schultz, R. Allsop, E. Dare; Secretary and Treasurer, J. W. Robins; Assistant Treasurer, N. Kellie; Council, H. A. Warby, G. Mitchell, A. Tollow, G. R. Seach, M. Cutts, R. A. Parker, G. H. Wilson, G. Menon, Dr. A. L. Green, W. D. Sullivan; Technical Committee, R. A. Parker, K. Blackwell, G. Menon, C. P. Healy, R. Allsop, L. N. Schultz; Technical Editor, T. P. Court; Auditor, D. G. Bell, A.C.A.; Solicitor, W. R. Nicol.

The Secretary Reports

The Honorary Secretary, Mr. J. W. Robins, reports that constitutional rules will be considerably revised, but as yet Council has not made final approval.

The annual meeting will be held in June of 1936, as a result of a decision to conclude the Society's Financial Year at the 30th June, rather than 31st December.

It has been decided to make lectures more of a practical nature than hitherto, taking the form of a demonstration covering all phases of laboratory work.

It is also proposed to immediately commence a series of additional monthly meetings, at which only matters of service will be dealt with such as Analysis of Receiver Design featuring the principal commercial receivers—discussion of special features, etc., and suggested methods of service. The object being to give the service man a more intimate knowledge of the receivers he will be called upon to deal with.

Radio Traders' Association of W.A.

14 A.N.A. House, St. George's Terrace, Perth, W.A.—Tel.: B 9201.

The Radio Traders' Association of W.A. is a section of the W.A. Wholesale Electrical Traders' Association.

Chairman: Alan Thomson, C/o Thomsons Ltd., 674 Hay St., Perth.

Committee: F. Beames, C. S. Southcott, H. E. Pead, A. J. Case, P. Plowman, H. U. Kendall.

Secretary: J. O. Smith, L.I.C.A., 14 A.N.A. House, Perth.

Generally, the Association was formed to undertake such work as may be deemed to be of mutual interest to members and the radio trade generally.

The Association is a very active body, and every opportunity is taken to obtain any improvement in conditions in the industry.

Radio-Electrical exhibitions have been held annually since 1932, and this year 1936, will be held in Government House Ballroom, commencing Monday, May 4, and concluding Monday, May 18. These exhibitions have been increasingly successful, both financially and otherwise.

The main feature of the operations of the Association for the past year has been the complete revision of the conditions of trading, particularly as between wholesalers and retailers, which has resulted in the adoption of conditions which are calculated to place the industry on a much more satisfactory basis than has been the case for some years past.

The Association is considered to be of great benefit to the industry in general and to members in particular.

Allied Radio Limited

Registered Office, 3rd Floor, Castlereagh House, 2b Castlereagh Street, Sydney. Secretary, S. J. Walton, Chartered Accountant (Aust.). Auditors, Messrs. W. F. Allworth & Sons, Chartered Accountants (Aust.), 2b Castlereagh Street, Sydney. Solicitors, Norman C. Oakes & Sagar, Spring Street, Sydney.

Directors: Claude Plowman (Airzone Ltd.), Norman S. Gilmour (Lekmek Radio Labs.), J. I. Carroll (New System Telephones & Emmco), A. E. Kaleski (Lawrence & Hanson Elec. Co. Ltd.), Otto Raz (Bloch & Gerber Ltd.), S. G. Cook (David Jones Ltd.), D. Eardley McLaren (Newton McLaren Ltd.).

Nominal capital: £2,000 in £1 shares. Minimum shareholding—for each firm or company, 10 shares fully paid on application.

Subscription: With the application form for shares, each shareholder is required to sign an agreement undertaking to pay a subscription equal to 2/6 per share per quarter. (As no shareholder will be asked to take more than 10 shares, the subscription will amount to £5 per annum).

ALLIED RADIO LIMITED—(Continued)—

The **policy** of the company is: (a) To act as a central body for the purpose of ensuring that its shareholders derive the full benefits under the best conditions of any existing or future agreements concerning patents in the radio and television field. (b) To see that the interests of its shareholders are conserved by establishing a constant oversight of the licensing arrangements of patent-holding groups, and where necessary to press for action under the terms of any particular license which may be involved. (c) To provide a centre for the exchange of views between the shareholders or their representatives on the board. (d) To negotiate agreements or otherwise deal with any situation which may arise from time to time and which is of common interest to shareholders. (e) To arrange for the formation if required, of any subsidiary company to handle the situations wherein only a section of its shareholders are interested.

Resignations.—A condition of the agreement signed with the application form provides that a shareholder may withdraw from the company at any time by paying three months subscription in advance and forfeiting to the board for disposal to the board's account, his equity in the shares.

Shareholding Qualifications.—Shareholders may be approved manufacturers, wholesalers, retailers or others, subject to the condition that they are not associated as participants in any patent-holding group (such as A.R.T.S.) or other body whose policy is, inter alia, to acquire patents. This condition is necessary in order that Allied Radio Limited may remain in a neutral and untrammelled position in respect of any patent holding group or groups with which it may be necessary to negotiate.

Directorate.—Provision has been made for a representative board, but with a sufficient number of directors resident in Sydney to ensure the proper conduct of the affairs of the company and with the further provision that directors residing elsewhere may appoint an approved Sydney proxy to act in their absence.

General.—It is pointed out by Allied Radio Ltd., that the capital of the company is not to be regarded as an indication **of its strength.** The capital has been kept at reasonable limits because it is considered that in most cases negotiation backed by unity pressure will achieve satisfactory results, particularly as provision is made for the formation, if necessary, of a subsidiary company to wage any unavoidable fight. The subsidiary would consist only of those shareholders interested, and it would have the organised moral support of Allied Radio Limited combined with full backing of the subsidiary company and its respective shareholders. It is claimed that the liability of shareholders in Allied Radio Limited will at all times be limited.

Australian Federation of Broadcasting Stations

Head Office: 371 Collins Street, Melbourne. 'Phone M 5532.

Branch Office: Kembla Building, Margaret Street, Sydney. 'Phone B 3835.

OFFICE-BEARERS FOR 1935-36: President—A. E. Bennett, Esq.

Vice-Presidents—Messrs. A. N. Kemsley and V. M. Brooker.

Secretary-General—M. B. Duffy, Esq.

Federal Council comprises representatives of City Stations and two Country Station representatives in Victoria and New South Wales.

Executive Council comprises representatives of Melbourne and Sydney stations and two country station representatives in Victoria and New South Wales.

The Federation started from small beginnings about 1928, when three of the Sydney Stations then operating decided that common action was necessary on certain matters, such as copyright. Since the first interstate Convention was held in 1930, the Federation has continued to grow in strength and membership until now it has 65 commercial stations as members. The growth is an indication of the development of commercial broadcasting in Australia during the last few years, and of the popularity of broadcasting as a medium of advertising.

The objects of the Federation may be briefly summarised as follows:—

As commercial broadcasting has developed, so have the problems confronting broadcasters, especially in their relationships with bodies holding various rights, such as musical copyright, gramophone records, patents and the like. In consequence, the time which station managements had to devote to these matters has been increasing each year. In order to strengthen and develop the organisation and to have an official of the Federation authorised to negotiate with the various interests, it was decided at the last Annual Convention to appoint Mr. M. B. Duffy as Secretary-General. Mr. Duffy has been President of the Federation on several occasions and is thoroughly conversant with all the problems confronting the stations. A further development was the formation of a Country Stations Section of the Federation for the discussion of problems peculiar to the country stations.

During the last twelve months, commercial stations have continued to strive for constantly improving programmes, and their efforts have been particularly successful. Representatives of several of the leading stations have been abroad during the year studying broadcasting conditions in other countries, and, generally, the commercial stations in Australia maintain a standard of programme in keeping with the leading broadcasting systems of the world.

The Federation has continued to keep a close watch on all governmental matters affecting broadcasting and has made representation on various subjects, including items suggested for adoption at the forthcoming International Copyright Convention.

In 1935 also agreements were entered into with the Associated Record Manufacturers for the use of gramophone records, and an agreement for a period of years was also completed with the Australasian Performing Right Association Limited for the use of copyright music.

W. A. Serviceman's Industrial Award

Agreement No. 19 of 1935
(Registered 28/11/35)

THIS Agreement made in pursuance of "The Industrial Arbitration Act, 1912-1935," this 26th day of November, one thousand nine hundred and thirty-five, between C. S. Baty & Co., J. G. Pritchard, Limited; A. Pidgeon; Thomsons, Limited; British General Electric Co. Limited, Airzone (W.A.), Limited; and H. C. Little & Co. Limited (hereinafter called "the Employers"), of the one part, and the Perth Radio Trade Industrial Union of Workers (hereinafter called "the Union"), of the other part, witnesseth that, for the considerations hereinafter appearing, the parties hereto mutually covenant and agree the one with the other as follows:—

1.—AREA. This Agreement shall operate over the area comprised within a radius of twenty-five (25) miles from the G.P.O., Perth.

2.—TERM. The term of this Agreement shall be twelve (12) months from the date hereof.

3.—DEFINITIONS. (a) General serviceman shall mean a worker employed in making, repairing, altering, assembling, testing, aligning, fault locating, winding and wiring radio machines, instruments or other apparatus.

(b) Workshop serviceman shall mean a worker exclusively or principally employed in the employer's workshop in making, repairing, altering, assembling, testing, aligning, fault-locating, winding and wiring radio machines, instruments or other apparatus.

(c) Bench assembler (i.e., wireman, installer, coil winder, assembler, cabinet fitter) shall mean a worker engaged in assembling and putting together the parts of a radio as received from the maker, and the wiring and hooking up of such parts in a radio set, the winding of coils used in radio sets, the installation of such sets, and the fitting up of radio sets in cabinets. Any work in the nature of altering, testing, or adjusting such parts shall be the work of a workshop serviceman.

(2) (a) Casual worker shall mean a worker employed for less than six (6) consecutive working days and who may be put off or leave the employer's service without notice.

(b) A casual worker shall be paid ten per cent. (10%) in addition to the rates prescribed.

(c) A casual worker shall not be employed or be paid for less than two (2) hours in any one day.

4.—Hours

(a) Forty-four (44) hours shall constitute a week's work for all workers.

(b) Each day's work for all workers shall not exceed eight (8) hours on Monday to Friday inclusive; Saturday, four (4) hours; to be worked in a continuous shift (exclusive of meal hour breaks).

(c) Meal hour breaks shall not exceed one (1) hour each.

(d) The hours of work shall be as follows:—

(i) General serviceman:—Between 7.30 a.m. and 9 p.m. on Monday to Friday inclusive and between 7.30 a.m. and 1 p.m. on Saturday.

(ii) Workshop serviceman and bench assembler:— Between 7.30 a.m. and 6 p.m., Monday to Friday inclusive, and between 7.30 a.m. and 1 p.m. on Saturday.

5.—Overtime

(a) For all work done beyond the hours of duty prescribed in Clause (4) payment shall be at the rate of time and a half for the first four (4) and double time thereafter.

(b) In the event of a worker being requested to hold himself in readiness for a call to work after ordinary hours, he shall be paid at ordinary rates for the time he so holds himself in readiness.

(c) All work performed beyond one quarter of an hour in any meal time shall be paid for at the rate of double time.

(d) No worker shall be compelled to work for more than five (5) hours without a break for a meal.

(e) When a worker, without being notified on the previous day, is required to continue working after the usual knock-off time for more than two (2) hours, he shall be provided with any meal required, or shall be paid one shilling and sixpence (1s. 6d.) in lieu thereof.

(f) Double time shall be paid for work done on Sunday, Christmas Day, Boxing Day, New Year's Day, Good Friday, Easter Monday, or Labour Day, except in connection with repairs to the employer's plant, which has broken down and has caused a stoppage of operations, or which may require overhauling and repairing, or adjusting, to prevent any such breakdown. Provided that this subclause shall not apply to workers employed on public address systems, who shall be allowed the equivalent time off at some other time, or have such equivalent time off added to their annual leave.

6.—Holidays

(a) Twelve (12) paid holidays per annum shall be granted each worker after twelve (12) months' continuous service: Provided always, that New Year's Day, Good Friday, Easter Monday, Labour Day, Christmas Day, and Boxing Day, or the days observed as such, shall be taken as they come as portion of the holidays. The balance of six days shall be granted as annual leave, at the convenience of the employer, but shall in any event be taken within six (6) months of becoming due.

(b) In the event of a worker being employed by an employer for portion only of a year, he shall only be entitled to such holidays on full pay as are proportionate to his length of service during that period with such employer, and if such holidays are not equal to the holidays given to the other employees, he shall not be entitled to work or pay whilst the other employees of such employer are on holidays on full pay.

(c) Except when employed subject to the conditions of Clause (5) (d) (Overtime) no worker shall be required to present himself for duty on any of the specially named holidays in subclause (a) of this clause. On any other public holiday an employer's establishment or place of business may be closed, in which case a worker need not present himself for duty, and the wage for that day may be deducted. If kept open or work be done, ordinary rates shall apply.

(d) Where a worker is dismissed for misconduct or dereliction of duty, he will not be entitled to the benefit of the provisions of this clause.

(e) Holiday pay shall not accrue during a worker's absence from his employment for any cause whatsoever.

7.—Contract of Service

(a) The contract of service shall be by the day, and shall be terminable by one day's notice on either side, except in the case of a casual worker.

(b) The employer shall be under no obligation to pay for any day not worked upon which the worker is required to present himself for duty, except such absence from work is due to illness and comes within the provisions of the next following clause, or such absence is on account of holidays to which the worker is entitled under the provisions of the Agreement.

(c) This clause does not affect the right to dismiss for misconduct, and in such case wages shall be paid up to the time of dismissal only.

(d) The employer shall be entitled to deduct payment for any day or portion of a day upon which the worker cannot be usefully employed because of any strike by the Union or Unions affiliated with it, or by any other Association or Union, or through the breakdown of the employer's machinery, or any stoppage of work by any cause which the employer cannot reasonably prevent.

(Continued on next page)

W.A. RADIO AWARD—(Continued)—

8.—Payment for Sickness

A worker shall be entitled to payment of non-attendance on the ground of personal ill-health, for one half-day for each completed month of service; Provided that payment for absence through such ill-health shall be limited to six days in each calendar year. Payment hereunder may be adjusted at the end of each calendar year, or at the time the worker leaves the service of the employer, in the event of the worker being entitled by service subsequent to the sickness to a greater allowance than that made at the time the sickness occurred. This clause shall not apply where the worker is entitled to compensation under the Workers' Compensation Act.

9.—Wages

	Per Week. £ s. d.
(a) Basic wage:—	
Metropolitan Area	3 10 6
Outside a fifteen (15) mile, but within a twenty-five (25) mile radius of the G.P.O. Perth	3 11 2
	Margin per week £ s. d.
(b) Adult Males:	
General serviceman	1 4 0
Workshop serviceman	1 1 0
Assembler	0 6 0
	Per week. % of Basic Wage
(c) Male junior workers:	
First 6 months' experience	20
Second 6 months' experience	25
Second year's experience	35
Third year's experience	45
Fourth year's experience	55
Fifth year's experience	65
Sixth year's experience	70
Seventh year's experience	85

(d) Where the services of a worker are dispensed with, all wages shall be paid on the day of dismissal or forwarded to him by post on the day following.

10.—Country Work

(a) When a worker is engaged on outside work, the employer shall pay all fares, and a proper allowance at current rates shall be paid for all necessary meals. Fares shall be second class, except when travelling by coastal boat, when saloon fares shall be paid.

(b) When a worker is engaged at such a distance that he cannot return at night, suitable board and lodging shall be found at the employer's expense.

(c) Travelling time outside ordinary working hours shall be paid for at ordinary rates up to maximum of twelve (12) hours in any twenty-four hour period, from the time of starting on the journey: Provided that, when the travelling is by boat, not more than eight hours shall be paid for in such period.

Notwithstanding anything contained in this clause, the employer and the worker may enter into such other arrangements as may be mutually satisfactory as regards country work performed, outside a radius of 25 miles from the G.P.O. Perth.

11.—Time and Wages Record

(a) Each employer shall keep a time and wages record, showing the name of each worker and the nature of his work, the hours worked each day, and the wages and allowances paid each week. Any system of automatic recording by means of machines shall be deemed a compliance with this provision to the extent of the information recorded.

(b) The time and wages record shall be open for inspection to a duly accredited official of the Union during the usual office hours, at the employer's office or other convenient place, and he shall be allowed to take extracts therefrom.

12.—Representative Interviewing Workers

In the case of a disagreement existing or anticipated concerning any of the provisions of the Agreement, an accredited representative of the Union shall be permitted to interview the workers during the recognised meal hour, on the business premises of the employer, but this permission shall not be exercised without the consent of the employer more than once in any one week.

13. HIGHER DUTIES. A worker engaged for more than two (2) hours in any one day on duties carrying a higher rate than his ordinary classification shall be paid the higher rate for the time so employed.

14.—NO REDUCTION. Nothing in this Agreement shall in itself operate to reduce the wage of any worker below the rate actually received by him at the date hereof.

15.—MALE JUNIOR WORKERS. (a) Each employer shall during the term of the Agreement be permitted to continue to employ the same number of juniors that he had in his employ at the date of making this Agreement.

(b) Additional junior workers may be employed in the proportion of one additional junior worker to one additional adult worker.

16.—TESTING EQUIPMENT. The employer shall supply all necessary testing equipment and parts for the repair of same.

17.—GENERAL SERVICEMAN USING HIS OWN VEHICLE. The employer and the worker may enter into such arrangements as are mutually satisfactory. Failing satisfactory arrangements being made, the matter shall be referred to the Board of Reference for settlement.

18.—SHIFT WORK. (a) Whenever shift work is worked all shifts except the day shift shall be paid for at the rate of time and a quarter.

(b) Work other than day shift shall not be recognised as night shift unless five consecutive nights are worked, but shall be deemed to be overtime; on the completion of the fifth consecutive night's work the worker shall be deemed to have been employed on night shift during that and the preceding four nights, and thereafter during any subsequent consecutive nights he is so employed. The intervention of a Sunday or a holiday on which work is not performed shall not be deemed to break the sequence.

(c) When night shift is to be paid at time and a quarter rate, as prescribed in the preceding subclause, overtime shall be based on the time and a quarter rate and calculated under Clause 5.

19.—CADETS. Notwithstanding anything herein contained or implied, a bona fide employer shall be permitted to appoint one son (or any other nominee) as a cadet to learn all the branches of the trade or calling of such employer. Only one such cadet at any particular time shall be permitted any employer.

20.—PIECEWORK. (a) Subject to the minimum wages rates and other conditions herein prescribed, an employer may remunerate any of his workers under any system of payment by results.

(b) The Union may during the currency of the Agreement apply to the Court for the correcting or regulation of any piece-work rate, time bonus rate, task rate or any other system of payment by results.

21.—BOARD OF REFERENCE. The Court may appoint for the purpose of the Agreement a Board or Boards of reference. Each Board shall consist of a Chairman and two other representatives, one to be nominated by each of the parties, as prescribed by the Regulations. There are assigned to each such Board, in the event of no agreement being arrived at between the parties to the Agreement, the functions of:—

(i) adjusting any matters of difference which may arise between the patries from time to time, except such as involve interpretations of the provisions of the Agreement or any of them;

(ii) classifying and fixing wages, rates, and conditions for any occupation or calling not specifically mentioned in the Agreement;

(iii) deciding any other matter that the Court may refer to such Board from time to time.

(Continued on page 107)

Victorian Radio Wages Award

Determination of the Radio Board

FACTORIES AND SHOPS ACTS

(Extract from "Victoria Government Gazette," No. 26, dated 25th February, 1935, pp. 745-46.)

NOTE.—This Determination applies to the Metropolitan District and the Geelong District, as defined in the Factories and Shops Acts and the Order in Council thereunder extending such Metropolitan District, such portions of the City of Sandringham as are not included within the said Metropolitan District; the cities of Ballarat, Bendigo, and Warrnambool; and the boroughs of Eaglehawk and Sebastopol.

In accordance with the provisions of the Factories and Shops Acts the Wages Board appointed to "determine the lowest prices or rates which may be paid to any person or persons or classes of persons employed in the trade of manufacturing, assembling or maintaining radio appliances, parts or accessories (other than batteries), but not including persons subject to the jurisdiction of any Wages Board heretofore appointed," has made the following Determination, namely:—

(1) That on the 27th February, 1935, the last previous Determination of this Board shall be revoked and replaced by this Determination.

(2) Apprentices or Improvers.

PROPORTIONATE NUMBER

Apprentices

One male apprentice to every three or fraction of three male workers receiving not less than 66/- per week of 46 hours.

One female apprentice to every three or fraction of three female workers receiving not less than 35/6 per week of 44 hours.

Improvers.

One male improver to every three or fraction of three male workers receiving not less than 66/- per week of 46 hours.

One female improver to every three or fraction of three female workers receiving not less than 35/6 per week of 44 hours.

WAGES PER WEEK OF 44 HOURS

Experience	Males s.	d.	Experience	Females s.	d.
1st year	14	0	1st year	14	0
2nd „	17	2	2nd „	17	2
3rd „	26	0	3rd „	22	8
4th „	33	4	4th „	28	2
5th „	42	10	5th „ and until 21 years of age	31	10
6th „ and until 21 years of age	49	11			

(3) Juvenile Workers.

Juvenile workers, i.e., persons under 21 years of age (other than apprentices or improvers), engaged on any work excepting set testing, service work, wiring complete sets, testing power transformers, and repair work.

WAGES PER WEEK OF 44 HOURS.

MALES

Commencing Age.

Experience	15 yrs. and under. s.	d.	16 years. s.	d.	17 years. s.	d.	18 years. s.	d.	19 years. s.	d.	20 years. s.	d.
1st year....	14	0	14	0	17	2	22	5	29	9	39	8
2nd „	17	2	17	2	22	5	28	8	36	0		
3rd „	26	0	28	7	33	10	41	1				
4th „	33	4	36	0	41	2						
5th „	42	10	47	4								
6th year and until 21 yrs. of age	49	11										

FEMALES

Commencing Age.

Experience	16 yrs. and under. s.	d.	17 years. s.	d.	18 years. s.	d.	19 years. s.	d.	20 years. s.	d.
1st year	14	0	15	8	19	10	25	0	27	1
2nd „	17	2	19	10	24	0	29	3		
3rd „	22	8	25	3	29	6				
4th „	28	2	30	9						
5th year and until 21 years of age	31	10								

PROPORTION OF JUVENILES EMPLOYED IN THE PROCESS OF WIRING.

Six juvenile workers to each adult, who if a male is receiving not less than 66/- per week of 46 hours, or if a female is receiving not less than 38/6 per week of 44 hours.

(4) No employer shall employ any male under 19 years of age or any female testing power transformers.

(5) Other Employees.

WAGES.

Males.

	Per week of 46 hrs. £	s.	d.
Servicemen	4	10	0
Repairers	3	18	6
Wiremen—wiring a complete set from a circuit diagram or model	3	13	6
Other wiremen	3	9	0
Installers	3	9	0
Set testers	3	9	0
Coil winders	3	9	0
Assemblers	3	6	0
Cabinet fitters	3	6	0
All others	3	6	0

	Per week of 46 hrs. £	s.	d.
The following additional rates shall be paid to Servicemen—			
Who use their own motor cars	3	0	0
Who use their own motor cycles and side cars	1	15	0
Who use their own motor cycles	1	5	0

Females.

	Per week of 44 hrs. £	s.	d.
Wiring a complete set from a circuit diagram or model	2	3	0
Employed at other wiring	1	18	6
Coil winders	1	18	6
All others	1	15	6

(6) Overtime.—All work done in excess of the maximum number of hours fixed as a week's work shall be paid for at the rate of time and a half.

(7) Payment for Holidays.—All employees shall be entitled to the following holidays without deduction of pay: New Years' Day, Australia Day, Good Friday, Easter Saturday, Easter Monday, Eight Hours Day, Christmas Day, and Boxing Day.

(8) Meal Allowance.—Any male employee over 16 years of age who is required to work overtime for more than two hours without being notified the previous day that he would be so required, shall either be supplied with a meal by the employer or paid a sum of 1/6.

(Continued on next page)

VICTORIAN RADIO WAGES BOARD—(Continued from page 104)—

(9) Definitions—Serviceman includes a person who maintains and repairs radio sets outside his employer's place of business and is engaged in servicing and constructing power amplifier equipment.

Set tester is a person who tests sets under working conditions with valves in sockets.

Wiring a complete set. A person shall be deemed to have wired a complete set when, in addition to completely wiring the power transformer therefor, such person does any portion of the remainder of the wiring of the set.

(10) Testing Equipment.—Employers shall supply testing equipment and parts for repairs.

(11) Special Rates.—Double time shall be paid for all work done on Sundays, New Year's Day, Australia Day, Good Friday, Easter Saturday, Easter Monday, Eight Hours Day, Christmas Day, and Boxing Day; but if any other day be by Act of Parliament or Proclamation substituted for any of the above-named holidays, the special rate shall only be payable for work done on the day so substituted.

(12) Piece-work.—The Board determines, under the provisions of Section 150 of the Factories and Shops Act 1928, that any employer may fix and pay piece-work prices to any person or persons or classes of persons employed at any work for which the Board has fixed the minimum wage, provided that any such employer shall base such piece-work prices on the earnings of an average worker working under like conditions, and such piece-work prices shall be fixed so that an average worker can earn not less than the wages that are fixed by the Board for such work.

D. GRANT, Chairman.

A. G. ALLEN, Secretary.

Victorian Scale of Wages

Applicable to Radio and Electrical Trades

Those engaged in the electrical and radio industries in Victoria should make themselves acquainted with the determination of the Shops Board No. 23 (electrical and radio goods) which applies to the following parts of Victoria:

The metropolitan district and Geelong district as defined in the Factories and Shops Act, 1928 (No. 3677) and the Order in Council thereunder, extending such metropolitan districts, such portions of the city of Sandringham as are not included within the metropolitan districts, the cities of Ballarat, Bendigo, Warrnambool, and Boroughs of Eaglehawk and Sebastopol.

The following wages are the lowest rates which may be paid to any person or persons or classes of persons employed in the business as a seller of (a) electrical goods, (b) wireless (radio) sets, parts or accessories.

Males

Wages per week of 47 hours. Persons in charge of a brand shop within the metropolitan area—£4/17/6. Outside metropolitan area—£4/13/6.

Canvassers, travellers, collectors, installers (who, in addition to their duties of canvassing, travelling, collecting or installing, are in any way connected with the sale of goods), salesmen—21 years of age £3/10/- or £3/7/6; 22 years of age, £4 or £3/17/6; 23 years of age and over, £4/10/- or £4/6/-; all others, £3/15/- or £3/10/-.

Females

£2/10/- or £2/7/6.

The first figures are the metropolitan wages and the others are outside the metropolitan area.

Heavy penalties are provided under the Factories and Shops Act for offences under that Act. It is essential that all people interested in the trade take note of this, and see that they are observing the prescribed rates.

The decision of the Tribunal as to what constitutes an employee is final and without appeal.

Queensland Radio Industry Award

Operative From October 25th, 1934

"ELECTRICAL machanic" shall mean an employee engaged in placing or affixing or running electrical conductors of all kinds and for all purposes from the point of supply to the point of utilisation, and also in the fixing inside of buildings and vehicles of all kinds of conduits and conductors. It shall include the erecting and connecting up of dynamos, motors, and switchboards, and the connecting up of all instruments and apparatus at the point of utilisation and supply for all purposes, including power, lighting, heating, and smelting, and safe working instruments, apparatus, telephones, bells, wireless apparatus, meter fixing, connecting of meters, and the erection, overhauling and repairing of storage batteries, and the assembling and renewing of finished parts, and marking out and mounting of any switch-boards, and the effecting of any repairs to electrical machines and appliances when it is necessary to carry out the work on the spot, or is incidental to such necessary work. The legitimate possession of a certificate of competency in this particular class of work issued by the Electrical Workers' Board under "The Electrical Workers Act of 1923" shall be recognised as proof of efficiency."

Part 2—Radio Industry

"14a. (1) Definition.—'Radio mechanic' shall mean an employee who is mainly employed to assemble and/or repair and/or service, and/or instal, and/or test radio receivers, and/or public address systems.

"(2) Wages.—The minimum rate of wages payable to radio mechanics shall be—

Continuous or Shift Workers or Employees whose work is not confined within the hours fixed for day workers—Radio Mechanics, per week (Southern Division) £5/7/10; (Mackay Division) £5/13/4; (Northern Division) £5/17/10.

Day Workers—Radio Mechanics, per week (Southern Division) £4/18/1; (Mackay Division) £5/3/7; (Northern Division) £5/8/1.

"(3) Except as to the definition and wages the provisions of Part 1 of this award shall apply to radio mechanics."

N.S.W. Electricians, Etc. (State) Award

This award covers all employees in radio factories (other than those controlled by members of the Metal Trades Employers' Association) in the State of New South Wales.

The provisions of this award are covered by the following publications, all of which are available from the Government Printing Office, Phillip Street, Sydney.

No. 2732 — 18th November, 1932
No. 2789 — 23rd December, 1932
No. 4189 — 14th June, 1935.

The last of these (No. 4189) covers the conditions at present applying and the major points which must be observed are as follows:—

Hours of Employment

The award provides for forty-four hours work in each week.

Wages

3(a) **Adult Males.**—The minimum weekly wage and minimum hourly rate shall be:—

Process workers—£3/14/6 per week; 1/9 9-22d. per hour.

Testers—£3/17/6 per week; 1/10 5-22d. per hour.

An employee who is required to and wholly assembles a radio receiver, and is responsible for its proper completion, and who does not carry out the work as a process worker (as defined in the full award) shall be treated as an electrical mechanic and paid the rate applicable for an electrical mechanic, as follows: £4/18/6 per week; 2/4 5-22d. per hour.

3(b) **Junior males** (Process Workers)—The minimum weekly wage to be paid to junior males when employed on day work as process workers shall be:—

	£	s.	d.
Under 16 years of age	1	0	7
At 16 years of age	1	7	0
At 17 years of age	1	14	3
At 18 years of age	2	4	1
At 19 years of age	2	11	5
At 20 years of age	2	18	10

(c) **Junior males** (Testers).—The minimum weekly wage to be paid to junior males when employed on day work as testers shall be:—

	£	s.	d.
At 18 years of age and under	2	6	0
At 19 years of age	2	13	11
At 20 years of age	3	1	8

(d) **Adult females:**—The minimum weekly wage to be paid to adult females when employed on day work shall be:—

	£	s.	d.
Adult females with less than six months' experience	1	19	0
Others	2	3	0

(e) **Junior females:**—The minimum weekly wage to be paid to junior females when employed on day work shall be:—

	£	s.	d.
Under 16 years of age	0	19	7
At 16 years of age	1	2	0
At 17 years of age	1	4	5
At 18 years of age	1	11	9
At 19 years of age	1	15	1
At 20 years of age	1	19	0

Federal Wages Award

Covering members of the Metal Trades' Employers' Association and other firms specifically cited in the award made by His Honour, Judge Beeby, on 15th May, 1935.

The award provides for forty-four hours work weekly and only applies to firms who are members of the Metal Trades Employers' Association or are specifically cited in the Award.

Copies of the full award may be obtained from the Commonwealth Government Enquiry Office, Commonwealth Bank Chambers, Sydney or Melbourne, and other States.

This award differs from the State Awards in that employees are to be paid in accordance with the amount of experience they have had.

Adult males—Particulars of the rates of pay should be obtained from the full award.

4(a) **Adult female labour** may be employed in the manufacturing and assembling of small parts of electrical and other machinery and appliances other than wet storage batteries, armature winding and such work in the sheet metal, enamelling and canister-making industry, and in core-making in which females were employed at the time of the making of this award.

Adult females shall be paid at the following weekly rates of wage:—

	£	s.	d.
If of less than 12 months' experience	2	1	6
If of 12 months or more experience	2	7	6

4(b) **Junior females** may be employed in the occupations set out in sub-clause (a) above of this clause at the following weekly rates of wage:—

(Continued on next page)

FEDERAL WAGES AWARD.—(Continued)

	s.	d.
1st year's experience	13	6
2nd year's experience	18	0
3rd year's experience	25	0
4th year's experience	31	6
5th year's experience	36	0
Thereafter until reaching 21 years of age	40	0

4(c) **Unapprenticed male juniors** may be employed in or in connection with manufacturing (as defined in clause 22 of this award) in all occupations (including as to core-making employment upon all classes of work which before the making of this award could be done by female employees under the award) for which apprenticeship is not provided by the award, except in the mixing of paste, pasting of grids, working with molten lead and/or the handling of plates in formation room, in the manufacture of wet storage batteries; except also in nut, bolt and spike manufacturing; and in stovemaking in the State of New South Wales, at the following weekly rates of wage:—

	s.	d.
1st year's experience	15	0
2nd year's experience	20	0
3rd year's experience	27	6
4th year's experience	37	6
5th year's experience	47	6
6th year's experience	55	0
7th year's experience	58	6

For the purposes of this and the immediately preceding sub-clause "experience" shall mean any form of employment in any branch of the Metal trades industries.

Juniors employed under this and the immediately preceding sub-clause shall on dismissal receive from their employer a certificate of the period of employment completed. Employers who wilfully employ juniors without taking into account previous experience shall be guilty of a breach of this award.

W.A. RADIO AWARD.—(Continued from page 103).

(iv) An appeal shall lie from any decision of such Board, in the manner and subject to the conditions prescribed in the Regulations to "The Industrial Arbitration Act, 1921-1935," which for this purpose are embodied in the Agreement.

22.—**JUNIOR WORKER'S CERTIFICATE.** Junior workers, upon being engaged, shall, if required, furnish the employer with a certificate containing the following particulars:—

(1) Name in full.
(2) Age and date of birth.
(3) Name of each previous employer and length of service with such employer.
(4) Class of work performed for each previous employer.

Such of the foregoing particulars as are within the knowledge of an employer shall be indorsed on the certificate and signed by the employer, upon request of the worker.

No worker shall have any claim upon an employer for additional pay in the event of the age or length of service of the worker being wrongly stated on the certificate. If any junior worker shall wilfully mis-state his age in the above certificate he shall be guilty of a breach of this Agreement.

Radio and Television Patents

1935 Transactions

Increased Interest in Television

COMPARED to 1934 there was much greater activity last year in radio and television patents in Australia. During the period the local patent office accepted 343 applications for patents relating to radio and television circuits and apparatus, cathode ray tubes, valves and other devices and components which may be reasonably classified as having some relationship to these or allied activities.

In 1934 the total was 286. What may be considered as purely radio circuits and arrangements decreased slightly, dropping by five to 161, but television circuits and apparatus showed over a one hundred per cent. increase, the total rising sharply from 48 to 102. Miscellaneous subjects such as speakers, resistors, condensers, valves and other components and sundry special arrangements, rose from 62 to 80.

The United States again was an easy first, as the country of origin, raising its score by 20 to 164, and Germany, as in 1934, was second with 80, a gain of 14. England came third with 50, an increase of one only. Australia made a healthy jump from 11 to 24, and Holland also leaped ahead from 7 to 24.

Other countries of the world could only contribute three between them. The United States' progress was due to increased activity in miscellaneous group. Germany fell back a long way in radio, from 38 to 10, but sprang from 11 to 58 in its supply of television subjects. Australia's increase was in the radio group, while Holland went ahead uniformly.

As to ownership, the Marconi Company again easily held pride of place, but dropping back one to 132 and falling back appreciably in its percentage. With television stationary it lost in radio but gained in miscellaneous. The Telefunken Co. showed an appreciable drop, from 63 to 51. This was due to a fall of 28 in radio, the television section of this company's activity going ahead by 16.

Radioaktiengesellschaft D.S. Loewe was a vigorous newcomer, contributing 30 to the total. All dealt with television, mostly with cathode ray tubes in many of their phases. Philips made substantial progress, moving up from 7 to 22, and the Neutrodyne group gained about 50 per cent. The International General Electric Co. Inc., was steady. The Baird interests came into the picture, but A.W.A. fell back among the "also rans."

From all this and the summary published below, it is apparent that television is receiving much more attention, not only in numbers of applications, but in the number of concerns that are interested in developing and protecting inventions. The interesting phase of this aspect is that Germany is playing by far the greatest part in this development, i.e., judging solely by the number of patent applications filed in this class. Cathode ray tubes are the most numerous items.

In other respects progress during 1935 did differ very much from that made during the previous year, so far as general tendencies are concerned. The domination exercised by overseas countries in technical development, as exemplified by patent proceedings, which has been so apparent for many years, is not relaxing to any extent. Australia certainly showed an advance of over 100 per cent., but a glance at the list set out below shows that the majority of the local inventions were concerned with more or less minor aspects of set design and construction.

Generally the year was a period of freedom from disputes over patent matters, but there was increased evidence of the fact that all parties but patent holders and licensees are more fully awake to the present position and possibilities of the future than they have been for many years. The lessons of the past have apparently been learned and when, if ever, a situation similar to that of 1933 arises, the respective parties will be better informed and more able to deal with it logically.

There is no sign of any variation in the policy of the patent holding concerns in protecting everything that is developed, irrespective of its immediate or potential value. They have every right to continue in this fashion, but it is difficult to avoid the opinion that much is being covered which can never serve a really useful purpose. Such protection means expenditure on the part of the patent holders and inevitably an added burden to patent users. Happily the industry is, at the moment, ably to carry this extra load without undue strain.

The commercial application of television has not yet become a matter for consideration by radio manufacturers. In the meantime, however, a tidy collection of television patents is being made by several concerns. Of these patents it may be truly said that their number is large and that in regard to many of them there is considerable doubt as to their true effect and validity. There is thus, the making of a "situation" at some future date.

In the circumstances, the potential users of these patents can do little beyond supplying themselves with as much information as they can, against the day when such matters must be discussed, so that when the time comes they will at least be able to appreciate the extent of the "situation" and discuss its phases intelligently.

SUMMARY

Countries of Origin

	U.S.A.	Eng.	Ger.	Holland	Australia	Others	Tl.
Radio	96	21	10	15	16	3	161
Television	23	19	58	1	1	—	102
Miscellaneous	45	10	12	6	7	—	80
Total	164	50	80	22	24	3	343

Ownership

Name	Radio	Television	Miscell.	Tl.
Marconi Co.	81	30	21	132
Neutrodyne Group	16	—	1	17
Philips	16	1	5	22
Telefunken	10	27	14	51
I.G.E. (U.S.A.)	6	2	3	11
D. S. Loewe	—	30	—	30
Baird	—	5	—	5
Sundry	32	7	36	75
Total	161	102	80	343

PATENTS

Radio Circuits

Marconi Wireless Telegraph Co. Ltd.

14414/33 Phase or frequency modulation, U.S.A.
15273/33 Radio Receivers, U.S.A.
15356/33 Modulated carrier transmitters, U.S.A.
15449/33 Automatic volume control, U.S.A.
15649/33 Oscillating systems, U.S.A.
15888/34 Modulated carrier systems, U.S.A.
15889/34 Frequency modulation receivers, U.S.A.
15892/34 Carrier wave systems, U.S.A.
15907/34 Tunable oscillatory circuits, U.S.A.
15908/34 Signalling systems, U.S.A.
15962/34 Ultra short wave modulated systems, England.
16008/34 Valve circuits, U.S.A.
16009/34 Valves and circuit arrangements, U.S.A.
16010/34 Multiplex telegraph receiving, U.S.A.
16063/34 Radio receivers, U.S.A.
16064/34 Tunable circuit and radio receivers, U.S.A.
16276/34 Thermionic valve apparatus, U.S.A.
16357/34 Superhet. receivers, U.S.A.
16369/34 Automatic gain control in superhets, England.
16484/34 Modulation systems, England.
16485/34 Oscillation generators, England.
16539/34 Oscillation generators, England.
16547/34 Modulating systems, U.S.A.
16617/34 Oscillation generators, England.
16670/34 Superheterodyne receivers, U.S.A.
16775/34 A.V.C. in Superhets., England.
16967/34 Detector Oscillator, U.S.A.
16968/34 Direction finding systems, England.
17078/34 Monitoring and remote control, U.S.A.
17079/34 Ultra h.f. transmitters, U.S.A.
17107/34 Oscillator, U.S.A.
17108/34 Valve circuit arrangements.
17203/34 Single sideband system, U.S.A.
17204/34 Ultra short wave receiver, U.S.A.
17205/34 Reflex superhet, U.S.A.
17266/34 Directional aerial, U.S.A.
17421/34 Phase modulation, U.S.A.
17422/34 A.V.C., U.S.A.
17442/34 Direction finding, England.
17600/34 Automatic alarm arrangements, U.S.A.
17603/34 Radio and like transmitters, U.S.A.
17604/34 Electron discharge tube apparatus, U.S.A.
17605/34 Electron discharge apparatus, U.S.A.
17607/34 Electron discharge tube apparatus, U.S.A.
17773/34 Generating very high frequency oscillations, U.S.A.
17981/34 Radio receivers, U.S.A.
17983/34 Electron discharge apparatus and circuits, U.S.A.
18175/34 Tuning systems for ultra shortwaves, England.
18194/34 Magnetron oscillation generators, England
18506/34 Receivers, heterodyne type. U.S.A.
18507/34 Amplifier circuits, U.S.A.
18544/34 Super-regenerative receivers, England.
18572/34 Oscillation generators, England.
18709/34 Radio receiving installations, England.
18914/34 Short wave radio apparatus, U.S.A.
19025/34 Very short wave radio systems, U.S.A.
19026/34 Very short wave radio apparatus, U.S.A.
19103/34 Power supply systems, U.S.A.
19106/34 Modulated wave transmitters, U.S.A.
19248/34 Oscillation generators, U.S.A.
19250/34 Carrier wave receivers, U.S.A.
19374/34 Multi-range receivers, U.S.A.
19497/34 Oscillation generators, U.S.A.
19547/34 Oscillation generator systems, U.S.A.
19548/34 Oscillation generators, U.S.A.
19549/34 Oscillation generators, U.S.A.
19668/34 Antenna selecting and coupling in diversity radio reception, U.S.A.
19669/34 Valves and receivers, U.S.A.
19690/34 Modulated wave transmitters, England.
19773/34 Gas and vapour discharge tubes and circuits, U.S.A.
19886/34 Noise suppressor circuits, U.S.A.
20190/34 Modulated wave receivers, U.S.A.
20202/34 Modulation monitoring installations, England.
20332/34 Modulated wave receivers, U.S.A.
20462/34 Oscillation generator arrangements, U.S.A.
20463/34 Radio signalling systems, U.S.A.
20464/34 Aperiodic antennae for wide wave bands, U.S.A.
20556/34 Modulated wave receivers, U.S.A.
20557/34 Modulated wave receivers, U.S.A.
20558/34 Valve circuit arrangements, U.S.A.
21846/35 Superheterodyne receivers, U.S.A.
18763/34 Modulation circuit, U.S.A.
18826/34 Superhet. with plurality of wave bands, U.S.A.
19325/34 Radio receiver, U.S.A.
19756/34 Radio receiver, U.S.A.
20149/34 Receiving apparatus for autobiles, Australia.
20230/34 Signal selecting system, U.S.A.
21668/35 Frequency band selecting system, U.S.A.
21670/35 Wave Signalling system, U.S.A.
22102/35 Wave signalling system, U.S.A.
22156/35 Variable inductance tuning device, U.S.A.
25391/35 Automatic volume control, U.S.A.
25392/35 Automatic "quieting" and automatic volume control, U.S.A.
25393/35 Superheterodyne receiver, U.S.A.

Neutrodyne Pty. Ltd. or Hazeltine Corp.

15367/33 Oscillator modulators, U.S.A.
15435/33 Modulation system, U.S.A.
17958/34 Modulation system, U.S.A.

N. V. Philips Gloeilampenfabrieken

15851/34 Superhet. oscillator circuits, Holland.
16095/34 Amplifier circuits, Holland.
17120/34 Multi-band receiver, Holland.
17742/34 Amplifier circuits, Holland.
18714/34 Controlling superheterodyne receivers, Holland.
18743/34 High frequency coupling, Holland.
18745/34 Thermionic amplifiers, Holland.
19148/34 Generating ultra high frequency oscillations, Holland.
19753/34 Filter comprising an integral resistance condenser, construction, Holland.
19189/34 Producing oscillations under the action of a magnetic field, Holland.
19195/34 Automatic muting control, Australia.
20272/34 Superheterodyne receivers, Holland.
20614/34 R.F. Amplifier, Holland.
20928/35 Superheterodyne receiving arrangements, Holland.
21242/35 Feed apparatus for receivers, Holland.
22389/35 High frequency amplifying circuits, Holland.

Telefunken Co.

12419/33 Amplifiers and oscillation generators, Germany.
15650/33 Valves and amplifier circuits, Germany.
16278/34 Frequency changer, Germany.
16938/34 Ultra short wave circuits,
18083/34 Relaxation oscillation generators, Germany.
18398/34 Navigation aiding systems, Germany.
19493/34 Navigation aiding systems, Germany.
19494/34 Ultra short wave receivers, Germany.
19666/34 Radio beacons, Germany.
20264/34 Navigation aiding systems, Germany.

(Continued on next page)

PATENTS—(Continued)—

International General Electric Corp.

16187/34 High frequency circuits, U.S.A.
16188/34 Amplifying apparatus, U.S.A.
18128/34 Radio beacon systems, U.S.A.
18129/34 Transmitter push pull amplifiers, U.S.A.
18973/34 Uniform impedance filter, U.S.A.
20486/34 Valve translating circuits, U.S.A.

E. G. Beard

15609/34 Radio receivers, Australia.
19369/34 Superheterodyne receivers, Australia.
19800/34 Shortwave converter and booster, Australia.
20565/34 Superheterodyne receivers, Australia.
20677/34 Coupling devices for receivers, Australia.

Radio Frequency Laboratories Inc.

17795/34 Frequency selective networks, U.S.A.
17796/34 Control of receiver output level, U.S.A.
17797/34 A.F. Amplifier, U.S.A.
20280/34 Circuits with gas filled triodes, U.S.A.
20670/34 Electrical oscillations of square wave form, U.S.A.

Standard Telephones & Cables (A/sia) Ltd.

15846/34 Antenna coupling to receiver, England.
16461/34 Signalling systems, U.S.A.

P. P. Eckersley and R. E. H. Carpenter

18603/34 Wire broadcasting, England.
19538/34 Wire broadcasting systems, England.

Sundry Applicants

16104/34 Coin-freed mechanism for sets, E. L. Barnes, Australia.
16829/34 Volume control for receivers, V. R. Horder, Australia.
17167/34 Inductive tuning systems, Johnson Laboratories, Inc, U.S.A.
17880/34 Directional receiving antenna systems, E. Bellini, France.
18149/34 Antenna systems, Amalgamated Wireless (A/sia) Ltd., Poland.
18040/34 Manufacture of chassis for receivers, R. J. Ray, Australia.
18422/34 Aerials for broadcasting, A. J. McKenzie, Australia.
19361/34 Wireless cabinets, F. W. P. Thom, Australia.
19380/34 Tuning dials, Stromberg-Carlson (A/sia) Ltd., Australia.
19478/34 Plate resonators for electro-optics within an ultra short wave range, E. E. W. Kassner, England.
19515/34 Image frequency suppression, R. Field, Australia.
19603/34 Electron multiplying devices. Television Laboratories Ltd., U.S.A.
19608/34 Universal power supply, C. D. Richardson, Australia.
19562/34 Signalling systems, The Mullard Radio Valve Co. Ltd., England.
20066/34 Navigational systems, Radio Navigational Instrument Corp. U.S.A.
20068/34 Controlling high frequency currents, Radio Corp. of America, U.S.A.
20170/34 Beat-note apparatus, L. Hart and H. E. Davis, Australia.
20716/34 Superhet. receiving systems, L. A. Peyton, South Africa.

TELEVISION

Marconi Wireless Telegraph Co. Ltd.

14752/33 "Tape" facsimile systems, England.
14680/33 Television transmitting systems, U.S.A.
15081/33 Cathode ray apparatus for television, U.S.A.
15890/34 Television systems, U.S.A.
15891/34 Mechanical filters for facsimile telegraph, U.S.A.
15906/34 Television transmitter, U.S.A.
15961/34 Scanning devices for television, England.
16011/34 Television receiving systems, U.S.A.
16012/34 Television receiving systems, U.S.A.
16065/34 Cathode ray tube for television, U.S.A.
16458/34 Sound, Television and like transmisison systems, U.S.A.
16483/34 Television and picture telegraph transmitter, England.
16559/34 Circuits for photo-electric cells, England.
16816/34 Television systems, England.
16860/34 Television systems, U.S.A.
16861/34 Television systems, U.S.A.
17206/34 Cathode ray tube, U.S.A.
17259/34 Impedance matching, England.
17521/34 Cathode ray tubes, England.
17601/34 Television systems, U.S.A.
17602/34 Cathode ray apparatus, U.S.A.
17694/34 Television systems, U.S.A.
18377/34 Television receivers, England.
19182/34 Photo - sensitive devices, U.S.A.
19249/34 Photo-electric cell, U.S.A.
19375/34 Television apparatus, U.S.A.
19496/34 Circuits for photo-electric tubes, U.S.A.
19887/34 Television receivers, U.S.A.
20448/34 Television systems, England.
20638/34 Cathode ray tube screens, U.S.A.

Radioaktiengesellschaft D. S. Loewe

14797/33 Braun valves, Germany.
15799/33 Braun tubes, Germany.
14800/33 Eliminating cross current faults in Braun tubes, Germany.
14861/33 Braun tube, Germany.
14862/33 Overcoming lateral pull in Braun tubes, Germany.
14904/33 Braun tube, Germany.
14949/33 Obtaining a delayed commencement in tube circuits, Germany.
14950/33 Oscillator for television, Germany.
15002/33 Braun tubes, Germany.
15618/33 Braun tubes, Germany.
15619/33 Braun tube, Germany.
15621/33 Television receiver, Germany.
15785/34 Correcting impulses for television, Germany.
15786/34 Luminescent screen for Braun valves, Germany.
15787/34 Producing cathode rays, Germany.
15902/34 Tele-transmission of film pictures, Germany.
17640/33 Synchronisation of television receivers, Germany.
17834/34 Cathode ray television transmitter, Germany.
17870/34 Photo-electric cell amplifier, Germany.
17871/34 Improvements in television, Germany.
17873/34 Detector arrangement for television, Germany.
18493/34 Detector arrangement for television purposes, Germany.
18494/34 Cathode ray tubes, Germany.
18516/34 Transmission connexion system for short-wave purposes, Germany.
18517/34 Method of operating Braun tubes, Germany.
18584/34 Braun tubes, Germany.
18765/34 Tilting connexion, Germany.
18766/34 Tilting apparatus for television with Braun tubes, Germany.
19762/34 Rectifier for television reception, Germany.
20469/34 Television amplifier, Germany.

Telefunken Co.

15016/33 Cathode ray tubes, Germany.
15905/34 Television systems, Germany.
16007/34 Cathode ray tube, Germany.
16277/34 Television systems, Germany.
16279/34 Cathode ray tubes, Germany.
16280/34 Television systems, Germany.
18085/34 Cathode ray tubes, Germany.
18086/34 Television transmitter, Germany.
18087/34 Cathode ray tubes, Germany.
18178/34 Cathode ray tube, Germany.
18280/34 Cathode ray tube, Germany.
18281/34 Cathode ray tube, Germany.
18282/34 Cathode ray tube, Germany.
18282/34 Cathode ray tube, Germany.
18283/34 Cathode ray tube, Germany.
18284/34 Cathode ray tube, Germany.
18285/34 Cathode ray tube, Germany.
18286/34 Cathode ray tube, Germany.
18394/34 Electron and ion ray tube, Germany.
18395/34 Gas filled cathode ray tube, Germany.
18505/34 Television systems, Germany.
19024/34 Television systems, Germany.
19495/34 Television systems, Germany.
19546/34 Television systems, Germany.
19888/34 Television systems, Germany.
20263/34 Television systems, Germany.
20265/34 Materials for fluorescent screens, Germany.
20641/34 Cathode ray tube apparatus, Germany.

(Continued on next page)

PATENTS—(Continued)—

Baird Television Ltd.

18868/34 Cathode ray television, England.
19459/34 Television systems, England.
20536/34 Television systems, England.
20723/34 Television or like systems, England.
21751/35 Television system apparatus, England.

Electric and Musical Industries Ltd.

17139/34 Television systems, England.
19536/34 Cathode ray tubes, England.

International General Electric Co. Inc.

18082/34 Electron beam tube, U.S.A.
21447/34 Photo-electric cell, U.S.A.

The General Electric Co. Ltd.

20093/34 Electrical timing circuits, England.
21017/35 Cathode ray oscillographs for television, England.

Sundry Applicants

14905/34 Cathode ray control, M. von Ardenne, Germany.
16652/34 Controlling signal frequencies in television, I. L. Maguire, Australia.
17397/34 Time base circuit, A. C. Cossor Ltd., England.
21241/34 Light sensitive layers, N. V. Philips' Gloeilampenfabrieken, Holland.

MISCELLANEOUS

Marconi Wireless Telegraph Co. Ltd.

16013/34 Loud speaker, U.S.A.
16774/34 Two-way telephone systems, England.
17606/34 Loud speakers, U.S.A.
17695/34 Loud speakers, U.S.A.
17774/34 Winding machines, U.S.A.
17881/34 Valves, U.S.A.
17882/34 Valve base arrangements, U.S.A.
17982/34 Cathode structures for valves, U.S.A.
18806/34 Generation of high voltages, U.S.A.
19027/34 Thermionic valves, U.S.A.
19028/34 Moulded articles and methods of manufacturing, U.S.A.
19104/34 Electron discharge devices, U.S.A.
19105/34 Vapour electron discharge tubes, U.S.A.
19373/34 Power supply systems for facsimile systems, U.S.A.
19667/34 Electron discharge devices, U.S.A.
19771/34 Electrode mount construction, U.S.A.
19772/34 Electrically insulated heater for valves, U.S.A.
20191/34 Loud speaker, U.S.A.
20636/34 Loud speakers, U.S.A.
20639/34 Synchronising apparatus (multiplex telegraphy), U.S.A.
20640/34 Positioning electrodes in valves, U.S.A.

Telefunken Co.

13231/33 Gas filled discharge tubes, Germany.
16939/34 Thermionic valves, Germany.
16940/34 Coils, Germany.
17985/34 Thermionic valves, Germany.
18392/34 Carbonising metals, U.S.A.
18393/34 Cementing materials, U.S.A.
18396/34 Loud speakers, Germany.
18397/34 Diaphragms for use in acoustic devices, Germany.
19580/34 Electron discharge devices, Germany.
19581/34 Incandescent cathode valve, Germany.
19582/34 Short wave valve, Germany.
19583/34 An electron valve, Germany.
19665/34 High frequency cables, Germany.
19769/34 Thermionic valves, Germany.

N. V. Philips' Gloeilampenfabrieken

15499/33 Oxide valve cathodes, Holland.
18715/34 Indirectly heated cathodes, Holland.
18884/34 Valve caps, Holland.
19996/34 Resistances and manufacture, Holland.
19997/34 Electric discharge tubes, Holland.

Magnavox (Aust.) Ltd.

18157/34 Voice coil and support, U.S.A.
18554/34 Speaker neutralising coil, U.S.A.
19903/34 Loud speakers, U.S.A.
20083/34 Condensers, U.S.A.

International General Electric Co. Inc.

19672/34 Making permanent magnets, U.S.A.
20713/34 Glass-to-metal seals, U.S.A.
21161/35 Piezo-electric crystals, U.S.A.

Standard Telephones and Cables (A/sia) Ltd.

19262/34 Wave transmission networks, U.S.A.
19263/34 Amplifying systems, U.S.A.

Ducon Condensers Pty. Ltd.

18768/34 Electrolytic condensers, U.S.A.
18769/34 Electrolytic condensers, U.S.A.

Electrical Research Products Ltd.

18511/34 Phonograph system, U.S.A.
20046/34 Sound recorders and reproducers, U.S.A.

Stromberg-Carlson (A/sia) Ltd.

19687/34 Acoustical labyrinth system, U.S.A.
20729/34 Variable condensers, Australia.

The General Electric Co. Ltd.

16671/34 Manufacture of electrodes, England.
16761/34 Signalling and distant control systems, England.

Sundry Applicants

13848/33 Time control apparatus for receivers, A. Midgley, Australia.
15368/33 Electron discharge device, Neutrodyne Pty. Ltd., U.S.A.
15465/33 Radio lounge chair, H. L. Cooper, Australia.
16262/34 Resistance units, H. Pender, U.S.A.
16478/34 Electrostatic condensers, A. P. J. Wetless, Australia.
16772/34 Intermediate transformers, F. W. P. Thom, Australia.
17155/34 Sound resonators, D. A. Thomson, Australia.
17348/34 Pick-ups, microphones and the like, Boonton Research Corp., U.S.A.
17692/34 Thermionic cathodes, The M-O Valve Co. Ltd., England.
17995/34 Driving electromotors in synchronism, Siemens Bros. & Co. Ltd., England.
18108/34 Loud speaker, The Rola Co., U.S.A.
18260/34 Fluorescent substances, L. A. Levy and D. W. West and Ilford Ltd., England.
18465/34 Electrode and method of manufacture, Hygrade Sylvania Corp., U.S.A.
18603/34 Wire broadcasting, P. P. Eckersley and R. E. H. Carpenter, England.
18710/34 Electron discharge devices, Electric & Musical Industries, England.
19100/34 Automatic record changephonograph, T. W. Small, U.S.A.
19570/34 Speaking heads for telegraphones, Stille Inventions Ltd., England.
19643/34 Variable inductances, Johnson Laboratories, Inc., U.S.A.
19998/34 Electrodes for electrolytic condensers, N. V. Maatschappij tot exploitatie van Uitindingen, Holland.
20879/35 Control of relays by discharge tubes, Radiovisor Parent Ltd., and H. W. Pook, England.
21827/35 Tuning indicators, E. F. Wilks & Co. Ltd., Australia.
22353/35 Radio Sockets, A. J. Schmitt, U.S.A.
22356/35 Radio tube shields, Goat Radio Tube Parts, Inc., U.S.A.

Australian Patent License

License No. 1

(Issued 1934 by Australian Radio Technical Services and Patents Company Limited.)

A License to use and exercise certain Australian Letters Patent for certain specific purposes as within in connection with Wireless Broadcast Receiving Apparatus and/or Radiogramophones.

AN AGREEMENT made this
day of 193 BETWEEN AUSTRALIAN RADIO TECHNICAL SERVICES & PATENTS COMPANY LIMITED having its registered office at 47 York Street Sydney in the State of New South Wales (hereinafter called "the Grantor") of the first part, and

of
(hereinafter called "the Licensee") of the second part

WHEREAS the AUSTRALIAN RADIO TECHNICAL SERVICES & PATENTS COMPANY LIMITED has the right to grant licences to the extent purpose and for the period of this agreement for all patents owned or controlled by AMALGAMATED WIRELESS (AUSTRALASIA) LIMITED, STANDARD TELEPHONES AND CABLES (AUSTRALASIA) LIMITED, N. V. PHILIPS GLOEILAMPENFABRIEKEN and NEUTRODYNE PROPRIETARY LIMITED but only from the first day of March, 1934, with respect to patents owned or controlled by AMALGAMATED WIRELESS (AUSTRALASIA) LIMITED and only from the second day of April, 1934, with respect to patents owned or controlled by NEUTRODYNE PROPRIETARY LIMITED.

AND WHEREAS the Licensee claims to be a bona fide manufacturer of wireless broadcast receiving apparatus and/or radio gramophones and as such manufacturer has applied to the Grantor to grant and the Grantor has agreed to grant to the Licensee a licence under the Letters Patent and upon the terms and conditions hereinafter mentioned and in consideration of the royalties herein reserved and assessed upon the basis agreed between the parties as being convenient. NOW IT IS HEREBY AGREED AS FOLLOWS:

1. (a) The expression "Broadcast Receivers" when herein used shall mean broadcast receiving apparatus (other than valves and loud speakers) for the reception of speech or music transmitted and intended for simultaneous reception by all listeners as distinct from point to point communication but only for private or domestic use or for the purpose of lectures or demonstrations in any institution of a charitable educational philanthropic or religious character (such lectures or demonstrations not being open to the public and not being held for payment) but not otherwise and shall not include such receivers combined with gramophones but shall include sets of component parts.

(b) The expression "Set of component parts" for broadcast receiving apparatus when herein used shall mean a number of component parts which are capable of being assembled so as substantially to constitute a broadcast receiver.

(c) The expression "Radiogramophone" when herein used shall mean a unitary instrument which is designed to incorporate valves (whether or not equipped with the valves themselves) and which is designed for the reproduction of sound through an electrically-operated loudspeaker alternatively from (a) apparatus designed for the reception and translation into sound of modulated electrical oscillations broadcast to the public and (b) apparatus (such as a turntable and pick-up) designed for the translation into sound of vibrations recorded on a sound record. Such expression does not include valves and does not include any radiogramophones combined with other apparatus dependent thereon either wholly or in part for its operation but does include battery eliminators as hereinafter defined when incorporated in a radiogramophone and any set of component parts which are capable of being assembled to substantially constitute a radiogramophone.

(d) The expression "Battery Eliminator" when herein used shall mean an apparatus which renders unnecessary the use of one or more batteries in the operation of broadcast receiving apparatus or a radiogramophone by facilitating the substitution therefor of electricity mains.

(e) The word "Valve" (or "Valves") when herein used shall be deemed where the context so admits to include inter alia a multiple valve a valve for rectifying electric current and other apparatus used in direct substitution for a valve.

(f) The expression "Multiple Valve" when herein used shall mean a valve designed to operate with more than one cathode-anode stream.

(g) The expression "Place of Public Entertainment" when herein used shall mean a place of public entertainment now existing or which during the subsistence of this Licence may exist and at which entertainment tax is or shall be payable or would be payable but for any statutory exemption granted subsequent to the first day of January, 1934. If during the subsistence of this Licence entertainment tax should be abolished then thereafter the expression shall mean a place of public entertainment now existing or which during the subsistence of this Licence may exist of the character of those places of public entertainment at which at the present time entertainment tax is in fact payable or would be payable but for any statutory exemption granted subsequent to the first day of January, 1934.

(h) The expression "Private or Domestic Use" as used herein shall be deemed to include also the manufacture and sale of broadcast receiving apparatus and radiogramophones to proprietors of for use in Public Houses Hotels Boarding Houses Restaurants, Cafes Tea Houses and/or small Dance Halls (only) PROVIDED that such are not attached to or do not form part of a theatre or cinema.

(i) The expression "Selling" when herein used shall be deemed to include selling on the so-called hire-purchase system.

2. (a) The Grantor grants and agrees to grant to the Licensee subject to the terms and conditions herein appearing a personal non-exclusive non-assignable license to use and exercise all or any of the inventions the subject of the Letters Patent applicable to broadcast receiving apparatus and radiogramophones respectively in respect of which and insofar as the Grantor now has or may hereafter during the subsistence of this Licence have power to grant Licences or Sub-Licences for the purposes and on the terms hereof (which Letters Patent are herein collectively called "the said Letters Patent") for the purpose of manufacturing using selling or letting on hire within the Commonwealth of Australia and such territories as may from time to time be administered under mandate by the said Commonwealth (a) broadcast receiving apparatus and (b) radiogramophones but in both cases only for private or domestic use or for the purpose of lectures or demonstrations in any institution of a charitable educational philanthropic or religious character (such lectures or demonstrations not being open to the public generally and not being held for payment) and not otherwise. Such Licence shall be deemed to have commenced on the first day of January 1934 insofar as relates to the patents owned or controlled by Standard Telephones & Cables (A/sia) Limited and N. V. Philips Gloeilampenfabrieken respectively and on and from the first day of March 1934 insofar as relates to the patents owned or controlled by Amalgamated Wireless (A/sia) Limited and on and from the second day of April 1934 insofar as relates to patents owned or controlled by Neutrodyne Proprietary Limited and shall continue until the thirty-first day of December 1938 unless previously revoked as hereinafter provided.

(b) The Licensee undertakes that all companies or firms now or hereafter during the subsistence of this Licence directly or indirectly owned or controlled by the Licensee and all Companies or Firms formed by the Licensee during the subsistence of this Licence and directly or indirectly owning or controlling the Licensee shall if engaged in any field of business to which this Licence is applicable forthwith accept Licences from the Grantor upon the same terms as this Licence and the Grantor agrees to grant such Licences accordingly. If the Licensee shall become directly or indirectly owned or controlled by a company or firm which does not hold or forthwith obtain a Licence from the Grantor upon the same terms as this Licence the Grantor shall be at liberty to revoke this Licence.

3. (a) Nothing contained herein shall be deemed to license the Licensee to manufacture sell or let on hire

(a) valves of any kind, or
(b) loudspeakers of any kind, or
(c) television receiving apparatus.

(b) Nothing herein contained shall be deemed to license the Licensee to manufacture sell or let on hire any individual component part of broadcast receiving apparatus or a radiogramophone other than in and forming part of broadcast receiving apparatus or a radiogramophone.

(c) The Licence hereby granted shall not authorise the use or exercise of broadcast receiving apparatus or any radiogramophone for any purpose whatsoever other than the purposes herein set forth and in particular shall not authorise the use or exercise of any of the said apparatus by operating the same for revenue-earning purposes. Nor shall this Licence authorise the use or exercise of any of the said apparatus for purposes of receiving broadcasting or operating any radiogramophone in relation in any manner to the service of any place of public entertainment or of any place in which any business requiring any Licence from public authority is conducted (except insofar as such use is authorised under the definition of "private and domestic use") or for use with a microphone.

4. The Licensee agrees with the Grantor as follows:

(a) Not without the previous written consent of the Grantor to export or sell for export or knowingly permit to be exported any broadcast receiving apparatus or radiogramophone.

(b) Not without the previous written consent of the Grantor to sell let on hire or put into use in the territory for which this Licence is granted any broadcast receiving apparatus or radiogramophones which have not been manufactured in the territory for which this Licence is granted.

(c) From time to time on the request of the Grantor to furnish to the Grantor diagrams and/or samples of all broadcast receiving apparatus and radiogramophones for the time being manufactured sold or let on hire by the Licensee.

(d) To attach or cause to be attached in a prominent position to all broadcast receiving apparatus and radiogramophones sold or put into use by the Licensee (or in the case of sets of component parts of such apparatus to supply for attachment by the constructor to the assembled apparatus) a plate indicating the number of valves (as hereinbefore defined but subject to the provisos contained in Sub-Clauses (f), (i) and (ii) of this Clause) on which the royalty for such apparatus is payable and bearing the following words: With respect to broadcast receiving apparatus:—

"No.......................... This instrument was manufactured under a licence granted by Australian Radio Technical Services and Patents Company Limited in respect of patents controlled by it for the reception in the Commonwealth of Australia and such territories as may from time to time be administered under mandate by the said Commonwealth of sound broadcast by wireless but only for private use and not for operation for any public or commercial or revenue-earning purpose. N.B.—A Post Office Licence is necessary."

With respect to radiogramophones:—

"No.............................. This instrument is manufactured under a licence granted by the Australian Radio Technical Services and Patents Company Limited in respect of patents controlled by it for the reception in the Commonwealth of Australia and such territories as may from time to time be administered under mandate by the said Commonwealth of sound broadcast by wireless and for the reproduction within the said territory of sound from records but only for private use and not for operation for any public or commercial or revenue-earning purpose. N.B.—A Post Office Licence is necessary."

Such plates shall be obtained only from and shall be supplied by the Grantor and no such plate shall be removed from any apparatus to any other without the previous consent in writing of the Grantor and no apparatus shall be considered as duly franked hereunder unless such plate be attached thereto. In addition if required the Licensee shall mark in accordance with the requirements of the Patent Acts of the Commonwealth of Australia or any amendments thereof made during the subsistence of this Licence all apparatus manufactured sold let on hire or put into use by the Licensee hereunder.

(e) So far as is reasonably practicable to make the conditions of this Licence a condition of every sale or hire binding upon and observable by every purchaser or hirer of any broadcast receiving apparatus or any radiogramophone sold or put into use by the Licensee.

(f) To pay to the Grantor by way of royalty:—

(i) In respect of each and every broadcast receiving apparatus sold let on hire or put into use by the Licensee employing or designed to employ a valve or valves

(a) in respect of patents owned or controlled by Standard Telephones and Cables (A/sia) Limited and N. V. Philips Gloeilampenfabrieken from the first day of January 1934 up to and including the twenty-eighth day of February 1934 the sum of one shilling and sixpence (1/6d.) and

(b) on and from the first day of March 1934 the sum of three shillings and sixpence (3/6d.) in respect of each and every valve included or intended to be employed therein whether or not such apparatus embodies or utilises or is designed or intended to embody or utilise any invention the subject of any of the said Letters Patent PROVIDED that in the case of multiple valves employed or intended to be employed in such broadcast receiving apparatus each and every cathode-anode stream contained therein shall be deemed to be one valve and the royalty shall be calculated accordingly;

(ii) In respect of each and every radiogramophone sold or let on hire or put into use by the Licensee employing or designed to employ a valve or valves (a) the sum of three shillings and sixpence (3/6d.) in respect of each and every valve employed or intended to be employed therein and in addition (b) the sum of three shillings and sixpence (3/6d.) whether or not such radiogramophone embodies or utilises or is designed or intended to embody or utilise any invention the subject of any of the said Letters Patent PROVIDED that in the case of multiple valves employed or intended to be employed in such radiogramophone each and every cathode-anode stream contained therein shall be deemed to be one valve and the royalty shall be calculated accordingly.

PROVIDED that at the end of each year of the term of the Licence granted to any Licensee an account shall be prepared by the Grantor showing the amount of royalties paid by such Licensee during such year under paragraph (1) of this subclause and such Licensee shall according to the Licensee's actual output of Broadcast Receivers during such year be entitled to a reduction on the royalties so paid by him calculated on the basis of the difference between the royalties so paid by the Licensee and the rates of royalty set out in the schedule hereto and the amount of such difference which may be payable to such Licensee shall be credited to such Licensee by the Grantor PROVIDED ALWAYS that no royalty shall be payable under paragraphs (i) and (ii) of this Sub-Clause (f) in respect of a battery eliminator incorporated in and forming part of a complete broadcast receiver or radiogramophone and PROVIDED ALWAYS that in respect of broadcast receiving apparatus or radiogramophones manufactured or sold by the Licensee which employ any patent under which the Grantor may become liable to pay a royalty to a third party or share a royalty with a third party the Grantor shall offer to the Licensee and the Licensee may accept the right to the inclusion in this licence of that patent on payment to the Grantor of an additional royalty of such amount as may be required to enable the Grantor out of the total royalties paid by the Licensee both to retain the royalties payable under paragraphs (i) and (ii) of this Sub-Clause (f) and to satisfy the terms of the Licence or Agreement under which royalty is or shall be payable by the Grantor. The Grantor shall if so required in writing by the Licensee furnish the Licensee with proof of the third party's claim to royalty. The Grantor shall upon request of the Licensee and the Licensee shall upon request of the Grantor permit the Grantor to examine free of charge diagrams and/or samples of broadcast receiving apparatus and radiogramophones manufactured or proposed to be manufactured by the Licensee and advise whether such apparatus embodies or utilises any invention the subject of any of the said Letters Patent under which the Grantor may be liable for royalty to a third party as herein mentioned. The Grantor shall inform the Licensee of the amount of any such additional royalty and any such additional royalty shall be shown separately in the returns hereinafter mentioned.

(g) Keep proper and accurate and separate accounts of everything necessary to ensure an accurate return to be made each calendar month in conformity with any of the provisions of this Licence showing separately the royalties payable under each of the paragraphs (i) and (ii) of the last preceding Sub-Clause (f) and to render such accounts within fifteen (15) days of the last day of each calendar month in each year to such person as the Grantor may designate to the Licensee from time to time and to accompany each such account with a remittance in respect of the royalties thereby shown to be due. In the event that the Licensee fails to keep the books of account above mentioned in addition to any other rights and remedies the Grantor may have the Licensee agrees to pay to the Grantor above mentioned the amount of royalty which the Grantor may by notice in writing to the Licensee stipulate as the amount estimated to be due unless the Licensee proves that the royalty due should be some other amount.

(h) The Licensee shall furnish monthly returns verified by the Auditor of the Licensee or by a Statutory Declaration of the proper officer and in the event of any dispute shall permit the Grantors to appoint a Public Accountant to inspect the books and accounts of the Licensees relative to this Licence.

(i) To pay to the Grantor on the execution hereof for the first yearly period of this Licence and thereafter so long as the Licensee shall continue to manufacture sell let on hire or put into use broadcast receivers and/or radiogramophones in advance each year during the period of this Licence the sum of one hundred and fifty pounds (£150) as minimum royalty for the yearly period, which sum shall in no event be returnable but from the initial minimum royalty payment under this Clause shall be deducted and regarded as full settlement of all claims for past infringement of patents owned or controlled by Standard Telephones and Cables (A/sia) Limited, as distinct from any claims under any patents owned or controlled by Amalgamated Wireless (Australasia) Limited or others the sum of ten pounds (£10) for every one thousand (1000) broadcast receivers manufactured during one year by the Licensee. For the purpose of computing such number the production of the Licensee for the quarter ending 31st March 1934 will be taken as the basis.

(j) Not at any time during the subsistence hereof to dispute or impeach or to assist others to dispute or impeach the validity of the said Letters Patent.

(k) Not without the previous written consent of the Grantor to sell or let on hire or put into use or permit to be sold let on hire or put into use any broadcast receiving apparatus or any radiogramophone except under the Licensee's own trade mark or trade name or any other trade mark or trade name which may be approved by the Grantors from time to time.

(l) Not to assign transfer mortgage grant sub-licences under or in any manner part with the possession or control of this Licence or any part of it without the previous written consent of the Grantor.

5. During the subsistence of this Licence the Grantor will keep the Licensee fully indemnified against costs and damages arising in connection with all actions proceedings claims and demands which may be made against the Licensee by any third party who seeks to establish or establishes to the satisfaction of a court of competent jurisdiction within the Commonwealth of Australia and such territories as may from time to time be administered under mandate by the said Commonwealth his right to restrain the user and exercise by the Licensee under the Grant contained under this Licence for any of the said Letters Patent on the ground that such user and exercise is an infringement of any legal rights or legal interests of such third party in such Letters Patent PROVIDED ALWAYS that the Grantor is immediately informed of the institution of such proceedings and is given full and complete rights to take over at its own cost and through its own solicitors the defence of such proceedings if it so requests and in that event the Licensee shall assist the Grantor in every reasonable manner but the Grantor shall be at liberty to compromise submit to judgment in abandon discontinue or otherwise dispose of the same as to it may seem expedient.

6. The Grantor may revoke this Licence upon the happenings of any of the following events:—

(a) If any royalty return or any royalty shown to be due is not rendered or is unpaid for thirty days (30) after the last day of any preceding month and remains unrendered or unpaid for seven days after notice in that behalf from the Grantor, or

(b) If there be any breach on the part of the Licensee of any other of the Agreements herein contained and the same be not remedied made good or desisted from within seven (7) days of notice on that behalf from the Grantor; or

(c) If the Licensee shall become bankrupt or compound with his creditors (or being a company) shall go into liquidation whether voluntary or compulsory;

any revocation of this Licence shall be without prejudice to all claims of the Grantor against the Licensee for outstanding royalties or prior breaches of this Licence or otherwise and also without prejudice to the provision of Clause 7 hereof.

7. (a) The Licensee agrees to grant to the Grantor upon request a non-exclusive non-transferable licence (but with the right to sub-license subsidiary or associated companies) to make use exercise and vend all or any of the inventions the subject of Letters Patent applicable to broadcast receiving apparatus and/or a radiogramophone in respect of which and insofar as the Licensee has or shall hereafter have power to grant a licence for the purposes of manufacturing using selling or letting on hire within the Commonwealth of Australia and such territories as may from time to time be administered under mandate by the said Commonwealth broadcast receiving apparatus and/or radiogramophones but only for private or domestic use or for the purpose of lectures or demonstrations in any institution of a charitable educational philanthropic or religious character (such lectures or demonstrations not being open to the public generally and not being held for payment)and not otherwise.

(b) If any invention in respect of which any such licence is herein agreed to be granted by the Licensee comes within the scope of the claims of any Letters Patent in respect of which the Licence is granted or agreed to be granted hereunder by the Grantor then the Grantor shall pay no royalty. If any such invention does not come within the scope as aforesaid then the Grantor shall be entitled to such licence on payment of a royalty at a rate not exceeding the lowest rate paid by any Licensee in respect of the same invention or if there is no other Licensee then at a rate not exceeding five per cent. (5%) of the net selling price of the article manufactured in accordance therewith or (whether or not there is another licensee) not exceeding the rate paid by the Licensee to the Grantor hereunder whichever is the smaller.

(c) Any such licence granted by the Licensees shall continue until the thirty-first day of December 1938 or for such other period as may be agreed upon.

IN WITNESS WHEREOF the parties hereto have duly executed these presents the day and year first hereinbefore written.

THE SCHEDULE HEREIN REFERRED TO

Annual Output of Broadcast Receivers employing or designed to employ the following aggregate number of valves as herein defined.	Rate per valve as defined excluding Rectifier, from 1/1/34	from 1/3/34
4 to 1999	1/6	3/6
2000 „ 3999	1/5½	3/5
4000 „ 5599	1/5	3/4
5600 „ 7199	1/4½	3/3
7200 „ 9999	1/4	3/2
10000 „ 12879	1/3½	3/1
12880 „ 17999	1/3	3/–
18000 „ 23199	1/2½	2/11
23200 „ 35999	1/2	2/10
36000 „ 43999	1/1½	2/9
44000 „ 59999	1/1	2/8
60000 „ 75999	1/0½	2/7
76000 „ 105999	1/–	2/6
106000 „ 135999	11½	2/5
136000 „ 191999	11	2/4
192000 „ 245999	10½	2/3
246000 „ 343999	10	2/2
344000 „ 442799	9½	2/1
442800 and over	9	2/–

The above rebates do not apply to Radiogramophones.

Hire Purchase Business

By N. W. SMITH, A.F.I.A., L.C.A.
Industrial Sales Manager I.A.C. Ltd.

THE first thing to keep in mind in regard to Instalment selling is that it is not by any means new. It is a certain phase of credit which many years ago was practised in regard to the transfer of land and buildings, but it is only in latter years that the real value of Instalment selling has become thoroughly understood.

As we all know, the world lives on Credit and for many years past merchandise has been sold on Open Credit and in many cases it has been difficult for people to meet large commitments, therefore, the only rational way to expect debts to be liquidated was by means of allowing debtors to liquidate their debts by paying the outstanding amounts in periodical payments. The large manufacturers and companies have always been able to secure credit from their bankers for uses in production but the extent of this Credit was purely confined to the producer. As against this no type of stable credit was provided for the Consumer until the advent of Instalment selling. About twenty years ago when a definite effort was made to prove the stability of Instalment selling, the ordinary Commercial Banks found that it was impracticable for them to handle this type of Credit in view of the detailed work attached thereto. As a means of overcoming this there came into being Finance Companies who devoted their entire activities to advancing consumer credit to individuals. Briefly, these Finance Companies operate by financing the consumer direct by advancing money on each commodity and in turn collecting this money from the individual by periodical repayments. With the advent of these Finance Companies merchants immediately found that their potential field for marketing had been increased in many cases from fifteen to fifty per cent., with the result that mass production could be maintained. Obviously by mass production the cost of each unit is considerably cheaper than would be the case if the factory only manufactured a small output.

The current rate for Instalment Credit is approximately 8% flat per annum. It is not a secret that this rate is somewhat in excess of Bank interest rate and many salesmen immediately believe that the rate is excessive and not economical to the purchaser. It has been positively proved by Economists that if Instalment selling were to be eliminated in connection with motor cars, Radio, refrigerators, electric stoves and all such commodities, the cost of production for each unit would increase between twenty and twenty-five per cent., with the result that instead of being able to buy a refrigerator which is now listed at £50, the price would be £60.

Contrary to this, on the Instalment basis the purchaser would pay a deposit and be charged about £4/10/- on the unpaid balance, or making in all a total cost of £54/10/-. Here also is an argument for the man who pays cash and asks for a discount, believing that he is not causing you any trouble by worrying you with Instalment selling. The list price is a cash price and the man who buys on Instalments pays a little more, and because thousands of people purchase on the Instalment system a cash buyer is provided with the commodity at twenty to twenty-five per cent. less than he would have to pay if the Instalment buyer did not keep up production. It may sometimes be said that refrigerators, electric stoves, motor cars, etc., are luxuries, whereas this is absolutely untrue. If you can conceive our modern world approximately twenty years hence you will view, with very little imagination, the entire elimination of the ice cart, horses, and fuel stoves, except in very remote and unmodern parts of the universe. When these days arrive a refrigerator will not be a luxury any more than it is a luxury at the present time. As regards wireless sets, these also are necessary to the human mind and body. We know that if any given person, particularly sales people, were to commence and work without any recreation over a period of five years the result would be that the same person would be either dead or useless. Our human make-up requires recreation and in that recreation music plays an important part and it may be safely said that Radio is the cheapest of music procurable in the world to-day. In addition to this of course, Wireless has many other advantages from an educational point of view and also for people in the outlying districts.

The object of this view of Instalment Credit is to positively sell everybody on the idea of developing and expanding Instalment Credit to stimulate sales in this direction.

Quite frequently the careful members of the population prefer to use the instalment method of purchase rather than disturb their bank savings. The saving habit is very valuable to the community in general and it has been regularly proved that it is much easier for a person to buy a commodity on the Hire Purchase plan and pay the instalments out of income that it is for the same person to use bank savings with the idea that these will be rebuilt again in the same way. The system enables right-thinking people to keep their personal reserve, which they may have in bank savings, intact and always ready for unforeseen contingencies.

From the foregoing you will observe that instalment selling has the following effects on the community in general:

(a) It has stimulated factory output resulting in the cheapening of commodities for the purchaser.

(b) It has increased the purchasing power of every individual and brought within the range of many individuals certain desired and hygienic commodities which the purchaser would not otherwise be able to buy.

(c) It encourages thrift.

(d) The Cash Purchaser buys at a price which he would not be able to do otherwise.

(e) The potential field of a Salesman is correspondingly increased by a further forty to seventy per cent., which enables him to earn more money.

(f) The merchant does not have to lend Open Credit to his customers because he has a Finance Company which will take over these transactions and take care of the collection thereof.

These are definite advantages to everyone concerned and are supported by knowledge plus facts.

Sales v. Credit

It is natural that every Sales Department in a selling organisation feels that it is carrying the biggest portion of the load. It is true that without sales there would be no need for the Manufacturing Department, the Accountancy Department, Service Department and Credit Department. However, the statement can easily be reversed by stating that without any one of these departments the Sales Department would soon cease to function.

Complete efficiency can only be achieved by continued co-operation, one department with the other. Perhaps many salesmen have never considered for a moment the hours scientists and research specialists spend over designs in laboratories perfecting certain commodities and adding little nicknacks to help the salesman sell the goods. By the same train of thought the Accountancy Department manipulates the money and are untiring in their efforts in securing payment for goods which the salesman has already sold and received commission for.

For many years there has been a feeling of tension between the Sales and Credit Department and it is mainly due to the fact that two individuals are looking at one prospective deal from two entirely different angles, the Salesman to make the sale and the Credit man to be sure that payment will be definitely made in due course. It is the duty of the Credit Department to extend every facility and assistance to the Salesman and conversely it is the duty of the Salesman to consider the Credit Department.

The Finance Company generally stipulates certain terms and conditions under which various commodities may be sold and it is realised that at times the regular terms will not meet the requirements of one particular purchaser and the Finance Company is generally quite prepared to make amendments and alterations in the plan to suit certain individuals who offer legitimate reasons.

The Finance Company must have ample money to take care of every Instalment sale that is made and their ability to supply consistent funds depends on the manner in which the transactions accepted pay out. This is the actual point which Finance Companies are confronted with. Instalment selling will not get into disrepute if the goods sold on the Instalment Plan are delivered on recognised terms and to people who can pay for the goods. This is also a vital point for every Salesman to consider because if Instalment selling is regarded unfavourably and is dispensed with, then the potential field for salesmen is cut in half.

Charts

As a means of assisting the sales force in finalising and effecting their sales, the Finance Company will supply Ready Reference Tables in order that the Purchaser can be advised the exact amount of the instalments on any given transaction. Generally speaking, the charts include all additional charges, such as, Fire Insurance, Stamp Duty, etc., irrespective of under what conditions.

Hire Purchase Agreements

The Hire Purchase Agreements are always compiled in the name of the Finance Company and no difficulty is generally experienced in signing up the purchaser on these particular forms which are in use generally.

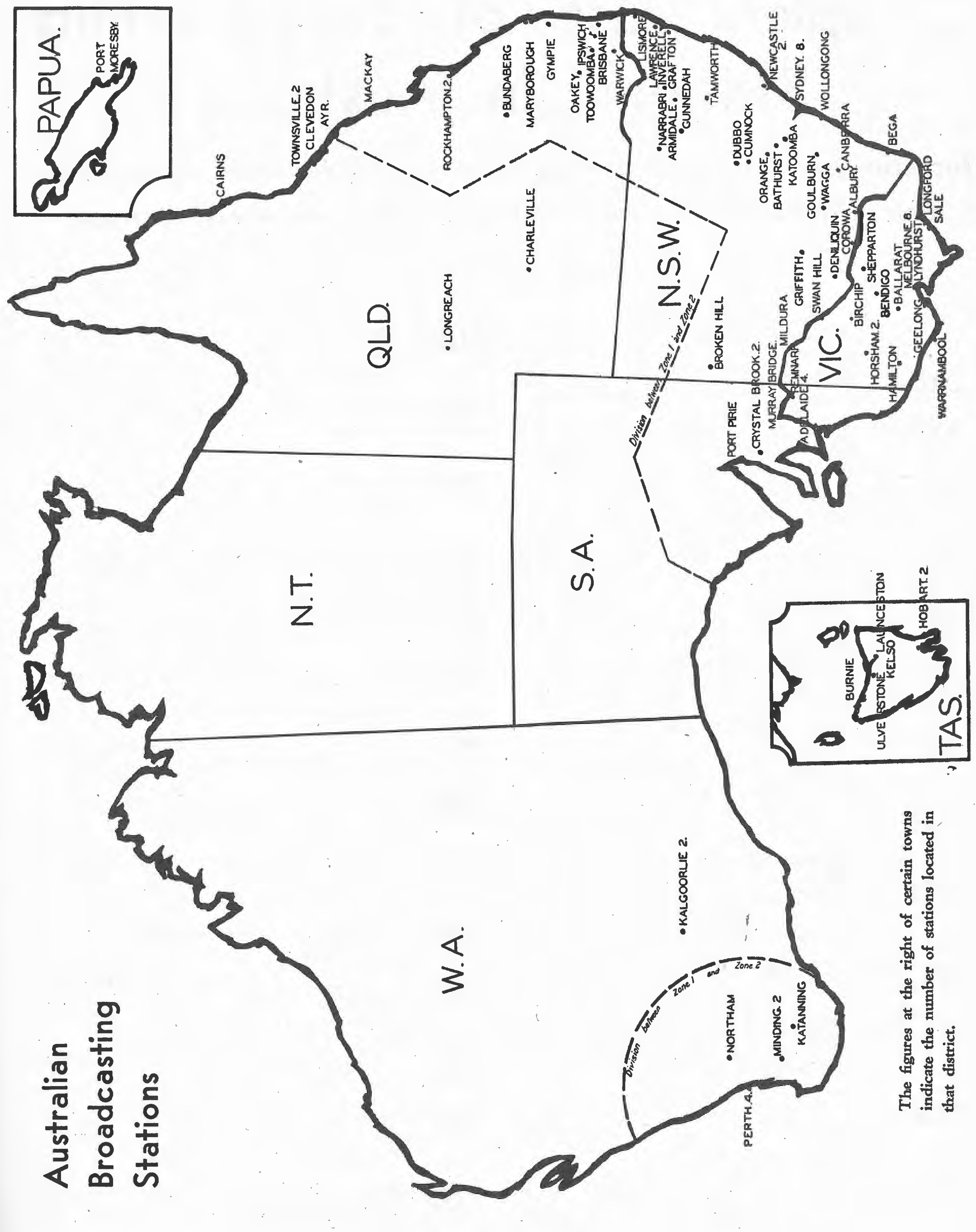
The Hire Purchase Agreement is simple to compile and generally covers a Schedule outlining the complete transaction, showing clearly to the hirer the method in which the commodity is being purchased and the manner in which he is paying for it. Directly underneath the Schedule, it is usual for provision to be made for signature by the parties to the agreement in order that any disputes in the future may be avoided.

Credit Proposal Form

It is the usual practice to incorporate in the Hire Purchase Agreement form a Credit Proposal paragraph calling for certain information from the hirer. With the exercise of a little discretion and tact, it is always possible to obtain the required data and when it is realised that the Finance Company must make collections from persons they have never seen, it will be appreciated that some knowledge of the circumstances of the hirer is desirable. It is best to keep in mind that the more information supplied in that regard, the better position the Collection Department is placed in when handling collection of the instalments.

Generally speaking, a salesman cannot be an effective collector and at the same time retain prestige and the average merchant house is set up for the purpose of manufacturing and/or selling their particular commodities. The Finance Company, on the other hand, can be of great assistance in practically eliminating altogether the collection of the instalment business. It is just as important to have every instalment met promptly on the due date as it is to receive the initial down payment, so that the money in hand is always in advance of the depreciation of the commodity.

It is impossible to cover every point on this exhaustive subject in this short review, but doubtless the seeds sown will give rise to many thoughts applicable to certain business requirements. The application of the system is in its comparative infancy and it is hoped that it will continue to expand with its consequent profit to manufacturers, merchants and retailers.



Australian Broadcasting Stations

The figures at the right of certain towns indicate the number of stations located in that district.

Complete List of Broadcasting Stations in Australia

Including Government Stations operated by the Australian Broadcasting Commission and Commercial Stations privately owned and operated.

* Denotes not yet in operation.

New South Wales

2AD 278 metres, 1080 k.c., 100 watts. Northern Broadcasters Ltd., ARMIDALE, N.S.W.

2AY 203 metres, 1480 k.c., 100 watts. Amalgamated Wireless (A/sia) Ltd. Studio, 610 Dean Street, ALBURY, N.S.W.

***2BE** BEGA, N.S.W.

2BH 221 metres, 1330 k.c., 100 watts. Radio Silver City Ltd., cnr. Cummins and Zebiana Sts., BROKEN HILL, N.S.W.

2BL 405 metres, 740 k.c., 3,000 watts. Australian Broadcasting Commission. Studio, 96-98 Market Street, SYDNEY.

***2BS** BATHURST, N.S.W.

2CA 286 metres, 1050 k.c., 500 watts. A. J. Ryan Broadcasters Ltd., Symondston, CANBERRA, F.C.T.

2CH 252 metres, 1190 k.c., 1,000 watts. N.S.W. Council of Churches' Service. Studio, 77 York Street, SYDNEY. Station at Dundas.

2CO 448 metres, 7,500 watts. Australian Broadcasting Commission. (Relaying 3LO and 3AR), COROWA, N.S.W.

***2DU** DUBBO, N.S.W.

2FC 492 metres, 610 k.c., 3,500 watts. Australian Broadcasting Commission. Studio, 96-98 Market Street, SYDNEY.

2GB 345 metres, 870 k.c., 1000 watts. Theosophical Broadcasting Station Ltd., 29 Bligh Street, SYDNEY.

2GF 248 metres, 1,210 k.c., 100 watts. Grafton Broadcasting Co. Ltd. Station, Turf Street, SOUTH GRAFTON, N.S.W.

2GN 216 metres, 1,390 k.c., 100 watts. Goulburn Broadcasting Co. Ltd., Auburn Street, GOULBURN, N.S.W.

2GZ 303 metres, 990 k.c., 2,000 watts. Country Broadcasting Services Ltd., ORANGE, N.S.W.

2HD 263 metres, 1,140 k.c., 500 watts. Airsales Broadcasting Co., Box 123, NEWCASTLE, N.S.W.

2KA 259 metres, 1,160 k.c., 100 watts. Radio Katoomba Ltd., KATOOMBA, N.S.W.

2KO 213 metres, 1,410 k.c., 500 watts. Newcastle Broadcasting Co. Ltd., A.M.P. Chambers, 57 Hunter Street, NEWCASTLE, N.S.W.

2KY 294 metres, 1,020 k.c., 1,000 watts. The Labour Council, N.S.W. Studio, 424 George Street, SYDNEY.

2LV 366 metres, 820 k.c., 100 watts. Northern Broadcasters Ltd., INVERELL, N.S.W.

2MO 221 metres, 1,340 k.c., 50 watts. M. J. Oliver, Marquis Street, GUNNEDAH, N.S.W.

2NC 244 metres, 1,230 k.c., 2,000 watts. Australian Broadcasting Commission. Relaying 2FC and 2BL. NEWCASTLE, N.S.W.

***2NZ** Country Broadcasting Services Ltd., 12 Spring St., SYDNEY.

2QN 208 metres, 1,440 k.c., 50 watts. Deniliquin Broadcasting Co. Ltd., End Street, DENILIQUIN, N.S.W.

2RG GRIFFITHS, N.S.W. Murrumbidgee Broadcasters Ltd.

2SM 236 metres, 1,270 k.c., 1,000 watts. Catholic Broadcasting Co., Australia House, Wynyard Square, SYDNEY.

2TM 231 metres, 1,300 k.c., 500 watts. Tamworth Radio Development Co., Peel Street, TAMWORTH, N.S.W.

LIST OF ALL BROADCASTING STATIONS IN AUSTRALIA—(Continued)—

2UE 316 metres, 950 k.c., 1,000 watts. Radio 2UE Sydney Ltd., 296 Pitt Street, SYDNEY.

2UW 270 metres, 1,110 k.c., 750 watts. Commonweath Broadcasting Corporation Ltd., 49 Market Street, SYDNEY.

2WG 261 metres, 1,150 k.c., 500 watts. Riverina Radio Broadcasting Co. Ltd., 16 Fitzmaurice Street, WAGGA, N.S.W.

2WL 210 metres, 1,430 k.c., 300 watts. Wollongong Broadcasting Co., Church and Edward Sts., WOLLONGONG, N.S.W.

2XN 224 metres, 1,340 k.c., 50 watts. Richmond River Broadcasters Ltd., LISMORE, N.S.W.

Victoria

3AK 200 metres, 1,500 k.c., 200 watts. Melbourne Broadcasters Pty. Ltd., 116 Queen Street, MELBOURNE.

3AR 517 metres, 580 k.c., 4,500 watts. Australian Broadcasting Commission. Studio, 120a Russell Street, MELBOURNE.

3AW 234 metres, 1,280 k.c., 600 watts. The Vogue Broadcasting Co. Pty. Ltd., 382 Latrobe St., MELBOURNE.

3BA 227 metres, 1,320 k.c., 500 watts. Ballarat Broadcasters Pty. Ltd., 56 Lydiard Street, BALLARAT, VIC.

3BO 309 metres, 970 k.c., 200 watts. Amalgamated Wireless (A/sia) Ltd., Allen's Walk, BENDIGO, VIC.

3DB 291 metres, 1,030 k.c., 600 watts. 3DB Broadcasting Station Pty. Ltd., 36 Flinders Street, MELBOURNE.

3GI 361 metres, 830 k.c., 7,000 watts. Australian Broadcasting Commission, Gippsland Regional, LONGFORD, near Sale.

3GL 222 metres, 1,350 k.c., 50 watts. Geelong Broadcasters Pty. Ltd., Moorabool Street, GEELONG, VIC.

3HA 297 metres, 1,010 k.c., 300 watts. Western Province Radio Pty. Ltd., 37 Gray Street, HAMILTON, VIC.

3HS 219 metres, 1,370 k.c., 50 watts. Wimmera Broadcasting Co. Pty. Ltd., 84 Wilson St., HORSHAM, VIC.

3KZ 254 metres, 1,180 k.c., 600 watts. Industrial Printing & Publicity Co., 24-30 Victoria St., CARLTON, N.3.

3LO 390 metres, 770 k.c., 3,500 watts. Australian Broadcasting Commission. Studio, 120a Russell Street, MELBOURNE.

3MA 333 metres, 900 k.c., 100 watts. Sunraysia Broadcasters Pty. Ltd., 22 Deakin Avenue, MILDURA, VIC.

3MS 204 metres, 1,470 k.c., 100 watts. Mallee Broadcasters Pty. Ltd., Cumming Avenue, BIRCHIP, VIC.

3SH 278 metres, 1,080 k.c., 100 watts. Swan Hill Broadcasting Co., Campbell Street, SWAN HILL, VIC.

3TR 242 metres, 1,240 k.c., 500 watts. Gippsland Publicity Pty. Ltd., Raymond Street, SALE, VIC.

3UZ 323 metres, 930 k.c., 600 watts. Nilsen's Broadcasting Service Pty. Ltd., 45 Bourke Street, MELBOURNE, VIC.

3WR 238 metres, 1,260 k.c., 500 watts. Goulburn Valley & N.E. Broadcasters Pty. Ltd., High Street, SHEPPARTON, VIC.

3XY 211 metres, 1,420 k.c., 600 watts. Station 3XY Pty. Ltd., 4 Bank Place, MELBOURNE.

3YB 283 metres, 1,060 k.c., 50 watts. WARRNAMBOOL, VIC.

Queensland

4AK 246 metres, 1,220 k.c., 1,000 watts. Brisbane Broadcasting Pty. Ltd., 47 Charlotte Street, BRISBANE.

4AY 207 metres, 1,450 K.C., 100 watts. Ayr Broadcasters Pty. Ltd., Ardmillan Road, AYR, Q'LAND.

4BC 268 metres, 1,120 K.C., 1,000 watts. J. B. Chandler & Co., 43 Adelaide Street, BRISBANE.

4BH 217 metres, 1,380 K.C., 1,000 watts. Broadcasters (Aust.) Ltd., Parbury House, Eagle Street, BRISBANE.

4BK 233 metres, 1,290 K.C., 500 watts. Brisbane Broadcasting Pty. Ltd., 47 Charlotte Street, BRISBANE.

4BU 203 metres, 1,480 K.C., 100 watts. Bundaberg Broadcasters Pty. Ltd., 117 Bourbong Street, BUNDABERG, Q'LD.

4CA 207 metres, 1,450 K.C. Amalgamated Wireless (A/sia) Ltd., CAIRNS, Q'LAND.

4GR 300 metres, 1,000 K.C., 500 watts. Gold Radio Service Ltd., 43 Adelaide Street, BRISBANE.

***4GY** GYMPIE, Q'LAND.

LIST OF ALL BROADCASTING STATIONS IN AUSTRALIA—(Continued)—

4IP 208 metres, 1,440 K.C., 50 watts. Ipswich Broadcasting Co. Pty. Ltd., Brisbane Street, IPSWICH, Q'LAND.

4LG Central Western Broadcasting Co., LONGREACH, Q'LAND.

4MB 283 metres, 1,060 K.C., 100 watts. Maryborough Broadcasting Co. Ltd. Studio, Kent Street, MARYBOROUGH, Q'LAND.

4MK 259 metres, 1,160 K.C., 100 watts. Mackay Broadcasting Service, 64 Nelson Street, MACKAY, Q'LAND.

4PM 221 metres, 1,360 K.C., 100 watts. Amalgamated Wireless (A/sia) Ltd. Studio, Musgrave Street, PORT MORESBY, PAPUA.

4QG 375 metres, 800 K.C., 2,500 watts. Australian Broadcasting Commission. Studio, State Ins. Buildings, BRISBANE.

4RK 330 metres, 910 K.C., 2,000 watts. Australian Broadcasting Commission (Relaying 4QG), ROCKHAMPTON, Q'LAND.

4RO 226 metres, 1,330 K.C., 50 watts. Rockhampton Broadcasting Co. Pty. Ltd., Cnr. East and William Streets, ROCKHAMPTON, QUEENSLAND.

4TO 256 metres, 1,170 K.C., 200 watts. Amalgamated Wireless (A/sia) Ltd. Studio, Flinders Street, SOUTH TOWNSVILLE, QUEENSLAND.

***4VL** 209.8 metres, 1,430 K.C., 50 watts. The Charleville Broadcasting Service Pty. Ltd., Burke Street, CHARLEVILLE, Q'LAND.

4WK 333 metres, 900 K.C., 50 watts. Warwick Broadcasting Co. Pty. Ltd., Albion Street, WARWICK, QUEENSLAND.

South Australia

5AD 229 metres, 1,310 K.C., 300 watts. Advertiser Newspapers Ltd., Weymouth Street, P.O. Box 392, ADELAIDE.

5CK 469 metres, 640 K.C., 7,500 watts. Australian Broadcasting Commission (Relaying 5CL), CRYSTAL BROOK, S.A.

5CL 411 metres, 730 K.C., 2,000 watts. Australian Broadcasting Commission. Studio, Hindmarsh Square, ADELAIDE.

5DN 313 metres, 960 K.C., 300 watts. Hume Broadcasters Ltd., 29 Rundle Street, ADELAIDE.

5KA 250 metres, 1,200 K.C., 300 watts. Sport Radio Broadcasting Co. Ltd., Richard's Building, Currie Street, ADELAIDE.

5MU 224 metres, 1,340 K.C., 100 watts. Murray Bridge Broadcasting Co. Ltd., Bridge Street, MURRAY BRIDGE, S.A.

5PI 288 metres, 1,040 K.C., 2,000 watts. Midlands Broadcasting Services Ltd., Box 392, Adelaide, PORT PIRIE, S.A.

5RM 353 metres, 850 K.C., 1,000 watts. River Murray Broadcasters Ltd. Studio, RENMARK, S.A.

Western Australia

6AM 306 metres, 980 K.C., 1,000 watts. Northam Broadcasters Ltd., Studio, NORTHAM, W.A.

6IX 242 metres, 1,240 K.C., 400 watts. W.A. Newspapers Ltd., St. Georges Terrace, PERTH, W.A.

6KG 248 metres, 1,210 K.C., 500 watts. Goldfields Broadcasters (1933) Ltd., 26 Hannan St., KALGOORLIE, W.A.

6ML 265 metres, 1,130 K.C., 500 watts. W.A. Broadcasters Ltd., Lyric House, Murray Street, PERTH, W.A.

6PR 341 metres, 880 K.C., 500 watts. Nicholson's Ltd., 86-90 Barrack Street, PERTH, W.A.

***6WB** W.A. Broadcasters Ltd. KATANNING, W.A.

6WF 435 metres, 690 K.C., 3,500 watts. Australian Broadcasting Commission. Studio, Hay St., PERTH, W.A.

Tasmania

7BU 455 metres, 660 k.c., 50 watts. Findlay Pty. Ltd., BURNIE, TAS.

7HO 349 metres, 860 k.c., 100 watts. Commercial Broadcasters Pty. Ltd., 82 Elizabeth Street, HOBART, TAS.

7LA 273 metres, 1,100 K.C., 300 watts. Findlays & Wills Broadcasters Pty. Ltd., 67 Brisbane Street, LAUNCESTON, TAS.

7UV 205 metres, 1,460 K.C., 300 watts. Northern Tasmania Broadcasters Pty. Ltd. Studio, Reibey Street, ULVERSTONE, TAS.

7ZL 508 metres, 590 K.C., 1,000 watts. Australian Broadcasting Commission. Studio, Elizabeth Street, HOBART, TAS.

7NT 423 metres, 710 K.C., 7,000 watts. Australian Broadcasting Commission. North Regional (Kelso, near Launceston).

Existing Australian National Broadcasting Stations

Station 1.	Approximate Location 2	Frequency KC. 3.	Wavelength m. 4.	Power Watts 5.	Ultimate Power 6.
2BL, Sydney	Coogee, 4½ miles S.E. of G.P.O.	855	351	3,000	
2CO, Corowa	3½ miles N.N.E. of P.O., Corowa	560	536	7,500	
2CR, Cumnock	Near Dubbo, N.S.W.	550	545	10	60
2FC, Sydney	Pennant Hills, 11¼ mls. N.W. of G.P.O.	665	451	3,500	
2NC, Newcastle	Beresfield, 11½ miles W.N.W. P.O., Newcastle	1,245	241	2,000	
2NR, Lawrence	Near Grafton, N.S.W.	700	429	7	30
3AR, Melbourne	North Essendon, 8 miles N.W. Eliz. St. P.O.	610	492	4,500	
3GI, Longford	Near Sale, Vic.	830	361	7	30
3LO, Melbourne	Braybrook, 5¾ miles W. Elizabeth Street P.O.	800	375	3,500	
3LR, Lyndhurst	5 miles from Dandenong	9,580	31.31	600	
3WV, W. Regional	Near Horsham, Vic.	580	517	10	60
4QG, Brisbane	25 Chains S.W. of G.P.O.	760	395	2,500	
4QN, Clevedon	Near Townsville, Q'ld.	600	500	7	30
4RK, Rockhampton	6 miles S.W. of P.O.	910	330	2,000	
5CK, Crystal Brook	2½ miles N.E. of P.O.	635	472	7,500	
5CL, Adelaide	Brooklyn Park, 3¼ miles W. of G.P.O.	730	411	2,000	
6GF, Kalgoorlie	Kalgoorlie, W.A.	720	417	2	
6WA, Minding	Near Wagin, W.A.	560	536	10	60
6WF, Perth	7 miles N. of G.P.O.	690	435	3,500	
7NT, Kelso	Near Launceston, Tas.	750	400	7	30
7ZL, Hobart	Radio Hill, 1¾ miles S.W. of G.P.O.	580	517	1,000	

New Transmitters are projected for 2BL, 2FC, 3AR and 3LO.

New Zealand Broadcasting Stations

As at February, 1936

1YA: **N.Z. Broadcasting Board, Karangahape Road, Auckland.** 10 k.w. 650 kc., 461.3 m. Transmission hours:—Monday to Saturday, 7 — 9 a.m., 10 a.m.—11 p.m.; Sundays, 9 a.m. to noon, 1—4.30 p.m., 6—10 p.m.

1YX: **N.Z. Broadcasting Board, Karangahape Road, Auckland.** 75 watts, 880 k.c. 340.7 m. Transmission hours: 5—6 p.m., 7—10 p.m. (daily except Sunday); Sunday, 6—10 p.m.

1ZB: **The Fellowship of the Friendly Road (Inc.), Queen's Arcade, Auckland.** 350 watts, 1090 k.c., 275.2 m. Transmission hours:—Tuesday, Wednesday, Thursday, Friday, 9 — 9.30 a.m., 10.15—11 a.m., 6.30—9.30 p.m.; Saturday, 9—9.30 a.m., 10.15—11 a.m.. Sunday, 9 a.m. to noon, 6.30—9.30 p.m.

1ZM: **W. W. Rodgers Ltd., Massey Road, Manurewa,** 200 watts, 1260 k.c., 238 m. Transmission hours: Monday, Tuesday, Wednesday, Thursday, Friday, 5 — 10 p.m., Saturday, 1 — 4 p.m., 5 p.m. to midnight; Sunday, 10 a.m. to 6 p.m., 7 — 10 p.m.; Holidays, 8 p.m. to midnight.

1ZJ: **Johns Ltd., Chancery Street, Auckland,** 100 watts, 1310 k.c., 228.9 m. Transmission hours: Tuesday and Thursday, noon to 2 p.m.; Wednesday, 7.30—9.30 p.m.

2YA: **N.Z. Broadcasting Board, Featherston Street, Wellington.** 5000 watts, 570 k.c., 526 m. Transmission hours:—Monday to Saturday 7 —9 a.m., 10 a.m.—11 p.m.; Sunday, 9 a.m. to noon, 1—4.30 p.m., 6—10 p.m.

2YB: **The North Taranaki Radio Society, Empire Building, King Street, New Plymouth.** 100 watts, 760 k.c., 395 m. Transmission hours:—Monday, 7—10 p.m.; Wednesday, 6.30—10 p.m.; Saturday, 6.30—10.30 p.m.; Sunday, 6—10 p.m. (2.30—4.30 Saturdays during football season).

2ZH: **C. B. Hansen, Dalton Street, Napier.** 90 watts, 820 k.c., 365.6 m. Transmission hours:—Monday, Tuesday, Friday, noon to 2 p.m., 7 — 10.30 p.m.; Wednesday, noon to 2 p.m., 6.30—10.30 p.m.; Thursday, noon to 2 p.m.; Saturday, 10 a.m. to 5 p.m., 7—11 p.m.; Sunday, noon to 3 p.m., 6.30—10 p.m.

2YC: **N.Z. Broadcasting Board, Featherston Street, Wellington.** 200 watts, 840 k.c., 356.9 m. Transmission hours: 5—6 p.m., 7—10 p.m. (daily except Sunday); Sunday, 6—10 p.m.

2ZP: **E. A. Perry, 128 Queen Street, Wairoa.** 210 watts, 900 k.c., 333.3 m. Transmission hours: Tuesday, 7—9 a.m., 6—10.30 p.m.; Wednesday, Thursday, Friday, 7—9 a.m.; Sunday, 7.30—9.30 a.m.

2ZF: **The Manawatu Radio Club, King Street, Palmerston North,** 250 watts, 960 k.c., 312.3 m. Transmission hours: Monday, Thursday, Saturday, 8—10 p.m.; Wednesday, 6.15—10 p.m.; Friday, 7—9.30 p.m.; Sunday, 7—9.30 p.m.

2ZJ: **C.T.C. Hands, 229 Gladstone Road, Gisborne.** 300 watts, 980 k.c., 303.9 m. Transmission hours: Monday, Friday, Saturday, 7—10 p.m.; Tuesday, Wednesday, noon to 1.30 p.m., 7—10 p.m.; Thursday, 7—8 p.m.

2ZM: **Atwater Kent Radio Service Ltd., 258 Gladstone Road, Gisborne.** 30 watts, 1150 k.c., 260.9 m. Transmission hours: Monday, 9.15 —10 a.m., 8—10.30 p.m.; Tuesday, Wednesday, Friday, 9.15—10 a.m.; Thursday, 9.15—10 a.m., 8—11 p.m.; Saturday, 9.15—10 a.m., 8—10.30 p.m.; Sunday, noon to 1 p.m., 7—11 p.m.

2ZD: **W. D. Ansell, 7 Rimu Street, Masterton.** 12 watts, 1170 k.c., 256.3 m. Transmission hours: Monday to Sunday, 8—10 p.m.

2ZL: **John Holden, 609 Park Road, Hastings.** 50 watts, 1240 k.c., 241.8 m. Thursday, 6.30—11 p.m.; Sunday, 9.30 a m. to noon.

2ZR: **2ZR Radio Club, Trafalgar Street, Nelson.** 60 watts, 920 k.c., 326.1 m. Transmission hours: Monday, Wednesday, 5—10 p.m.; Tuesday, Thursday, Friday, 6—10 p.m.; Saturday, 2.30—4.30 p.m., 6—10 p.m.; Sunday, 10.45 a.m. to 1 p.m., 6.15—9.30 p.m.

2ZO: **J. V. Kyle, 50 Waldegrave Street, Palmerston North.** 200 watts, 1400 k.c., 214.2 m. Transmission hours: Tuesday, 6.30—10 p.m.; Thursday, 7.30—10 p.m.

3YA: **N.Z. Broadcasting Board, Gloucester Street, Christchurch.** 10 k.w., 720 k.c., 416.4 m. Transmission hours: Monday to Saturday, 7—9 a.m., 10 a.m. to 11 p.m.; Sunday, 9 to noon, 1—4.30 p.m., 5.30—10 p.m.

3ZR: **West Coast Radio Society, Bright Street, Cobden, Greymouth.** 250 watts, 940 k.c., 319 m. Transmission hours: Monday to Friday, 7.30—8.30 a.m., 3—5 p.m., 6—7 p.m., 7.30—10 p.m.; Saturday, 7.30—8.30 a.m., 1.30—5 p.m., 6—11 p.m.; Sunday, noon to 1.30 p.m., 5.30—6.30 p.m., 7—9 p.m.

3YL: **The N.Z. Broadcasting Board, Gloucester St., Christchurch.** 250 watts, 1200 k.c., 250 m. Transmission hours: Week-days, 5—6 p.m., 7 —10 a.m.; Sunday, 6—10 p.m.

(Continued on next page)

NEW ZEALAND BROADCASTING STATIONS—(Continued from page 122)—

3ZM: **W. J. Green and J. Younger, 253 Brougham Street, Christchurch.** 100 watts, 1470 k.c., 204.1 m. Transmission hours: Monday, Tuesday, Thursday, 7.30—10 a.m., 5—6 p.m., 7—10 p.m.; Wednesday, 7.30—10 a.m., 5—6 p.m., 7—10.15 p.m.; Friday, 7.30—10 a.m.; Saturday, 7.30 a.m. to 2 p.m., 8 p.m. to midnight; Sunday, 11 a.m.—2 p.m., 5—6 p.m., 7—10 p.m.

4ZP: **R. T. Parsons, 155 Layard Street North, Invercargill.** 450 watts, 620 k.c., 483.6 m. Transmission hours: Monday to Friday, 12.30—1.30 p.m., 7—10 p.m.; Saturday, 7—10 p.m.; Sunday, 11 a.m. to noon, 6.30—10 p.m.

4YA: **N.Z. Broadcasting Board, Stuart Street, Dunedin.** 10 k.w., 790 k.c., 379.5 m. Transmission hours: Monday to Saturday, 7—9 a.m., 10 a.m. to 11 p.m.; Sunday 9 to noon, 1—4.30 p.m., 5.30—10 p.m.

4ZB: **Otago Radio Association, 180 Rattray Street, Dunedin.** 78 watts, 1010 k.c., 297 m. Transmission hours: Wednesday, 6.30—11 p.m.; Thursday, 6—11 p.m.; Sunday, 10 a.m. to noon.

4ZM: **McCracken and Walls, 17 George Street, Dunedin.** 100 watts, 1010 k.c., 297 m. Transmission hours: Monday, Wednesday, Thursday, Friday, 9—11.45 a.m., 1—2 p.m.; Tuesday, 9—11.45 a.m., 1—2 p.m., 6—11 p.m.; Saturday, 9 a.m. to noon, 5—10 p.m.; Sunday, 2—10 p.m.

4ZO: **Barnett's Radio Supplies, The Octagon, Dunedin.** 25 watts, 1010 k.c., 297 m. Transmission hours: Monday to Friday, noon to 1 p.m., 2—3 p.m., 5—6 p.m.; Monday, 8—11 p.m.; Friday, 7—11 p.m.; Saturday, noon to 1 p.m.

4YO: **The N.Z. Broadcasting Board, Stuart Street, Dunedin.** 200 watts, 1140 k.c., 263.2 m. Transmission hours: Week-days, 5—6 p.m., 7 —10 p.m.; Sunday, 6—10 p.m.

4ZL: **Radio Service Ltd., 243 Macandrew Road, Dunedin.** 100 watts, 1220 k.c., 245.9 m. Transmission hours: Monday and Thursday, 7—9 a.m., 7.30—11 p.m.; Tuesday, Wednesday and Friday, 7—9 a.m.; Saturday, 7—9 a.m., 7—11 p.m.; Sundays, 8—10 a.m.

4ZC: **John I. Bilton, Lowburn Ferry, Cromwell, Otago.** 45 watts, 1280 k.c., 234.2 m. Transmission hours: 7—9 p.m. daily.

4ZR: **Renton and Clark, Clyde Street, Balclutha.** 10 watts, 1340 k.c., 224 m. Transmission hours: Tuesday, 7.30—10 p.m.; Thursday, 7 —10 p.m.; Sunday, 10 a.m. to noon, 7.30—9.30 p.m.

N.Z. Radio Licenses in Force at 31st December, 1935

CLASS OF LICENSE	DISTRICTS				
	Auckland	Canterbury	Otago	Wellington	Total
Receivers	56,916	33,102	24,912	67,560	182,490
Dealers	398	225	144	389	1,156
Experimental (Amateur)	234	180	110	415	939
Experimental (Research)	2	—	—	2	4
Special	1	—	—	4	5
Free	171	68	49	104	392
Broadcasting	4	2	7	9	22
Totals	57,726	33,577	25,222	68,483	185,008

EXTRACTS FROM N.Z. RADIO REGULATIONS

Radio receiving licenses cost £1/10/- per annum.

Temporary licenses can be obtained for 10/- per week of 7 days or fraction thereof.

All licenses expire on March 31st of each year, and any licenses renewed within 3 months of March 31st have to pay the additional 12 months license at 2s. 1d. per calendar month.

Free licenses are issued to blind persons, to institutions, homes and asylums for blind persons.

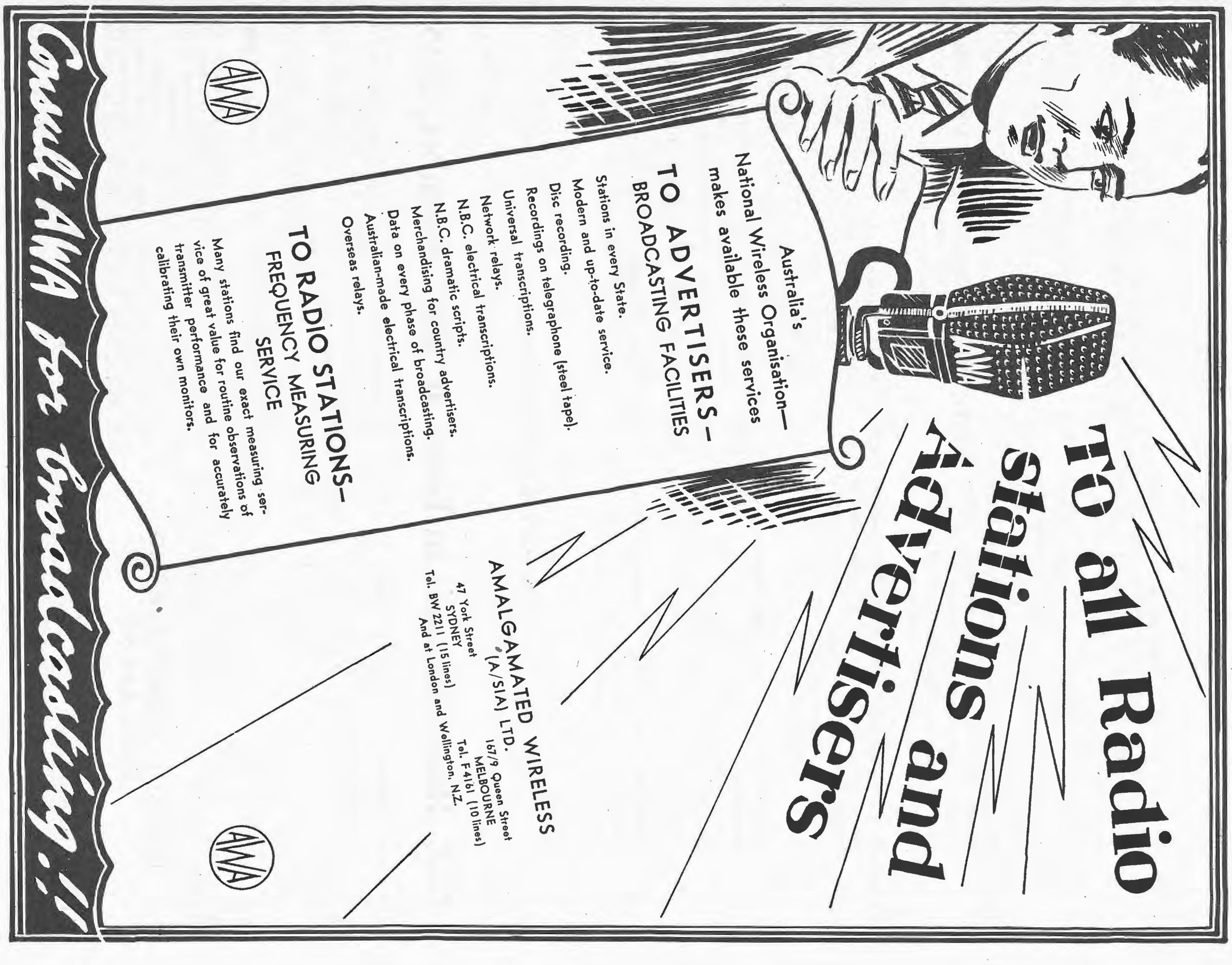
It is an offence against the Regulations for any receiving set to be in an oscillating condition, to the detriment of reception by other licensees.

The N.Z. Radio Regulations cover over 65 pages of printed matter.

The radio dealers licenses are divided into five classes. Class 1, 2, 3, and 5 are issued to persons to respect of a fixed place of business. Persons wishing to carry on business in more than one fixed place, shall obtain additional license.

Class 5 license may be issued to a person engaged in the repair and servicing of radio apparatus, and will entitle him to sell or offer for sale apparatus designed for wireless. Every radio licensed dealer shall exhibit for external observation a sign bearing the words "Licensed Radio Dealer."

Radio dealers license for Class 1 costs £15 per annum, Class 2, £7/10/- p.a., Class 3 £2 p.a., Class 4, £15 p.a.



Listeners' Licenses (All Classes) in Australia Since 1924

At end of	N.S.W. Licenses in force	N.S.W. Ratio to 100 of Population	VIC. Licenses in force	VIC. Ratio to 100 of Population	Q'LD. Licenses in force	Q'LD. Ratio to 100 of Population	S.A. Licenses in force	S.A. Ratio to 100 of Population	W.A. Licenses in force	W.A. Ratio to 100 of Population	TAS. Licenses in force	TAS. Ratio to 100 of Population	COMMONWEALTH Licenses in force	COMMONWEALTH Ratio to 100 of Population
1924.														
July	906	.04	187	.01	23	.003	74	.01			16	.008	1,206	.02
Aug.	6.945	.3	887	.05	160	.02	309	.05	333	.09	54	.02	8,688	.1
Sept.	13,861	.6	1,398	.08	356	.04	537	.1	576	.1	131	.06	16,859	.3
Oct.	16,721	.8	3,080	.2	456	.05	885	.16	784	.2	161	.08	22,087	.4
Nov.	22,442	.9	5,957	.3	533	.06	1,095	.2	1,301	.3	201	.09	31,529	.54
Dec.	26,071	1.1	8,327	.5	633	.07	1,345	.25	1,716	.4	244	.1	38,336	.66
1925.														
Jan.	28,397	1.2	10,975	.6	697	.08	1,579	.27	2,321	.6	305	.14	44,274	.76
Feb.	30,450	1.3	13,953	.8	825	.09	1,874	.34	2,756	.7	365	.17	50,223	.85
Mar.	31,796	1.4	16,459	.9	942	.11	2,198	.4	3,029	.8	429	.19	54,853	.93
Apr.	32,847	1.4	18,036	1.09	1,050	.12	2,507	.46	3,215	.9	478	.2	58,133	.99
May	33,906	1.5	19,383	1.1	1,177	.14	2,855	.5	3,392	.93	518	.23	61,231	1.04
June	34,857	1.54	20,290	1.22	1,267	.15	3,331	.62	3,562	.97	567	.26	63,874	1.08
July	35,504	1.57	21,357	1.28	1,362	.17	4,096	.77	3,679	1.02	607	.28	66,605	1.1
Aug.	37,565	1.6	23,776	1.4	1,704	.2	4,775	.89	3,943	1.09	720	.33	72,483	1.24
Sept.	38,892	1.7	26,232	1.5	2,229	.26	5,259	.97	4,083	1.1	790	.36	77,485	1.31
Oct.	37,203	1.6	28,442	1.7	2,892	.34	5,774	1.07	4,124	1.1	836	.38	79,271	1.34
Nov.	34,744	1.5	31,318	1.8	3,660	.43	6,099	1.1	4,179	1.1	853	.39	80,853	1.37
Dec.	34,911	1.5	33,988	2	4,141	.49	6,985	1.29	4,192	1.15	913	.41	85,130	1.44
1926.														
Jan.	34,108	1.5	38,323	2.2	4,476	.5	8,568	1.01	4,198	1.1	967	.44	90,640	1.5
Feb.	32,444	1.4	45,274	2.7	4,795	.5	9.734	1.7	3,959	1	1,013	.46	97,219	1.6
Mar.	33,188	1.4	49,402	2.9	5,247	.6	10,480	1.9	3,764	1	1,064	.5	103,145	1.7
Apr.	34,100	1.4	53,547	3.1	5,951	.6	11,029	2	3,759	1	1,114	.5	109,500	1.8
May	35,438	1.5	57,700	3.4	6,681	.7	11,624	2.1	3,877	1	1,171	.5	116,491	1.9
June	37,082	1.61	64,587	3.83	8,450	.98	12,657	2.27	4,003	1.07	1,281	.58	128,060	2.14
July	39,206	1.7	70,070	4.1	12,892	1.4	13,764	2.4	4,113	1.1	1,347	.6	141,392	2.3
Aug.	41,929	1.8	77,493	4.6	15,082	1.7	14,631	2.6	4,157	1.1	1,444	.6	154,736	2.5
Sept.	44,962	1.9	83,077	4.9	16,619	1.9	14,904	2.6	4,225	1.1	1,649	.7	165,436	2.7
Oct.	47,127	2.04	89,055	5.28	17,971	2.08	15,252	2.7	4,143	1.1	1,750	.8	175,298	2.9
Nov.	47,879	2.06	95,136	5.6	18,902	2.1	15,136	2.7	4,118	1.1	1,849	.8	183,020	3.02
Dec.	48,858	2.1	97,744	5.8	19,414	2.2	15,165	2.7	4,114	1.09	1,933	.92	187,228	3.09

Listeners' Licenses (All Classes) in Australia Since 1924

At end of	N.S.W. Licenses in force	N.S.W. Ratio to 100 of Population	VIC. Licenses in force	VIC. Ratio to 100 of Population	Q'LD. Licenses in force	Q'LD. Ratio to 100 of Population	S.A. Licenses in force	S.A. Ratio to 100 of Population	W.A. Licenses in force	W.A. Ratio to 100 of Population	TAS. Licenses in force	TAS. Ratio to 100 of Population	COMMONWEALTH Licenses in force	COMMONWEALTH Ratio to 100 of Population
1927.														
Jan.	50,301	2.2	101,635	5.9	20,082	2.3	15,469	2.7	4,047	1	2,008	.9	193,542	3.2
Feb.	51,154	2.2	104,428	6.1	20,425	2.3	15,773	2.7	4,014	1	2,078	1	197,872	3.2
Mar.	52,528	2.2	106,081	6.2	20,787	2.3	15,807	2.8	3,932	1	2,153	1	201,288	3.3
Apr.	54,561	2.3	108,732	6.3	21,335	2.4	15,738	2.8	3,890	1	2,259	1	206,515	3.4
May	57,251	2.4	113,977	6.6	22,287	2.5	16,061	2.8	3,874	1	2,351	1	215,801	3.5
June	59,880	2.55	118,965	6.95	23,249	2.63	16,791	2.96	3,903	1.03	2,461	1.14	225,249	3.68
July	62,869	2.68	122,443	7.15	23,957	2.71	17,503	3.09	3,922	1.04	2,592	1.20	233,286	3.82
Aug.	65,803	2.78	126,830	7.36	24,235	2.74	17,797	3.13	3,943	1.03	2,730	1.25	241,338	3.93
Sept.	69,212	2.93	130,236	7.56	24,699	2.79	18,329	3.22	3,987	1.04	2,912	1.38	249,375	4.06
Oct.	71,479	3.03	132,871	7.72	24,914	2.81	18,417	3.23	3,932	1.03	3,125	1.87	254,738	4.15
Nov.	72,162	3.04	133,746	7.75	25,203	2.82	18,645	3.27	3,911	1.02	3,343	1.60	257,010	4.17
Dec.	72,854	3.05	134,825	7.80	24,433	2.73	18,792	3.29	3,872	1.00	3,403	1.63	258,179	4.19
1928.														
Jan.	74,323	3.13	135,729	7.86	24,787	2.77	19,126	3.35	3,829	.99	2,510	1.20	260,304	4.22
Feb.	75,212	3.15	136,410	7.86	24,813	2.77	19,388	3.38	3,820	.98	2,720	1.30	262,363	4.23
Mar.	75,869	3.16	136,481	7.83	24,920	2.77	19,452	3.38	3,780	.96	2,838	1.31	263,340	4.22
Apr.	77,010	3.20	136,712	7.84	25,072	2.79	19,605	3.40	3,756	.96	2,912	1.34	265,067	4.25
May	78,698	3.27	136,496	7.84	25,239	2.80	19,969	3.46	3,740	.95	3,036	1.40	267,178	4.28
June	80,197	3.34	137,758	7.91	25,287	2.82	20,319	3.53	3,774	.96	3,172	1.46	270,507	4.33
July	82,872	3.45	139,023	7.98	25,685	2.86	20,736	3.60	3,798	.97	3,327	1.54	275,441	4.42
Aug.	85,196	3.55	141,344	8.11	25,736	2.86	21,088	3.66	3,844	.98	3,480	1.61	280,688	4.50
Sept.	87,622	3.63	142,597	8.15	25,673	2.84	21,305	3.70	3,848	.97	3,645	1.72	284,690	4.54
Oct.	88,783	3,67	141,988	8.12	25,566	2.83	21,514	3.73	3,844	.97	3,855	1.82	285,550	4.56
Nov.	90,177	3.72	143,250	8.19	25,235	2.77	22,019	3.81	3,830	.96	3,946	1.87	288,457	4.59
Dec.	91,709	3.78	141,890	8.11	25,224	2.77	22,120	3.81	3,814	.95	4,117	1.95	288,874	4.59
1929.														
Jan.	92,681	3.83	141,279	8.08	24,761	2.72	22,420	3.88	3,819	.96	4,204	1.99	289,164	4.60
Feb.	94,404	3.87	141,642	8.07	24,543	2.68	22,682	3.93	3,820	.95	4,198	1.99	291,289	4.61
Mar.	95,487	3.92	141,932	8.09	24,642	2.67	22,942	3.97	3,790	.94	4,327	2.05	293,120	4.64
Apr.	96,877	3.97	143,393	8.17	24,627	2.69	23,186	4.01	3,767	.93	4,467	2.12	296,317	4.69
May	98,550	4.04	143,344	8.17	24,681	2.70	23,573	4.09	3,799	.94	4,604	2.17	298,551	4.73
June	101,012	4.13	142,750	8.15	24,744	2.70	24,021	4.15	3,890	.96	4,782	2.21	301,199	4.75
July	102,787	4.20	142,293	8.08	24,856	2.71	24,346	4.20	3,936	.97	4,974	2.30	303,192	4.78
Aug.	104,580	4.28	140,529	7.98	24,910	2.72	24,474	4.23	3,938	.97	5,131	2.37	303,562	4.79
Sept.	105,549	4.29	140,309	7.94	24,218	2.63	24,647	4.25	4,122	1.01	5,311	2.49	304,156	4.78
Oct.	107,489	4.37	144,295	8.16	23,505	2.54	24,737	4.27	4,353	1.06	5,441	2.56	309,820	4.86
Nov.	108,244	4.40	143,466	8.12	23,204	2.50	25,166	4.34	4,658	1.13	5,575	2.62	310,313	4.87
Dec.	107,503	4.37	144,141	8.16	22,449	2.42	25,481	4.38	4,727	1.15	5,680	2.67	309,981	4.86

Listeners' Licenses (All Classes) in Australia Since 1924

At end of	N.S.W. Licenses in force	N.S.W. Ratio to 100 of Population	VIC. Licenses in force	VIC. Ratio to 100 of Population	Q'LD. Licenses in force	Q'LD. Ratio to 100 of Population	S.A. Licenses in force	S.A. Ratio to 100 of Population	W.A. Licenses in force	W.A. Ratio to 100 of Population	TAS. Licenses in force	TAS. Ratio to 100 of Population	COMMONWEALTH Licenses in force	COMMONWEALTH Ratio to 100 of Population
1930														
Jan.	108,835	4.41	144,165	8.13	22,388	2.41	25,337	4.37	4,759	1.15	5,590	2.63	311,074	4.86
Feb.	108,780	4.40	142,196	8.02	22,422	2.41	25,140	4.34	4,857	1.17	5,606	2.63	309,001	4.83
Mar.	109,193	4.42	141,853	8.00	22,589	2.43	25,265	4.36	5,023	1.21	5,649	2.66	309,572	4.84
Apr.	109,256	4.41	140,945	7.93	22,476	2.41	25,253	4.35	5,163	1.24	5,668	2.59	308,711	4.81
May	110,682	4.47	141,081	7.94	22,797	2.45	25,448	4.39	5,552	1.33	5,762	2.64	311,322	4.87
June	111,253	4.49	140,072	7.88	23,335	2.51	25,729	4.43	5,755	1.38	6,048	2.76	312,192	4.88
July	115,345	4.65	143,716	8.00	23,628	2.54	27,102	4.67	6,631	1.59	6,582	3.00	323,004	5.03
Aug.	120,673	4.86	147,180	8.25	24,217	2.59	28,227	4.86	7,298	1.25	7,442	3.45	335,037	5.21
Sept.	117,915	4.74	144,925	8.13	24,193	2.57	28,002	4.82	7,547	1.80	7,587	3.52	330,169	5.13
Oct.	118,189	4.75	143,819	8.07	24,214	2.57	28,082	4.83	7,668	1.81	7,655	3.55	329,627	5.12
Nov.	117,885	4.74	142,421	7.99	24,235	2.57	28,266	4.86	7,809	1.86	7,691	3.57	328,307	5.10
Dec.	119,131	4.79	141,687	7.95	24,418	2.59	28,447	4.90	8,030	1.92	7,752	3.59	329,465	5.12
1931.														
Jan.	118,507	4.78	140,142	7.87	24,297	2.59	28,198	4.87	8,103	1.95	7,755	3.60	326,993	5.08
Feb.	118,720	4.77	138,908	7.79	24,193	2.57	28,407	4.90	8,230	1.97	7,812	3.63	326,270	5.06
Mar.	119,398	4.79	138,784	7.76	24,241	2.57	28,723	4.95	8,388	2.01	7,879	3.58	327,413	5.07
Apr.	120,612	4.82	138,152	7.71	24,542	2.59	29,205	5.02	8,645	2.05	7,978	3.61	329,134	5.08
May	120,642	4.84	137,306	7.64	24,256	2.56	29,729	5.12	8,789	2.10	8,093	3.68	328,815	5.09
June	122,470	4.91	137,005	7.66	24,108	2.55	30,238	5.21	9,075	2.17	8,232	3.74	331,128	5.12
July	122,259	4.88	136,183	7.58	24,320	2.55	30,681	5.26	9,219	2.19	8,256	3.76	330,918	5.10
Aug.	120,583	4.81	133,965	7.44	24,182	2.54	30,449	5.22	9,364	2.23	8,077	3.68	326,620	5.03
Sept.	120,686	4.82	132,563	7.37	24,790	2.58	30,679	5.26	9,621	2.29	8,260	3.77	326,599	5.02
Oct.	122,039	4.87	132,968	7.39	25,550	2.66	31,155	5.34	9,961	2.37	8,506	3.88	330,179	5.08
Nov.	123,372	4.92	133,709	7.44	25,931	2.70	31,600	5.42	10,433	2.48	8,669	3.91	333,714	5.13
Dec.	125,409	5.00	134,173	7.46	26,449	2.76	32,160	5.51	10,800	2.57	8,667	3.96	337,654	5.19
1932.														
Jan.	127,734	5.09	134,523	7.48	26,775	2.79	32,560	5.58	11,046	2.63	8,756	4.00	341,394	5.25
Feb.	130,866	5.20	136,211	7.57	27,341	2.84	33,049	5.66	11,269	2.67	8,819	4.02	347,555	5.33
Mar.	132,861	5.28	135,995	7.56	27,671	2.88	33,757	5.78	11,489	2.73	8,888	4.05	350,661	5.38
Apr.	135,295	5.37	138,388	7.68	28,174	2.92	34,608	5.92	11,841	2.81	9,127	4.09	357,433	5.48
May	138,329	5.49	139,397	7.74	28,656	2.97	35,815	6.12	12,234	2.90	9,341	4.18	363,772	5.56
June	141,745	5.63	139,592	7.75	29,060	3.02	37,227	6.36	12,745	3.02	9,567	4.28	369,936	5.67
July	145,101	5.76	141,032	7.82	29,293	3.04	38,206	6.53	13,292	3.15	9,835	4.40	376,759	5.77
Aug.	148,422	5.88	143,270	7.94	29,784	3.09	39,371	6.78	13,827	2.28	10,113	4.56	384,787	5.88
Sept.	150,415	5.95	145,316	8.05	30,051	3.11	40,178	6.86	14,291	3.39	10,301	4.65	390,552	5.97
Oct.	152,996	6.06	147,652	8.18	30,375	3.14	41,039	7.01	14,950	3.55	10,478	4.73	397,490	6.08
Nov.	157,506	6.23	151,498	8.39	31,534	3.24	42,312	7.22	15,568	3.68	10,846	4.90	409,264	6.25
Dec.	159,972	6.33	156,307	8.66	32,183	3.31	43,362	7.40	16,127	3.79	11,229	5.08	419,180	6.40

Listeners' Licenses (All Classes) in Australia Since 1924

At end of	N.S.W. Licenses in force	N.S.W. Ratio to 100 of Population	VIC. Licenses in force	VIC. Ratio to 100 of Population	Q'LD. Licenses in force	Q'LD. Ratio to 100 of Population	S.A. Licenses in force	S.A. Ratio to 100 of Population	W.A. Licenses in force	W.A. Ratio to 100 of Population	TAS. Licenses in force	TAS. Ratio to 100 of Population	COMMONWEALTH Licenses in force	COMMONWEALTH Ratio to 100 of Population
1933.														
Jan.	163,139	6.45	158,975	8.81	33,037	3.40	44,594	7.61	16,639	3.94	11,437	5.17	427,821	6.53
Feb.	165,282	6.52	161,244	8.92	33,768	3.46	45,605	7.78	17,136	4.05	11,597	5.24	434,632	6.62
Mar.	169,034	6.65	164,393	9.09	34,613	3.55	46,670	7.90	17,691	4.18	11,978	5.42	444,379	6.77
Apr.	171,403	6.72	164,600	9.09	34,904	3.59	47,547	8.03	18,283	4.32	12,051	5.35	448,788	6.83
May	175,125	6.88	167,682	9.17	35,554	3.65	48,900	8.27	19,453	4.60	12,293	5.56	459,007	7.00
June	178,387	7.00	171,318	9.46	36,314	3.72	50,261	8.49	20,604	4.87	12,593	5.59	469,477	7.14
July	182,312	7.15	176,195	9.73	37,000	3.79	51,484	8.70	21,409	5.08	12,884	5.72	481,374	7.32
Aug.	185,864	7.12	178,721	9.83	38,097	4.03	52,682	9.00	22,599	5.16	13,270	5.83	491,233	7.41
Sept.	189,386	7.26	181,425	9.98	38,894	4.11	53,723	9.18	23,452	5.35	13,461	5.91	500,341	7.55
Oct.	192,966	7.29	183,507	10.08	39,902	4.21	54,532	9.31	23,999	5.47	13,628	5.99	508,534	6.67
Nov.	195,509	7.49	184,749	10.15	40,480	4.29	55,057	9.40	24,707	5.63	13,785	6.06	514,287	7.76
Dec.	197,869	7.56	184,861	10.14	40,918	4.31	55,762	9.51	25,325	5.76	13,893	6.11	518,628	7.81
1934.														
Jan.	201,654	7.71	186,717	10.25	42,021	4.43	56,539	9.64	25,985	5.91	14,087	6.19	527,003	7.93
Feb.	204,618	7.82	187,918	10.31	44,280	4.66	57,322	9.77	26,457	6.01	14,292	6.28	534,887	8.05
Mar.	218,770	8.34	199,660	10.94	49,258	5.19	61,252	9.91	27,202	6.18	14,554	6.27	543,715	8.17
Apr.	212,903	8.12	194,746	10.67	47,076	4.96	59,548	10.15	28,136	6.39	15,014	6.47	557,423	8.37
May	218,770	8.34	199,660	10.94	49,258	5.19	61,229	10.42	29,540	6.71	15,658	6.75	574,115	8.62
June	227,289	8.66	207,324	11.36	52,185	5.50	64,303	10.94	31,476	7.15	16,582	7.14	599,159	9.00
July	238,625	9.07	211,442	11.57	54,906	5.80	66,938	11.38	33,293	7.55	17,470	7.60	622,674	9.34
Aug.	247,757	9.42	218,442	11.94	57,414	5.99	69,141	11.75	34,639	7.83	18,238	8.00	645,631	9.67
Sept.	251,967	9.57	220,290	12.04	59,074	6.16	69,838	11.87	35,279	7.98	18,400	8.07	654,848	9.81
Oct.	256,117	9.73	223,999	12.24	60,719	6.34	70,863	12.05	36,238	8.20	18,627	8.17	666,563	9.98
Nov.	259,645	9.87	225,670	12.33	61,847	6.45	71,587	12.17	36,899	8.34	18,777	8.23	674,425	10.10
Dec.	262,988	9.97	227,135	12.33	62,721	6.54	72,476	12.31	37,417	8.46	18,897	8.29	681,634	10.19
1935.														
Jan.	265,887	10.08	227,760	12.41	63,857	6.65	73,171	12.43	38,004	8.59	19,086	8.38	687,765	10.28
Feb.	269,394	10.22	229,756	12.52	63,703	6.64	73,756	12.53	38,550	8.71	19,320	8.48	694,479	10.38
Mar.	272,342	10.29	232,116	12.63	64,605	6.74	74,408	12.62	39,249	8.87	19,486	8.42	702,206	10.47
Apr.	274,364	10.37	233,913	12.73	65,589	6.83	75,294	12.77	39,968	9.03	19,653	8.53	708,781	10.57
May	277,921	10.50	236,853	12.89	66,931	6.97	76,286	12.94	40,650	9.18	19,957	8.62	718,598	10.71
June	279,166	10.53	237,247	12.90	67,546	7.02	76,515	12.97	41,257	9.29	20,121	8.76	721,852	10.74
July	280,731	10.59	239,694	13.03	69,034	7.17	77,756	13.18	42,249	9.51	20,495	8.92	729,959	10.87
Aug.	282,147	10.64	242,036	13.16	70,002	7.27	78,346	13.28	43,221	9.73	20,848	9.07	736,600	10.97
Sept.	285,641	10.76	244,716	13.31	71,387	7.37	79,142	13.41	44,057	9.88	21,282	9.30	746,225	11.09
Nov.	291,924	10.99	249,351	13.56	73,785	7.62	81,024	13.56	44,836	10.06	21,615	9.45	754,250	11.22
Dec.	294,232	11.06	250,758	13.63	74,911	7.72	81,707	13.73	45,580	10.22	21,951	9.59	763,598	11.35
Oct.	288,402	10.87	246,587	13.36	72,786	7.52	80,088	13.85	46,219	10.34	22,244	9.73	770,152	11.43

Monthly Totals by States

Broadcast Listeners' License Figures for 1935

Figures in brackets alongside New Issues, Renewals, and Cancellations, indicate the free licenses included in the totals of those respective columns.

To obtain the paid licenses, deduct those figures in brackets from the figure on the left. The totals of free licenses in the last column on the right should be deducted from the monthly total column to obtain the net paid licenses in force. Experimental licenses are paid and are included in all totals.

	New Issues	Renewals	Total Issues	Cancellations	Monthly Total	Net Increase	Popln. Ratio	Total Experimental	Includes Free Blind
JANUARY									
N.S.W.	5,160 (17)	14,729 (87)	19,889	2,261 (4)	265,887	2,899	10.08	491	479
Victoria	2,974 (4)	11,537 (88)	14,511	2,349 (5)	227,760	625	12.41	354	509
Queensland	1,441 (2)	3,364 (15)	4,805	305 (1)	63,857	1,136	6.65	164	153
S. Aust.	1,128 (1)	3,735 (22)	4,863	433 (4)	73,171	695	12.43	145	202
W. Aust.	660 (3)	1,886 (13)	2,546	73 (28)	38,004	587	8.59	72	92
Tasmania	483	1,067 (11)	1,550	294 (4)	19,086	189	8.38	36	65
C'wealth	11,846 (27)	36,318 (236)	48,164	5,715 (46)	687,765	6,131	10.28	1,262	1,500
FEBRUARY									
N.S.W.	4,403 (11)	14,479 (46)	18,882	896 (3)	269,394	3,507	10.22	490	487
Victoria	2,915 (11)	12,541 (42)	15,456	919 (5)	229,756	1,996	12.52	343	515
Queensland	1,314 (5)	3,283 (11)	4,597	1,468 (1)	63,703	154	6.64	157	157
S. Aust.	1,129 (4)	3,376 (20)	4,505	544 (4)	73,756	585	12.53	143	202
W. Aust.	675 (4)	1,585 (14)	2,260	129	38,550	546	8.71	71	96
Tasmania	504 (8)	666 (2)	1,170	270	19,320	234	8.48	33	73
C'wealth	10,940 (43)	35,930 (135)	46,870	4,226 (13)	694,479	6,714	10.38	1,237	1,530
MARCH									
N.S.W.	4,612 (6)	14,980 (47)	19,592	1,664 (2)	272,342	2,948	10.29	494	491
Victoria	3,883 (7)	12,938 (47)	16,821	1,523 (3)	232,116	2,360	12.63	353	519
Queensland	1,270	3,711 (21)	4,981	368	64,605	902	6.74	160	157
S. Aust.	1,233	3,928 (21)	5,161	581 (2)	74,408	652	12.62	144	200
W. Aust.	861 (6)	1,922 (11)	2,783	162	39,249	699	8.87	68	102
Tasmania	487 (3)	828 (12)	1,315	321	19,486	166	8.42	32	76
C'wealth	12,346 (22)	38,307 (159)	50,653	4,619 (7)	702,206	7,727	10.47	1,251	1,545
APRIL									
N.S.W.	4,554 (7)	14,723 (27)	19,277	2,532 (2)	274,364	2,022	10.37	510	496
Victoria	4,070 (53)	13,996 (12)	18,066	2,273	233,913	1,797	12.73	358	572
Queensland	1,438 (7)	3,453 (11)	4,891	454 (1)	65,589	984	6.83	168	163
S. Aust.	1,394 (4)	4,472 (18)	5,866	508	75,294	886	12.77	149	204
W. Aust.	913 (3)	2,272 (7)	3,185	194 (1)	39,968	719	9.03	75	104
Tasmania	512 (1)	841 (2)	1,353	345 (2)	19,653	167	8.53	32	75
C'wealth	12,881 (75)	39,757 (77)	52,638	6,306 (6)	708,781	6,575	10.57	1,292	1,614
MAY									
N.S.W.	5,798 (5)	20,141 (26)	25,939	2,241 (4)	277,921	3,557	10.50	511	497
Victoria	5,116 (12)	18,652 (54)	23,768	2,176 (20)	236,853	2,940	12.89	347	564
Queensland	1,955 (3)	4,847 (14)	6,802	613 (4)	66,931	1,342	6.97	174	162
S. Aust.	1,619 (2)	6,244 (29)	7,863	627	76,286	992	12.94	150	206
W. Aust.	1,296 (14)	3,242 (11)	4,538	614	40,650	682	9.18	79	118
Tasmania	671 (2)	1,298 (3)	1,969	367 (5)	19,957	304	8.62	32	77
C'wealth	16,455 (38)	54,424 (137)	70,879	6,638 (28)	718,598	9,817	10.71	1,293	1,624
JUNE									
N.S.W.	5,768 (11)	22,777 (41)	28,545	4,523 (1)	279,166	1,245	10.53	518	507
Victoria	4,716 (2)	20,482 (40)	25,198	4,323 (5)	237,247	394	12.90	361	561
Queensland	1,913 (3)	5,739 (18)	7,652	1,298 (2)	67,546	615	7.02	177	163
S. Aust.	1,661 (2)	7,423 (18)	9,084	1,432 (1)	76,515	229	12.97	150	207
W. Aust.	1,298 (5)	3,798 (8)	5,096	691	41,257	607	9.29	81	123
Tasmania	744 (1)	1,682 (8)	2,426	580 (3)	20,121	164	8.76	33	75
C'wealth	16,101 (24)	61,901 (133)	78,002	12,847 (12)	721,852	3,254	10.74	1,320	1,636

MONTHLY TOTALS BY STATES—(Continued)—

	New Issues	Renewals	Total Issues	Can-cellations	Monthly Total	Net Increase	Popln. Ratio	Total Experi-mental	Includes Free Blind
JULY									
N.S.W.	6,384 (6)	27,944 (29)	34,328	4,819 (1)	280,731	1,565	10.59	520	512
Victoria	5,463 (18)	22,230 (37)	27,693	3,016	239,694	2,447	13.03	359	579
Queensland	2,203 (8)	6,411 (7)	8,614	715 (1)	69,034	1,488	7.17	177	170
S. Aust.	1,912 (3)	8,304 (20)	10,216	671 (3)	77,756	1,241	13.18	155	207
W. Aust.	1,409 (7)	4,160 (6)	5,569	417	42,249	992	9.51	83	130
Tasmania	891 (2)	1,893 (5)	2,784	517	20,495	374	8.92	35	77
C'wealth	18,262 (44)	70,942 (104)	89,204	10,155 (5)	729,959	8,107	10.87	1,329	1,675
AUGUST									
N.S.W.	6,077 (11)	26,160 (37)	32,237	4,661 (5)	282,147	1,416	10.64	534	518
Victoria	5,470 (4)	23,876 (45)	29,346	3 128 (2)	242,036	2,342	13.16	356	581
Queensland	1,811 (8)	5,954 (10)	7,765	843	70,002	968	7.27	179	178
S. Aust.	1,734 (6)	8,710 (16)	10,444	1,144	78,346	590	13.28	155	213
W. Aust.	1,169 (4)	4,015 (2)	5,184	197 (4)	43,221	972	9.73	80	130
Tasmania	1,003 (1)	1,915 (3)	2,918	650	20,848	353	9.07	36	78
C'wealth	17,264 (34)	70,630 (113)	87,894	10,623 (11)	736,600	6,641	10.97	1,340	1,698
SEPTEMBER									
N.S.W.	4,903 (3)	21,294 (20)	26,197	1,409 (2)	285,641	3,494	10.76	536	519
Victoria	4,510 (5)	16,758 (31)	21,268	1,830 (1)	244,716	2,680	13.31	375	585
Queensland	1,754 (5)	5,039 (10)	6,793	369 (4)	71,387	1,385	7.37	185	179
S. Aust.	1,339 (5)	4,933 (8)	6,272	543	79,142	796	13.41	157	218
W. Aust.	1,009 (7)	2,921 (2)	3,930	173	44,057	836	9.88	80	137
Tasmania	782 (2)	1,110 (3)	1,892	348	21,282	434	9.30	37	80
C'wealth	14,297 (27)	52,055 (74)	66,352	4,672 (7)	746,225	9,625	11.09	1,370	1,718
OCTOBER									
N.S.W.	4,687 (7)	19,619 (27)	24,306	1,926 (3)	288,402	2,761	10.87	542	523
Victoria	4,429 (11)	17,182 (26)	21,611	2,558 (5)	246,587	1,871	13.36	372	591
Queensland	1,727 (8)	5,001 (5)	6,728	328	72,786	1,399	7.52	179	187
S. Aust.	1,526 (1)	4,528 (4)	6,054	644 (1)	80,024	882	13.56	160	218
W. Aust.	1,056 (6)	2,947 (4)	4,003	277	44,836	779	10.06	80	143
Tasmania	693 (3)	1,023 (3)	1,716	360	21,615	333	9.45	37	83
C'wealth	14,118 (36)	50,300 (69)	64,418	6,093 (9)	754,250	8,025	11.22	1,370	1,745
NOVEMBER									
N.S.W.	4,574 (11)	19,497 (29)	24,071	1,052 (6)	291,924	3,522	10.99	546	528
Victoria	4,085 (13)	15,466 (20)	19,551	1,321 (10)	249,351	2,764	13.56	376	594
Queensland	1,577 (2)	4,626 (11)	6,203	578	73.785	999	7.62	180	189
S. Aust.	1,367 (4)	4,341 (9)	5.708	384	81,007	983	13.73	161	222
W. Aust.	985 (5)	2,901 (4)	3,886	241	45,580	744	10.22	83	148
Tasmania	696 (5)	944 (5)	1,640	360 (2)	21,951	336	9.59	37	86
C'wealth	13,284 (40)	47,775 (78)	61,059	3,936 (18)	763,598	9,348	11.35	1,383	1,767
DECEMBER									
N.S.W.	4,043 (14)	16,926 (17)	20,969	1,735	294,232	2,308	11.06	546	542
Victoria	3,533 (7)	13,935 (9)	17,468	2,126 (3)	250,758	1,407	13.63	376	598
Queensland	1,432 (7)	3,648 (4)	5,080	306 (1)	74,911	1,126	7.72	180	195
S. Aust.	1,423 (1)	4,329 (5)	5,752	642	81,788	781	13.85	159	223
W. Aust.	845 (4)	2,394 (2)	3,239	206	46,219	639	10.34	88	152
Tasmania	551 (5)	960 (1)	1,511	258	22,244	293	9.73	38	91
C'wealth	11,827 (38)	42,192 (38)	54,019	5,273 (4)	770,152	6,554	11.43	1,387	1,801

Commonwealth Monthly Totals of Broadcast Listeners' License Figures for 1935

	New Issues	Renewals	Total Issues	Can-cellations	Monthly Total	Net Increase	Popln. Ratio	Totals Experi-mental	Include Free Blind
January	11,846	36,318	48,164	5,715	687,765	6,131	10.28	1,262	1,500
February	10,940	35,930	46,870	4,226	694,479	6,714	10.38	1,237	1,530
March	12,346	38,307	50,653	4,619	702,206	7,727	10.47	1,251	1,545
April	12,881	39,757	52,638	6,306	708,781	6,575	10.57	1,292	1,614
May	16,455	54,424	70,879	6,638	718,598	9,817	10.71	1,293	1,624
June	16,101	61,901	78,002	12,847	721,852	3,254	10.74	1,320	1,636
July	18,262	70,942	89,204	10,155	729,959	8,107	10.87	1,329	1,675
August	17,264	70,630	87,894	10,623	736,600	6,641	10.97	1,340	1,698
September	14,297	52,055	66,352	4,672	746,225	9,625	11.09	1,370	1,718
October	14,118	50,300	64,418	6,093	754,250	8,025	11.22	1,370	1,745
November	13,284	47,775	61,059	3,936	763,598	9,348	11.35	1,383	1,767
December	11,827	42,192	54,019	5,273	770,152	6,554	11.43	1,387	1,801
Totals	169,621	600,531	770,152	81,103	8,734,465	88,518	130.08	15,834	19,853

Listeners' License Figures in Force in Areas Within 50 Miles of Principal Cities and Towns

Quarter Ended 31st March, 1935

N.S.W. and F.C.T.

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Homes.
Sydney	198,597	1,441,811	13.77	58
Remainder of State	73,745	1,203,841	6.12	27
State (inc. F.C.T.)	272,342	2,645,652	10.29	44
Albury—				
N.S.W. Sec.	2,636	30,792	8.56	38
Vic. Sec.	2,495	38,016	6.56	28
Bathurst	5,596	93,390	5.99	25
Broken Hill (exc. S.A.)	2,154	28,257	7.62	30
Canberra— (inc. N.S.W.) ..	2,434	33,586	7.25	31
Corowa—				
N.S.W. Sec.	2,924	32,168	9.09	41
Vic. Sec	2,833	48,963	5.78	24
Dubbo	1,767	31,277	5.65	25
Goulburn	3,862	61,541	6.28	28
Grafton	1,997	42,314	4.72	21
Gunnedah	2,190	47,214	4.64	21
Lismore—				
N.S.W. Sec.	3,867	90,680	4.26	20
Q'ld. Sec.	196	5,812	3.37	14
Moss Vale	9,256	114,179	8.11	35
Newcastle	23,814	242,606	9.81	42
Orange	3,461	79,855	4.33	19
Tamworth	2,519	50,312	5.01	23
Wagga	4,442	73,086	6.08	28
Wollongong—				
Inc. Sydney	195,967	1,392,480	14.07	58
Exc. Sydney	15,199	147,073	10.34	42

Victoria

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Homes.
Melbourne	180,688	1,203,822	15.00	62
Remainder of State	51,428	633,767	8.11	34
State	232,116	1,837,589	12.63	52
Ballarat	17,941	161,826	11.09	44
Bendigo	8,811	126,454	6.96	27
Geelong—				
Inc. Melbourne .	182,280	1,148,212	15.87	66
Exc. Melbourne .	19,318	156,164	12.37	52
Hamilton	4,324	55,555	7.77	33
Horsham	3,369	44,380	7.59	32
Mildura—				
Vic. Sec.	1,967	23,976	8.28	36
N.S.W. Sec.	253	3,584	7.06	28
Sale	4,019	49,869	8.05	33
Shepparton—				
Vic. Sec.	6,135	79,996	7.61	31
N.S.W. Sec.	276	3,085	8.95	35
Swan Hill—				
Vic. Sec.	2,013	29,583	6.80	29
N.S.W. Sec.	269	5,490	4.90	22

Queensland

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Homes.
Brisbane	42,101	400,684	10.50	45
Remainder of State	22,504	559,068	4.02	17
State	64,605	959,752	6.74	29
Ayr	1,999	37,957	5.26	22
Cairns	898	48,850	1.87	7
Mackay	944	29,065	3.24	14
Maryborough	2,580	53,527	4.82	19
Rockhampton	3,327	47,944	6.93	30
Toowoomba	8,337	123,059	6.77	30
Townsville	2,012	40,055	5.02	22
Warwick—				
Q'ld. Sec.	4,953	84,287	5.87	26
N.S.W. Sec.	125	4,052	3.08	11

South Australia

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Homes.
Adelaide	57,327	393,587	14.56	58
Remainder of State	17,081	195,699	8.73	39
State (inc. N.T.) .	74,408	589,286	12.62	52
Crystal Brook	6,135	50,128	12.23	52
Port Lincoln	803	7,196	11.15	48
Port Pirie	4,804	43,330	11.08	49
Mt. Gambier—				
S.A. Sec.	969	17,181	5.64	23
Vic. Sec.	1,066	7,922	13.45	56
Murray Bridge (ex. Metrop. area)	5,830	72,910	8.00	33
Renmark	1,627	21,501	7.57	33

Western Australia

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Homes.
Perth	29,601	238,407	12.42	53
Remainder of State	9,648	204,299	4.72	19
State	39,249	442,706	8.86	37
Albany	626	9,416	6.64	25
Bunbury	1,645	33,848	4.86	19
Collie	1,622	35,470	4.57	17
Geraldton	477	9,984	4.79	22
Kalgoorlie	1,079	23,257	4.64	18
Katanning	1,320	14,537	9.08	38
Merredin	898	15,031	5.97	25
Narrogin	754	15,847	4.76	20
Northam— (exc. Perth)	1,498	37,782	3.96	17
Wagin	1,039	17,767	5.84	25
Wiluna	170	10,348	1.64	5

Tasmania

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Homes.
Hobart	10,758	101,383	10.61	46
Remainder of State	8,728	130,070	7.48	32
State	19,486	231,453	8.42	36
Burnie	3,692	48,377	7.63	34
Devonport	7,079	86,597	8.17	35
Launceston	6,598	82,196	8.02	34
Queenstown	744	9,719	7.65	31
Ulverstone	3,323	80,697	4.11	18

Listeners' License Figures in Force in Areas Within 50 Miles of Principal Cities and Towns

Quarter Ended June 30th, 1935

N.S.W. and F.C.T.

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Ratio of Licenses to 100 of Homes.
Sydney	203,782	1,442,092	14.13	60
Remainder of State	75,384	1,208,669	6.23	27
State (inc. F.C.T.)	279,166	2,650,761	10.52	45
Albury—				
N.S.W. Sec.	2,646	30,792	8.59	39
Vic. Sec.	2,547	38,016	6.69	28
Bathurst	5,819	93,390	6.23	26
Broken Hill— (Exc. S.A.)	2,144	28,257	7.59	30
Canberra— (Inc. N.S.W.)	2,433	33,586	7.24	31
Corowa—				
N.S.W. Sec.	2,924	32,168	9.09	41
Vic. Sec.	2,979	48,963	6.08	25
Dubbo	1,820	31,277	5.81	26
Goulburn	3,925	61,541	6.38	28
Grafton	2,097	42,314	4.95	22
Gunnedah	2,332	47,214	4.94	23
Lismore—				
N.S.W. Sec.	3,929	90,680	4.33	20
Q'ld. Sec.	206	5,812	3.54	14
Moss Vale	9,574	114,179	8.38	36
Newcastle	24,792	242,606	10.22	44
Orange	3,542	79,855	4.44	19
Wagga	4,551	73,086	6.23	29
Tamworth	2,682	50,312	5.33	24
Wollongong—				
Inc. Sydney	200,973	1,392,480	14.43	59
Exc. Sydney	15,734	147,073	10.70	44

Victoria

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Ratio of Licenses to 100 of Homes.
Melbourne	185,906	1,203,858	15.44	63
Remainder of State	51,341	635,505	8.07	33
State Total	237,247	1,839,363	12.90	54
Ballarat	17,858	161,826	11.03	44
Bendigo	8,950	126,454	7.07	28
Geelong—				
Inc. Mel.	185,933	1,148,212	16.19	68
Exc. Mel.	19,527	156,164	12.50	53
Hamilton	4,349	55,555	7.82	34
Horsham	3,413	44,380	7.69	32
Mildura—				
Vic. Sec.	1,998	23,976	8.33	36
N.S.W. Sec.	262	3,584	7.31	29
Sale	4,097	49,869	8.21	34
Shepparton—				
Vic. Sec.	6,230	79,996	7.78	31
N.S.W. Sec.	271	3,085	8.78	37
Swan Hill—				
Vic. Sec.	2,103	29,583	7.10	31
N.S.W. Sec.	263	5,490	4.79	21

Queensland

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Ratio of Licenses to 100 of Homes.
Brisbane	44,480	402,870	11.04	47
Remainder of State	23,066	559,343	4.12	18
State Total	67,546	962,213	7.02	30
Ayr	2,089	41,529	5.03	22
Cairns	954	48,850	1.95	8
Mackay	957	29,065	3.28	14
Maryborough	2,716	53,527	5.07	20
Rockhampton	3,445	47,944	7.18	31
Toowoomba	8.832	123,059	7.17	32
Townsville	2,094	40,055	5.22	23
Warwick—				
Q'ld. Sec.	5,299	84,287	6.28	28
N.S.W. Sec.	128	4,052	3.16	11

South Australia

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Ratio of Licenses to 100 of Homes.
Adelaide	59,110	393,508	15.02	60
Remainder of State— (inc. N.T.)	17,405	196,411	8.86	39
State (inc. N.T.)	76,515	589,919	12.97	54
Crystal Brook	6,188	50,128	12.34	53
Port Lincoln	804	7,196	11.17	48
Port Pirie	4,848	43,330	11.11	49
Mt. Gambier—				
S.A. Sec.	1,006	17,181	5.85	24
Vic. Sec.	1,102	7,922	13.91	58
Murray Bridge (ex. Metrop. area)	6,114	72,910	8.38	33
Renmark	1,696	21,501	7.88	32

Western Australia

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Ratio of Licenses to 100 of Homes.
Perth	31,201	243,172	12.83	55
Remainder of State	10,056	200,900	5.00	21
State Total	41,257	444,072	9.29	38
Albany	684	9,416	7.26	27
Bunbury	1,815	33,848	5.36	21
Collie	1,791	35,470	5.05	19
Geraldton	503	9,984	5.04	23
Kalgoorlie	1,089	23,257	4.68	18
Katanning	1,434	14,537	9.86	41
Merredin	937	15,031	6.23	26
Narrogin	821	15,847	5.18	22
Northam, ex Perth	1,615	37,782	4.27	18
Wagin	1,122	17,767	6.31	27
Wiluna	206	10,348	2.00	7

Tasmania

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Ratio of Licenses to 100 of Homes.
Hobart	11,221	99,911	11.23	48
Remainder of State	8,900	129,800	6.86	30
State Total	20,121	229,711	8.76	38
Burnie	3,864	48,377	7.99	35
Devonport	7,408	86,597	8.55	37
Launceston	6,890	82,196	8.38	36
Queenstown	782	9,719	8.05	32
Ulverstone	3,471	80,697	4.30	19

Listeners' License Figures in Force in Areas Within 50 Miles of Principal Cities and Towns

Quarter Ended September 30th, 1935

N.S.W. and F.C.T.

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Ratio of Licenses to 100 of Homes.
Sydney	207,725	1,443,527	14.39	61
Remainder of State	77,916	1,210,519	6.43	28
State (inc. F.C.T.)	285,641	2,654,046	10.76	46
Albury—				
N.S.W. Section	2,671	30,792	8.67	39
Vic. Section	2,606	38,016	6.85	28
Bathurst	6,171	93,390	6.61	28
Broken Hill, exc. S.A.	2,387	28,257	8.45	34
Canberra, inc. N.S.W.	2,530	33,586	7.53	32
Corowa—				
N.S.W. Section	2,962	32,168	9.21	41
Vic. Section	3,035	48,963	6.19	25
Deniliquin—				
N.S.W. Section	1,110	15,954	6.96	31
Vic. Section	1,609	22,271	7.22	32
Dubbo	1,904	31,277	6.08	27
Goulburn	4,029	61,541	6.55	29
Grafton	2,178	42,314	5.15	23
Gunnedah	2,415	47,214	5.11	24
Katoomba, ex. Metro. Area	15,087	168,687	8.94	37
Lismore—				
N.S.W. Section	4,055	90,680	4.46	21
Q'ld. Section	203	5,812	3.49	14
Moss Vale	9,933	114,179	8.70	37
Newcastle	25,457	242,606	10.49	45
Orange	3,803	79,855	4.76	20
Tamworth	2,756	50,312	5.47	25
Wagga	4,676	73,086	6.39	29
Wollongong, ex. Syd.	16,339	147,073	11.11	47

Victoria

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Ratio of Licenses to 100 of Homes.
Melbourne	188,857	1,202,806	15.70	64
Remainder of State	55,859	635,160	8.79	36
State	244,716	1,837,966	13.31	55
Ballarat	18,477	161,826	11.41	45
Bendigo	9,303	126,454	7.35	28
Birchip	2,922	44,214	6.61	30
Geelong, ex. Melb.	20,749	156,164	13.28	55
Hamilton	4,435	55,555	7.98	34
Horsham	3,639	44,380	8.19	34
Mildura—				
Vic. Section	2,146	23,976	8.96	38
N.S.W. Section	278	3,584	7.76	30
Sale	4,403	49,869	8.82	36
Shepparton—				
Vic. Section	6,214	81,247	7.64	33
N.S.W. Section	288	4,319	6.67	30
Swan Hill—				
Vic. Section	2,107	29,583	7.12	31
N.S.W. Section	264	5,490	4.81	21

Queensland

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Ratio of Licenses to 100 of Homes.
Brisbane	46,671	405,264	11.51	49
Remainder of State	24,716	562,683	4.39	19
State	71,387	967,947	7.37	32
Ayr	2,288	41,529	5.51	25
Bundaberg	2,185	46,421	4.71	19
Cairns	1,086	48,850	2.22	9
Gympie	3,727	68,492	5.44	23
Ipswich, ex. Bris.	6,108	129,964	4.70	21
Mackay	1,037	29,065	3.56	16
Maryborough	3,030	53,527	5.66	23
Oakey	5,031	83,064	6.06	28
Rockhampton	3,785	47,944	7.89	35
Toowoomba	9,291	123,059	7.55	35
Townsville	2,271	40,055	5.66	25
Warwick—				
Q'ld. Sec.	5,504	84,287	6.53	29
N.S.W. Sec.	116	4,052	2.86	10

South Australia

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Ratio of Licenses to 100 of Homes.
Adelaide	62,250	393,455	15.82	63
Remainder of State (inc. N.T.)	16,892	196,471	8.59	39
State (inc. N.T.)	79,142	589,926	13.41	56
Crystal Brook	6,332	50,128	12.63	54
Port Lincoln	818	7,196	11.36	49
Port Pirie	4,982	43,330	11.49	51
Mt. Gambier—				
S.A. Sec.	1,050	17,181	6.11	26
Vic. Sec.	1,179	7,922	14.88	62
Murray Bridge, exc Metrop. area	6,389	72,910	8.76	37
Renmark	1,837	21,501	8.54	35

Western Australia

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Ratio of Licenses to 100 of Homes.
Perth	33,329	244,395	13.64	58
Remainder of State	10,728	201,297	5.33	21
State	44,057	445,692	9.88	41
Albany	752	9,416	7.99	30
Bunbury	2,021	33,848	5.97	23
Collie	1,963	35,470	5.53	21
Geraldton	586	9,984	5.87	27
Kalgoorlie	1,189	23,257	5.11	20
Katanning	1,569	14,537	10.79	45
Merredin	988	15,031	6.57	28
Narrogin	898	15,847	5.67	24
Northam, ex. Perth	1,753	37,782	4.64	19
Wagin	1,236	17,767	6.95	29
Wiluna	236	10,348	2.28	8

Tasmania

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Ratio of Licenses to 100 of Homes.
Hobart	11,745	99,480	11.80	51
Remainder of State	9,537	129,248	7.38	32
State	21,282	228,728	9.30	40
Burnie	4,044	48,377	8.36	37
Devonport	7,822	86,597	9.03	39
Kelso	7,923	90,769	8.72	38
Launceston	7,315	82,196	8.90	38
Queenstown	820	9,719	8.40	34
Ulverstone	3,698	80,697	4.58	20

Listeners' License Figures in Force in Areas Within 50 Miles of Principal Cities and Towns

Quarter Ended December 31st, 1935

N.S.W. and F.C.T.

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Homes.
Sydney	212,699	1,446,320	14.70	69
Remainder of State	81,533	1,212,976	6.72	25
State (inc. F.C.T.)	294,232	2,659,296	11.06	48
Albury—				
N.S.W. Sec.	3,032	30,792	9.85	44
Vic. Sec.	2,643	38,016	6.95	29
Bathurst	6,414	93,390	6.87	29
Broken Hill, exc. S.A.	2,416	28,257	8.55	34
Canberra, inc. N.S.W.	2,672	33,586	7.95	34
Corowa—				
N.S.W. Sec.	3,073	32,168	9.55	43
Vic. Sec.	3,128	48,963	6.38	26
Deniliquin—				
N.S.W. Sec.	1,166	15,954	7.31	32
Vic. Sec.	1,699	22,271	7.62	33
Dubbo	2,002	31,277	6.40	28
Goulburn	4,259	61,541	6.92	30
Grafton	2,305	42,314	5.45	24
Gunnedah	2,581	47,214	5.47	25
Katoomba—				
ex. Metrop. Area	15,507	168,687	9.19	38
Lismore—				
N.S.W. Sec.	4,294	90,680	4.74	22
Q'land Sec.	220	5,812	3.7	15
Moss Vale	10,343	114,179	9.06	39
Newcastle	26,166	242,606	10.78	46
Orange	3,998	79,855	5.01	22
Tamworth	2,940	50,312	5.84	26
Wagga	4,889	73,086	6.69	31
Wollongong—				
Ex. Sydney	16,867	147,073	11.47	48

Victoria

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Homes.
Melbourne	194,872	1,204,139	16.18	67
Remainder of State	55,886	635,653	8.79	36
State	250,758	1,839,792	13.63	56
Ballarat	18,915	161,826	11.72	46
Bendigo	9,376	126,454	7.69	29
Birchip	2,974	44,214	6.72	30
Geelong, ex. Melb.	21,028	156,164	13.46	56
Hamilton	4,490	55,555	8.08	34
Horsham	3,740	44,380	8.42	35
Mildura—				
Vic. Sec.	2,150	23,976	8.96	38
N.S.W. Sec.	284	3,584	7.92	31
Sale	4,649	49,869	9.32	38
Shepparton—				
Vic. Sec.	6,438	81,247	8.04	34
N.S.W. Sec.	301	4,319	6.97	31
Swan Hill—				
Vic. Sec.	2,092	29,583	7.07	30
N.S.W. Sec.	286	5,490	5.21	23

Queensland

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Homes.
Brisbane	48,796	406,144	12.01	52
Remainder of State	26,115	563,910	4.6	20
State	74,911	967,947	7.74	32
Ayr	2,444	41,529	5.89	26
Bundaberg	2,383	46,421	5.13	21
Cairns	1,162	48,850	2.38	10
Gympie	3,839	68,492	5.60	24
Ipswich—				
Ex. Brisbane	6,707	129,964	5.16	23
Mackay	1,116	29,065	3.83	17
Maryborough	3,100	53,527	5.79	24
Oakey	5,268	83,064	6.34	30
Rockhampton	3,988	47,944	8.32	36
Toowoomba	9,762	123,059	7.93	36
Townsville	2,421	40,055	6.04	26
Warwick—				
Q'land Sec.	5,932	84,287	7.03	32
N.S.W. Sec.	120	4,052	2.96	10

South Australia

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Homes.
Adelaide	64,433	393,730	16.36	65
Remainder of State (Inc. N. Ter.)	17,355	196,594	8.82	40
State (inc. N.T.)	81,788	589,926	13.85	55
Crystal Brook	6,411	50,128	12.79	55
Port Lincoln	887	7,196	12.33	53
Port Pirie	5,062	43,330	11.68	51
Mt. Gambier—				
S.A. Sec.	1,072	17,181	6.24	26
Vic. Sec.	1,193	7,922	15.07	63
Murray Bridge—				
exc. Metro. Area	6,651	72,910	9.12	39
Renmark	1,958	21,501	9.1	39

Western Australia

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Homes.
Perth	34,864	244,609	14.25	61
Remainder of State	11,355	202,131	5.62	23
State	46,219	446,740	10.34	42
Albany	789	9,416	8.38	32
Bunbury	2,192	33,848	6.48	25
Collie	2,131	35,470	6.01	23
Geraldton	610	9,984	6.11	28
Kalgoorlie	1,248	23,257	5.37	21
Katanning	1,691	14,537	11.63	50
Merredin	1,022	15,031	6.79	29
Narrogin	961	15,847	6.06	26
Northam—				
Exc. Perth	1,854	37,782	4.91	21
Wagin	1,334	17,767	7.51	32
Wiluna	254	10,348	2.45	8

Tasmania

Locality.	Licenses.	Population.	Ratio of Licenses to 100 of Popln.	Homes.
Hobart	12,176	99,410	12.25	53
Remainder of State	10,068	129,155	7.80	34
State	22,244	228,565	9.73	42
Burnie	4,210	48,377	8.70	38
Devonport	8,148	86,597	9.40	40
Kelso	8,272	90,769	9.11	40
Launceston	7,632	82,196	9.29	40
Queenstown	884	9,719	9.09	36
Ulverstone	3,886	80,697	4.82	21

Country-Metropolitan License Distribution

In Various States and the Commonwealth

THE following figures show the quarterly license figures in the various metropolitan and country areas for each State for 1935.

It must be specially noted that the generally accepted boundaries for the metropolitan areas are not exactly in accordance with that as defined by the Commonwealth Statistician, and to assist the radio industry throughout Australia in a proper determination of the various figures, it will be noted that the names of the various municipalities are given here under each State.

New South Wales

	31/3/35	30/6/35	30/9/35	31/12/35
Metropolitan				
Licenses	180,768	185,239	188,528	192,883
Population	1,252,318	1,251,839	1,252,938	1,255,389
Ratio: Licenses to 100 Population	14.43	14.80	15.05	15.36
Dwellings	61	63	64	65
% of State	66	66	66	66

Metropolitan Area of Sydney includes: Alexandria, Annandale, Ashfield, Auburn, Balmain, Bankstown, Bexley, Botany, Burwood, Canterbury, Concord, Darlington, Drummoyne, Dundas, Eastwood, Enfield, Ermington and Rydalmere, Erskineville, Glebe, Granville, Holroyd (part), Homebush, Hunter's Hill, Hurstville, Kogarah, Kuring-gai, Lane Cove, Leichhardt, Lidcombe, Manly, Marrickville, Mascot, Mosman, Newtown, Paddington, Parramatta, Petersham, Randwick, Redfern, Rockdale, Ryde, St. Peters, Strathfield, Sydney, Sydney North, Vaucluse, Waterloo, Waverley, Willoughby, Woollahra.

	31/3/35	30/6/35	30/9/35	31/12/35
Country				
Licenses	91,574	93,927	97,113	101,349
Population	1,393,334	1,398,922	1,401,063	1,403,907
Ratio: Licenses to 100 Population	6.57	6.71	6.93	7.22
Dwellings	29	29	30	31
% of State	34	34	34	34
State				
Licenses	272,342	279.166	285,641	294,232
Population	2,645,652	2,650,761	2,654,046	2,659,296
Ratio: Licenses to 100 Population	10.29	10.53	10.76	11.06
Dwellings	44	45	46	48
% of State	—	—	—	—

Victoria

	31/3/35	30/6/35	30/9/35	31/12/35
Metropolitan				
Licenses	162,962	166,406	171,114	174,919
Population	1,001,486	1,000,966	1,000,025	1,001,200
Ratio: Licenses to 100 Population	16.27	16.62	17.11	17.48
Dwellings	68	69	71	73
% of State	70	70	70	70

Metropolitan Area of Melbourne includes: Box Hill, Brighton, Brunswick, Camberwell, Caulfield, Chelsea, Coburg, Collingwood, Essendon, Fitzroy, Footscray, Hawthorn, Kew, Malvern, Melbourne, Melbourne South, Mordialloc, Northcote, Oakleigh, Port Melbourne, Prahran, Preston. Richmond, Sandringham, St. Kilda, Williamstown, and Shires of Braybrook (part), Heidelberg (part), Moorabbin.

	31/3/35	30/6/35	30/9/35	31/12/35
Country				
Licenses	69,154	70.841	73,602	75,839
Population	836,103	838,397	837,941	838,592
Ratio: Licenses to 100 Population	8.27	8.44	8.78	9.04
Dwellings	34	35	36	37
% of State	30	30	30	30
State				
Licenses	232,116	237,247	244,716	250,758
Population	1,837,589	1,839,363	1,837,966	1,839,792
Ratio: Licenses to 100 Population	12.63	12.90	13.31	13.63
Dwellings	52	54	55	56
% of State	—	—	—	—

Queensland

	31/3/35	30/6/35	30/9/35	31/12/35
Metropolitan				
Licenses	36,552	38,405	40,229	42,098
Population	303,569	305,708	307,522	308,188
Ratio: Licenses to 100 Population	12.04	12.56	13.08	13.65
Dwellings	51	54	56	58
% of State	56	57	57	56

Metropolitan Area of Brisbane includes: State Electoral Districts, Bremer (part), Brisbane, Brisbane South, Bulimba, Buranda, Enoggera (part), Fortitude Valley, Hamilton, Ithaca, Kelvin Grove, Kurilpa, Logan (part), Maree, Merthyr, Nundah, Oxley (part), Sandgate (part), Toowong, Windsor, Wynnum (part).

	31/3/35	30/6/35	30/9/35	31/12/35
Country				
Licenses	28,053	29,141	31,158	32,813
Population	656,183	656,505	660,425	661,866
Ratio: Licenses to 100 Population	4.27	4.43	4.71	4.95
Dwellings	18	19	20	21
% of State	44	43	43	44
State				
Licenses	64,605	67,546	71,387	74,911
Population	959,752	962,213	967,947	970,054
Ratio: Licenses to 100 Population	6.74	7.02	7.37	7.72
Dwellings	29	30	32	33
% of State	—	—	—	—

South Australia

	31/3/35	30/6/35	30/9/35	31/12/35
Metropolitan				
Licenses	50,075	51,495	54,423	56,179
Population	314,429	314,061	313,984	314,210
Ratio: Licenses to 100 Population	15.88	16.39	17.33	17.81
Dwellings	64	66	69	72
% of State	67	66	69	69

Metropolitan Area of Adelaide includes: Corporations Adelaide, Brighton, Colonel Light Gardens, Glenelg, Henley and Grange, Hindmarsh, Kensington and Norwood, Port Adelaide, St. Peters, Thebarton, Unley, and the following District Councils: Burnside, Campbelltown, Marion, Mitcham, Payneham, Prospect, Torrens West, Walkerville,

COUNTRY-METROPOLITAN LICENSE DISTRIBUTION—(Continued)—

South Australia (Contd.)

	31/3/35	30/6/35	30/9/35	31/12/35
Country				
Licenses	24,333	25,020	24,719	25,609
Population	274,857	275,858	275,942	276,114
Ratio: Licenses to 100 Population	8.85	9.07	8.95	9.27
Dwellings	37	39	39	39
% of State	33	34	31	31
State				
Licenses	74,408	76,515	79,142	81,788
Population	589,286	589,919	589,926	590,324
Ratio: Licenses to 100 Population	12.62	12.97	13.41	13.85
Dwellings	52	54	56	57
% of State	—	—	—	—

Western Australia

	31/3/35	30/6/35	30/9/35	31/12/35
Metropolitan				
Licenses	28,214	29,727	31,683	33,137
Population	209,222	214,473	215,639	215,734
Ratio: Licenses to 100 Population	13.50	13.86	14.69	15.36
Dwellings	58	60	63	66
% of State	72	72	72	72

Metropolitan Area of Perth includes: Municipalities: Claremont, Cottesloe, Fremantle, Fremantle East, Fremantle North, Guildford, Midland Junction, Perth, Subiaco, and the following Road Board Districts: Bassendean, Bayswater, Belmont Park, Buckland Hill, Canning, Melville, Nedlands, Peppermint Grove, Perth, Perth South, Swan (part).

	31/3/35	30/6/35	30/9/35	31/12/35
Country				
Licenses	11,035	11,530	12,374	13,082
Population	233,484	229,599	230,053	231,006
Ratio: Licenses to 100 Population	4.73	5.02	5.38	5.66
Dwellings	19	20	22	23
% of State	28	28	28	28
State				
Licenses	39,249	41,257	44,057	46,219
Population	442,706	444,072	445,692	446,740
Ratio: Licenses to 100 Population	8.87	9.29	9.88	10.34
Dwellings	37	38	41	42
% of State	—	—	—	—

Tasmania

	31/3/35	30/6/35	30/9/35	31/12/35
Metropolitan				
Licenses	7,684	7,921	8,268	8,518
Population	61,427	60,038	59,777	59,735
Ratio: Licenses to 100 Population	12.51	13.19	13.83	14.26
Dwellings	53	56	59	61
% of State	39	39	39	38

Metropolitan Area of Hobart includes: Glenoreby, Hobart, Kingborough (part), Clarence (part).

	31/3/35	30/6/35	30/9/35	31/12/35
Country				
Licenses	11,802	12,200	13,014	13,726
Population	170,026	169,673	168,951	168,830
Ratio: Licenses to 100 Population	6.94	7.19	7.70	8.13
Dwellings	30	31	33	35
% of State	61	61	61	62
State				
Licenses	19,486	20,121	21,282	22,244
Population	231,453	229,711	228,728	228,565
Ratio: Licenses to 100 Population	8.42	8.76	9.30	9.73
Dwellings	36	38	40	43
% of State	—	—	—	—

Commonwealth

	31/3/35	30/6/35	30/9/35	31/12/35
Metropolitan				
Licenses	466,255	479,193	494,245	507,734
Population	3,142,451	3,147,085	3,149,930	3,154,466
Ratio: Licenses to 100 Population	14.83	15.22	15.68	16.09
Dwellings	62	64	66	68
% of State	66	66	66	66
Country				
Licenses	235,951	242,659	251,980	262,418
Population	3,563,987	3,568,954	3,574,375	3,580,315
Ratio: Licenses to 100 Population	6.62	6.80	7.04	7.33
Dwellings	28	29	30	31
% of State	34	34	34	34
State				
Licenses	702,206	721,852	746,225	770,152
Population	6,706,438	6,716,039	6,724,305	6,734,771
Ratio: Licenses to 100 Population	10.47	10.74	11.09	11.43
Dwellings	44	45	47	48
% of State	—	—	—	—

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S.A.A. Rules For Radio Apparatus and Installations

(Extracts from the S.A.A. Wiring Rules, etc.)

The Standards Association of Australia, in December, 1934, issued a new edition of the S.A.A. Wiring Rules (Code No. CC. 1—1934) which contains Australian Standard Rules for the Electrical Equipment of Buildings, Structures and Premises. The Rules, which are divided into two parts, namely, Part 1, Wiring Methods, and Part 2, Materials, cover all electrical installations for power and lighting, and the installation of the power connections for radio apparatus. In New South Wales the Local Government Department, the Fire and Accident Underwriters' Association, and the Electricity Supply Authorities have adopted these Rules, and in most of the other Australian States either the S.A.A. Rules have been adopted or have served as a model for the Rules in force. We understand that a separate Code, to be known as the S.A.A. Radio Code, is to be issued shortly. The Code is to contain Rules for the design, construction, and installation of Radio and/or Electro-Acoustic Apparatus, and an Australian Standard Specification for Radio and/or Electro-Acoustic Apparatus. This Code may be obtained on issue from the Standards Association of Australia, Science House, Cnr. Gloucester and Essex Streets, or at any of the Association's Branches at a small cost. The portions of the S.A.A. Wiring Rules affecting radio installations and other sound reproducing equipment connected to electric power mains are quoted below.

117. JOINTS AND CONNECTIONS.

(c) Fluxes for Soldering. Corrosive fluxes shall not be used in making soldered joints.

151. LIMITING PRESSURE. No fitting, accessory, appliance or apparatus shall be connected direct to a circuit operating at a pressure more than 15% above the pressure rating of such fitting, accessory, appliance or apparatus unless the sanction, in writing, of the Supply Authority for such connection has previously been obtained. No such permission shall be given in the case of medical or dental appliances, radio receiving equipment or electrically operated toys.

162. DETAILS OF TESTS.

(c) Continuity of Metallic Conduits and Sheathings. The continuity resistance of metallic conduits and sheathings measured between the earthing connection and any other point on the completed installation, shall not exceed the resistance referred to in Rule 515, Clause (a), Continuity and Resistance, which shall not in any case exceed 2 ohms.

326. JOINTS AND CONNECTIONS IN CABLES.

(h) Cable Sockets and Terminal Connections. At terminal connections every cable except flexible cables and those cables having fewer than seven strands shall be either:

- (i) soldered into a cable socket of such a size that all strands of the conductor can enter the socket simultaneously; or
- (ii) clamped in a terminal or binding post; or
- (iii) terminated in an approved solderless tag or terminating device; or
- (iv) made solid by soldering and securely clamped under a clamping screw or between metal surfaces.

331. AERIAL CONDUCTORS.

(i) Wireless Aerials. Aerial cables shall not cross over or under or pass in close proximity to any wireless aerial or any stay wire in connection therewith, or be erected in such a position that it is possible for them to make contact with a wireless aerial or stay wire, or for any person to simultaneously touch any wire and a wireless aerial or stay wire (see S.A.A. Radio Code (No. CC.3) regarding the installation of wireless aerials).

351. FLEXIBLE CORDS.

(a) Types. No flexible cord shall be used unless it is one of the types specified in Part II. Rules 2351 and 2352, and complies with the requirements of those Rules for the types of cord in question.

(b) Overall Braiding or Covering. Twisted flexible cords without overall braiding shall be used only for pendants and wiring of fixed fittings. In all other positions and for all other purposes only tough rubber covered flexible cords or flexible cords made up to a circular or oval section and braided overall shall be used.

(g) Doorways, Walls, Partitions, etc. A flexible cord shall not be fixed in position through a doorway, window, wall or partition beyond the room in which such flexible cord is connected to the permanent wiring, and where a flexible cord passes through a partition within a room or other space, the hole through which it passes shall be bushed with porcelain tubing.

441. APPLIANCES.

(b) Reduction in Voltage. No appliance shall be connected to a circuit in which the pressure differs by more than 15% from the pressure at which the appliance is rated, and for which it was designed and manufactured, except through an approved transformer or converting equipment complying with the requirements of, and installed in accordance with, the Rules (see also Rule 151, Limiting Pressure, and Rule 457, Clause (d), Auto-transformers).

(c) Connection of Fixed Appliances and Portable Appliances. Every appliance according to its type shall be connected to the circuit wiring in one of the following manners:

(i) **Fixed Apparatus.** Where conductors are run in conduit or where metal or rubber sheathed cables are used, the conduit, metal sheath or rubber sheath, as the case may be, shall terminate in and be properly secured to the terminal box.

(ii) **Portable Apparatus.** The permanent wiring shall terminate at suitable outlet, plug socket, end box, connecting device (with or without fuses), etc., the connection to the appliance being made by means of suitable flexible cable or cord.

453 RADIO RECEIVING INSTALLATIONS.

(a) General. Every radio receiving installation shall comply with the provisions of the S.A.A. Radio Code (No. CC.3). In addition, where the apparatus depends for its operation on the use of energy derived from public or private electric power mains, such apparatus shall be installed in the manner provided in these Rules and the following.

(b) Connection. Electricity from supply mains or private generating plant shall be conveyed to radio receiving sets only through permanent wiring or through a proper authorised outlet, such as a plug and socket or other connecting device.

(c) Isolation of Parts from Supply Mains. Every exposed part (including earth connections, aerial connection and connections to external speakers, batteries, etc.) shall be completely isolated by suitable insulation, condensers or transformers, from the supply mains.

(Continued on next page)

457. TRANSFORMERS.

(a) Transformers — General. The installation of every transformer other than an instrument transformer, a bell transformer or a transformer incorporated in radio receiving equipment (see Rule 453, Radio Receiving Installations), a battery charging rectifier, a motor starter or other similar apparatus shall be carried out in accordance with the requirements of the Rule.

(c) Step-Up Transformers. Where a step-up transformer is used to raise the pressure above that at which electricity is supplied at the consumer's terminals no connection other than that made by an earthing conductor shall be made between the primary and secondary windings. Unless all wiring and terminals at the higher pressure are enclosed by an insulating or earthed metal cover, such transformers shall be installed only in places inaccessible to unauthorised persons.

(d) Auto-Transformers. No auto-transformer shall be used to reduce more than 20% or to reduce to low or extra-low pressure the voltage of electricity to be conveyed to any circuit, appliance or apparatus.

(e) Instrument Transformers. Potential transformers shall be protected on the primary side by suitable cut-outs. One side of the secondary winding of all instrument transformers and the core of such transformers shall be earthed in accordance with Section 5, Earthing.

(f) Supports. Unless encased, transformers shall be carried on supports of incombustible material.

(g) Enclosures. Every protecting case or enclosure containing a transformer shall be of incombustible material.

458. CHOKE COILS AND RESISTANCES.

(a) General. For the purpose of the Rule, the term "transformer" shall include also "choke coil and resistance" and the appropriate provisions of Rule 457, Transformers, shall apply to choke coils and resistances.

(b) Prohibited Use of Choke Coils and Resistances. Choke coils and resistances shall not be used for reducing the voltage to portable appliances, battery chargers with exposed live terminals, medical and dental appliances, electrically operated toys or other appliances which are liable to be handled in normal use.

501. EARTHING OF EQUIPMENT.

(a) Appliances, etc., to be Earthed. The following shall be effectively earthed in accordance with these Rules:

(i) **Portable Appliances.** The exposed metal frame or case of all portable appliances, fittings, apparatus, etc., installed in earthed situations.

(ii) **Plug Sockets.** The earthing terminal of all plug sockets installed in earthed situations.

502. APPARATUS, APPLIANCES, Etc., WITH DOUBLE INSULATION. Notwithstanding the provisions of Rule 501, "Earthing of Equipment," appliances and apparatus having exposed metal separated from live conductors by double insulation need not be earthed.

34. **Definition, Double Insulation,** shall mean that the insulating material intervenes not only between the conductor and its surrounding envelope (in the case of a cable) or immediate support (in the case of a bare conductor) but also between the envelope or the support, as the case may be, and earth.

511. METHOD OF EARTHING.

(d) Earthing Portable Appliances. All exposed parts required to be earthed shall be connected to earth, as required under Clause (c) of this Rule, by means of an earthing conductor enclosed with the current carrying conductors within the flexible cord. This earthing conductor shall be connected at one end to the earthing pin on the plug, and at the other end in the following manner:

(i) by the connection of all conductors, including the earthing conductor, to suitable fixed terminals on the accessory, appliance, or apparatus; or

(ii) by means of contact pins, for all conductors including the earthing conductor; or

(iii) by means of contact pins for the active conductors and a sliding spring contact for the earthing conductor.

In cases (ii) and (iii) the arrangement shall be such that the connection to earth shall be completed before the current circuit is made, and **vice versa.**

In all cases where a portable fitting or appliance is earthed, the connection to earth of the frame of the fitting or appliance shall be made automatically when the plug is connected to the supply or (in the case of a fitting or appliance provided with contact pins) when the plug is connected to the supply and the socket is fitted in position on the contact pins. The connection to earth aforesaid shall be broken automatically when the plug is disconnected from the supply or (in case of a fitting or appliance provided with contact pins) when the plug is disconnected from the supply pins or the socket is withdrawn from the contact pins.

NOTE.—A plug socket used or to be used for the connection of a portable fitting or appliance which is by these Rules required to be earthed shall be deemed to be in an earthed situation.

(f) Connections. The ends of all earthing leads shall be provided with approved solderless clamps or otherwise connected in accordance with Rule 326, Joints and Connections in Cables.

512. EARTHING SYSTEM AND CONNECTIONS.

(a) Earth Connection — Water System Available.

(i) **Inside Buildings.** Where a suitable water supply is available, the earth connection shall be made at the main water supply pipe. This connection, wherever practicable, shall be inside the building as close as possible to the first point of entry of the water supply. It shall be made to a section of water pipe of sufficient size to carry the maximum current likely to flow to earth under extreme fault conditions. The point selected for the earth connection shall be accessible, permanently dry, and not exposed to possible mechanical injury.

(ii) **Outside Buidings.** Where a suitable point of connection is not available inside the building, the connection shall be made outside the building. This connection shall comply with the requirements of Sub-clause (a) (i) of this Rule, and, in addition, it shall be adequately protected from the effects of the weather, atmosphere, etc., by a sealing compound or paint which will prevent oxidation of the surface.

(c) Earth Connection — Water System Not Available. Where an effectively earthed water pipe system is not available, a galvanised iron water pipe or pipes, as required by the Authorised Inspector, each of not less than ¾ in. internal diameter, shall be driven vertically into the ground to such depth as will ensure adequate contact with the moist subsoil. Not less than 4 feet of each such pipe shall be buried under the ground. Alternatively, an earth plate or plates approved by the Authorised Inspector shall be used.

515. EARTHING PRECAUTIONS.

(a) Continuity and Resistance.

(i) **Continuity.** Metal conduit and conduit fittings or metallic sheathing of cables shall be mechanically and electrically continuous.

(ii) **Joints in Conduits and Cable Sheathings.** Every joint in conduit cable sheathing or envelope shall be so made that the current carrying capacity of the joint is not less than that of the conduit, cable sheathing or envelope itself.

(iii) **Resistance of Conduits and Cable Sheathings.** The electrical resistance of conduit or sheathing measured between the earth connection at the main switchboard and any other point on the completed installation shall be low enough to permit the passage of the current necessary to operate the fuse, circuit breaker, or the earth leakage release of the circuit breaker protecting the circuit. The electrical resistance of the earthing system measured from the connections to the water pipe or earth pipe or plate or to any point on the conduits or sheathings shall not exceed 2 ohms.

(b) Position and Fixing of Earthing Conductor. The earthing conductor shall be placed in such a position and attached to the pipes, conduit, cables, appliances, etc., in such a manner that it cannot be accidentally damaged or cut. The earthing conductor shall be securely fixed over its entire length in a permanent manner by clamps, clips, saddles, or staples, etc., which shall not in any way damage the conductor.

(c) Buried Earthing Conductor. Where an earthing conductor is buried, it shall be protected in the same manner as insulated cables installed under similar conditions.

(d) Accessibility. All connections of the earthing conductor to the installation and to the earthing system itself shall be readily accessible.

(e) Prohibited Connections. Sprinkler pipes or pipes conveying gas, hot water or inflammable liquid shall not be used as earthing media. The earthing systems of all electrical installations shall be kept clear of lightning protection systems of the building or structure.

516. EARTHING CONDUCTORS.

(a) Material and Protection.

(i) Except as provided in Sub-clause (ii) of this Clause (a) every earthing conductor shall be of high conductivity copper and shall be bare. Where exposed to excessive dampness or to corrosion or in contact with lead sheathed cable, it shall be protected by tinning, or other means which will effectively prevent corrosion under the conditions of use.

(ii) Galvanised solid iron or steel wire or rod, the conductivity of which is not less than that of the copper earthing conductor required under these Rules and not smaller than No. 5 S.W.G., may be used for earthing conductors under the ground or immediately adjacent to the ground with the approval of the Authorised Inspector and in suitable situations.

(b) Minimum Size and Carrying Capacity. Copper earthing conductors shall be:

(i) stranded cable; or

(ii) flat copper strip not less than ¾in. wide by No. 18 gauge; or

(iii) circular or rectangular copper bar not smaller than 0.15 sq. in. in cross-section.

The minimum cross-sectional area of any stranded copper earthing conductor shall be 0.0045 sq. in. (7/.029in.) which shall be deemed sufficient for installations or a part of an installation not exceeding 50 amperes connected load. Where the connected load exceeds 50 amperes the carrying capacity of any earthing conductor (as determined from Tables A-II. and A-III., for a cable of equivalent cross-sectional area) shall be not less than one-third of the carrying capacity of the largest conductor to be protected thereby and not less than one-third of the full load current of any motor fitting or appliance earthed thereby. Where the multiple earthed neutral system is employed the cross-sectional area of the main earthing conductor shall be not less than half that of the main neutral conductor.

If the cross-sectional area of the largest live conductor of a flexible cord used with a portable appliance is smaller than 0.0045 sq. in., the cross-sectional area of the earthing conductor in the flexible cord shall not be less than that of such live conductor.

517. EARTH CLIPS.

(a) Removal of Paint etc. Paint, enamel, compound and other non-conducting material shall be removed from the surface of the metal section to which the earth clip is attached to permit of effective contact between the clip and such surface.

2115. TERMINALS AND CONTACT PINS.

(f) Cord Grips. Every fitting, accessory, appliance or apparatus intended for connection by means of a flexible cord or flexible cable, shall be provided with a clamp or grip which will effectively relieve the connection of any pull on the cord or cable.

2351. CONDUCTORS OF FLEXIBLE CORDS.

(b) Types of Flexible Cords. Flexible cords shall be one of the following types or of such other types as may be approved from time to time by the Standards Association of Australia, and shall comply with the requirements of this Rule, as to cords of that type, i.e.,

Type A—High Insulation Type.

Type B—Fire-resisting Type.

Type A—High Insulation Type. The conductors of flexible cords of the high insulation type shall be insulated as follows:

(i) If each conductor is composed of plain copper wires, it shall be lapped with cotton, insulated with pure rubber not less in radial thickness than is shown in Table A-V. (Flexible Cords—Dimensions) applied in two layers and overlapped with cotton; otherwise

(ii) The wires of each conductor shall be effectively and uniformly coated with tin free from all impurities, and each conductor shall be insulated with one layer of pure rubber and two layers of vulcanising rubber. The radial thickness of such rubber insulation shall be not less than is shown in Table A-V.

Type B—Fire-resisting Type. The conductors of flexible cords of the fire-resisting type shall be insulated as for Type A under (i), above, for plain copper wires, or

As under (ii) above, for tinned copper wires, except that the radial thickness of the rubber insulation shall be as shown in Table A-V. In the latter case, the vulcanising rubber may be applied in one layer.

Fire-resisting Covering. This insulation shall, in addition, be immediately surrounded by a continuous woven sleeve or wrapping of asbestos or other approved fire-resisting covering of a thickness not less than 0.025 in.

(c) Earthing Conductors of Flexible Cords. The foregoing requirements of this Rule with respect to insulation and fire-resisting covering need apply only to those conductors of a flexible cord which are normally intended to carry current. An earthing conductor contained within a flexible cord, if not so insulated or covered, shall be covered by a wrapping of cotton or other material in a manner which will prevent the adhesion of rubber and deterioration of the tinning (if any).

2441. APPLIANCES AND APPARATUS—GENERAL.

(b) Protection Against Contact. The current carrying parts of all appliances and apparatus shall be so arranged that they are not more exposed to personal contact than is necessary for their efficient working and where possible all live parts shall be protected and/or shielded so that it is impossible for the person using the appliance to touch them or make contact with them accidentally.

(c) Nameplate. There shall be fitted to every electrical appliance or apparatus a permanent visible nameplate on which shall be clearly and indelibly marked the following information:

(i) The name of the Manufacturer.

(ii) The maker's designation number or catalogue number.

(iii) The system (including details of pressure, phases and frequency, etc.) upon which the appliance or apparatus is intended to operate.

(iv) The consumption of the appliance or apparatus in watts or kilowatts or the full load current of the appliance or apparatus in amperes.

There shall also be provided on this nameplate a clear space not smaller than ½-in. x ½-in. suitable for any branding or marking which may be required by an Approvals Authority.

(f) Reduction of Voltage.

Portable Appliances, Battery Chargers, Medico-Electric Apparatus and Toys. No portable appliance, battery charger with exposed live terminals, medical or dental appliance or electrically operated toy shall operate from supply mains through a resistance, auto-transformer or any apparatus for reducing the pressure, other than a transformer with independent primary and secondary windings (See Part I., Rule 441, Clause (b), Reduction in Voltage).

2453. RADIO AND ELECTRO-ACOUSTIC EQUIPMENT

All radio and electro-acoustic equipment shall conform to the S.A.A. Radio Code (S.A.A. Code No. CC 3, including A.S.S. No. C. 69, Radio and Acoustic Apparatus for connection to Public or Private Electric Power Mains).

Explanatory Notes

Aerial Wires

Antennae is the plural of the word "antenna," which is another name for aerial. The wire gauges given in brackets are the approximate equivalents of the diameter in inches specified in the rules. For example, 3/.036 in. means three strands of wire having a diameter of 0.036 inches, equivalent to No. 20 standard wire gauge.

The wire insulation referred to as "600 megohm grade" is a vulcanised rubber covering with an outer braid coloured black or red. It is the kind of wire used by electricians in the wiring of houses for electric light and power. The term

(Continued on next page)

S.A.A. RULES FOR RADIO APPARATUS AND INSTALLATIONS—(Continued)—

"600 megohm" refers to the resistance of the insulation to leakage currents through it from the wire to the outside for a piece of the cable one mile long under certain conditions. Notice that the lead-in must not come within 12 inches of electric light or power wires unless special precautions are taken. This is a rule which should always be kept in mind, as it is very easily violated when installing lead-in and indoor aerials.

The Earth Wire

The 7/22, 600 megohm wire specified for earthing a radio set is very thick and unwieldy, and it is best to keep it out of sight as far as possible by leading it out of the building as near as possible to the set.

Rule 515 (a) (iii) is practically certain to be complied with if the size of the wire and the manner of earthing specified are in order. Notice particularly that driven pipe grounds must be of galvanised pipe not less than ¾-in. inside diameter, and the minimum depth in the ground not less than 4 ft.

Care should be taken that the earth wire is protected against possible mechanical damage. The specifications for the earth clamp should be kept in mind when buying these small devices. Most clamps do not comply with these requirements.

Rule 516 should not be overlooked. Earth leads for radio have 7 strands, and the bared ends must be rendered solid, either by soldering or by the use of a cable socket or lug such as is used in electrical work.

Additional Safety Requirements S.A.A. Radio Code

Preliminary details of the Radio Code, laid down by the Standards Association are to hand, and sections which are of particular interest to radio manufacturers and installation engineers are presented herewith. It must be clearly understood that these are draft specifications only, and are subject to change before the Code is finally published. These details are from that section of the code which will be known as C.69. Immediately following this will be found the draft specification for the "Installation" section of the Code, which is to be known as CC.3. The above remarks apply equally to this section of the Code.

IV.—Marking

5. Caution Notice.—The case of the apparatus shall also be provided, in a conspicuous position, with a notice to the effect that the apparatus is operated from electricity supply mains at a pressure which may be dangerous, and that no adjustments or alterations to the interior portions of the apparatus should be attempted nor should the apparatus be opened without previously removing the connector (plug or adaptor) from the supply mains.

V.—Design and Construction

6. Construction of Cases.

(f) All holes for the passage of cables or cords through the cases shall be furnished with insulating bushing having smooth rounded edges, so as to avoid abrasion of the cables or cords.

7. Protection of Live Parts.

(d) Where one or more switches are provided as a part of the apparatus and for the purposes of interrupting the supply from the mains, every such switch shall be of approved pattern, and shall disconnect both poles, or alternatively, an approved double-pole connector of not less than 5 amps. rating will suffice, provided that access to live parts cannot be obtained, while such connector is in place.

(f) Power units and/or power operated sets of the transformerless type.

- (i) Shall be completely enclosed in an external insulating case, so arranged, that it is not possible to gain access to the inner structure, case or frame, without disconnecting (by an approved means) both "poles" from the supply mains.
- (ii) Shall have the live parts of the inner structure isolated from the case or frame, by an isolating condenser (or other approved means), which shall not be capable of passing a current exceeding 5 milliamperes to case or frame when the full rated voltage is applied in the normal manner of operation.
- (iii) Shall have the operating shafts positively insulated from the metal case or frame.

9. Power Transformers.

(a) Power transformers shall be of the double-wound type and of substantial design. All material used in the construction of the transformers, except insulation, shall be non-ignitable. The amount of ignitable insulation shall be as small as practicable.

(b) The primary winding shall be effectively insulated from the core, the case and the secondary windings.

(c) The mid-tap of the secondary winding of the transformer, which supplies power to the rectifying device shall be effectually connected to the metal case or frame. If this tap be connected to frame through a resistor (such as a bias resistor) or choke (such as for smoothing) it shall be of robust design, so as to preclude any possibility of accidentally breaking the circuit to frame. Should the tap be connected to frame through the field coil of the loudspeaker by means of an attachment plug, which runs to the loudspeaker, it will not be considered to be properly connected unless the plug is definitely held in place or unless the apparatus is to be fitted with an attachment plug to prevent access to live parts (Clause 7d.).

13. Earth and Aerial Terminals.

(a) **Earth Terminal.** (For power earthing).

Exposed metal cases and/or frames shall be provided with a common "power earthing terminal" to enable the apparatus to be earthed in accordance with Section 17 of the S.A.A. Wiring Rules. The terminal shall be mounted on, and metallically connected to, the main metal case or frame, and shall be metallically connected to all other exposed metal parts of the apparatus; it shall be distinctly marked "EARTH."

(b) Earth Terminals (for radio earthing).

If a "Radio Earthing Terminal" be fitted it shall comply with the conditions specified in sub-clauses (b), (i), (ii) and (iii) of Clause 13 of this Specification, as follow:

- (i) It shall have the exposed portion insulated in an approved manner.
- (ii) It shall be positively insulated from the frame in an approved manner by a suitable bush or other effective means.
- (iii) It shall be isolated from the inner structure by an approved mica dielectric condenser of a capacity not exceeding 0.025 mfd. or by other approved means.

(c) Aerial Terminal.—The "aerial terminal" shall comply with the conditions specified in sub-clauses (b), (i), (ii), and (iii) of Clause 13 of this Specification.

(Details of tests, and conditions for "approval" will be found in the complete Specification C. 69).

Additional Installation Requirements S.A.A. Radio Code

1. Extent and Application. The rules of this Code cover the installation of radio and electro-acoustic apparatus.

Materials and Apparatus

2. Quality of Materials and Apparatus. Where radio or electro-acoustic apparatus depends for its operation on the use of energy derived from public or private electricity supply mains it shall conform to the requirements of S.A.A. No. C. 69—Radio and Acoustic Apparatus.

Installation

3. General. All radio and electro-acoustic apparatus shall be installed in accordance with the requirements of this Code and the Wiring Rules of the Standards Association of Australia.

4. Power Connection. Electricity from supply mains shall be conveyed to radio receiving apparatus only through permanent wiring or a proper authorised outlet.

Earthing

5. Power Earthing.

i. Where apparatus is used in damp situations or in places where the conditions are such that a person touching the apparatus could simultaneously make contact with earth through a conducting floor or walls, or earthed metal, exposed metal cases and/or frames shall be effectively earthed. Power earthing conductors shall be of stranded copper and shall not be smaller than 7/.029in.; they shall in all respects conform to the provisions of Section 5-CC1, 1934, of the S.A.A. Wiring Rules with respect to earthing, but shall be insulated cables; the insulation being 600 megohm grade.

ii. Where apparatus is used in situations where accidental contact with earth is not possible (see conditions specified in "5" (1) above) exposed metal cases and/or frames shall not be earthed.

iii. Where "line filters," or similar devices having the "earthing terminal" connected to the mains through a condenser of capacity greater than 0.025 mfd. are installed as part of, or in conjunction with, A.C. apparatus, the earthing terminal of the device shall be positively insulated from its exposed metal case or frame (if any), and shall be effectively earthed. The earthing conductor shall comply with the conditions for power earthing conductors specified in "5" (i) above; in addition the insulated earthing conductor shall be taken through the case of the device in an approved manner to preclude any possibility of the user touching a bare part of the earthing wire. The earthing terminal of such devices when used in conjunction with apparatus installed under the conditions of 5 (ii) above, shall not be connected to the case or frame and/or the "radio earth terminal" of such apparatus.

6. Radio Earthing. Where apparatus is fitted with a "radio earthing terminal," (Clause 13b, Code C. 69) a radio earth conductor may be connected to that terminal for the purpose of improving reception. Radio earthing conductors shall comply with the conditions specified in Clause 15 of this Code.

Aerials

Exterior to Building

7. Location.

Aerials, counterpoises and stay wires exterior to buildings shall not pass over or under aerial electric light or power wires, nor shall they be so located that failure of either aerial, counterpoise, stay wire, or of the abovementioned electric light or power wires could result in a contact between the aerial, counterpoise, and/or stay wires and such electric light or power wires, or the wires of the Postmaster-General's Department or Fire Brigade.

8. Construction, Erection and Supporting.

Aerials, counterpoises and their supports shall be constructed and created in a strong and durable manner, and shall be so located as to prevent accidental contact between aerial or counterpoise wires, and electric light or power wires, or the wires of the Postmaster-General's Department or Fire Brigade, by sagging or swinging.

9. Form and Size of Cables.

Aerial and counterpoise conductors shall be stranded and, if of copper, hard drawn and of cross sectional area not less than that shown in the Table below. The stress of such conductors shall not exceed 20,000 lbs. per sq. in.

Conductors of metals other than copper may be used provided that their breaking strength is not less than that of the copper conductors shown in the following Table for the given spans—

Size of Cables

Span (between supports)	Minimum Size
Not exceeding 120 ft.	3/.036in.
Exceeding 120 ft.	7/.036in.

10. Leading-in Wires.

Leading-in wires forming the connection between outdoor aerials and counterpoise systems and the apparatus shall comply with the following requirements—

(a) Leading-in wires shall be of copper, copper-clad steel, or other approved metal, which does not corrode excessively, and shall in no case be smaller than 1/.044in. (approx. 18g. S.W.G.).

(b) The portion of the leading-in wires inside the building shall be covered with insulation of not less than 600 megohm grade.

(c) Leading-in wires both inside and outside of buildings shall not come nearer than 12 inches to electricity supply mains or electrical communication circuits unless separated therefrom by a continuous and firmly fixed non-conductor with a well maintained permanent separation. The non-conductor shall be in addition to any insulation on the wire.

(d) Leading-in wires shall enter a building through a non-combustible, non-absorptive insulating bushing, so arranged as to prevent the entry of moisture.

(e) Leading-in conductors inside buildings shall comply with the conditions specified in Clause 15 of this Code.

11. Protective Service.

All leading-in wires shall be provided with a protective device (lightning arrester) of approved pattern, which shall be fixed outside the building near the point where the wires enter the building. The protective device shall be mounted on a non-ignitable base away from inflammable material and shall provide an air gap not exceeding 0.005 in. between aerial and earth connections.

12. Aerial Earthing Switch.

The use of an aerial earthing switch is desirable, but does not obviate the necessity for the protective device required by Clause 11 above. Such switch, if installed separately from the protective device, may be placed within the building and shall form, in its closed position, a shunt around the protective device. Where situated within reach of the radio receiving equipment, such earthing switch shall be of the all-insulated type.

13. Cut-outs in Aerial Circuit.

If cut-outs are used in the aerial circuit they shall be placed so that they cannot interfere with the function of the protective device.

Aerials Within Buildings

14. Location of Indoor Aerials.

Aerials within buildings shall be so placed and constructed that they cannot come into contact with wires or apparatus (other than the radio receiving equipment) connected to the electricity supply mains or communication circuit.

Aerial conductors (within buildings) shall comply with the conditions specified in Clause 15 of this Code.

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S.A.A. RULES FOR RADIO APPARATUS AND INSTALLATIONS—(Continued)—

15. Conductors for Indoor Aerials, Radio Earthing and Leading-in connections inside buildings shall be—

i. Of stranded copper, or a total cross section of not less than 0.00066 sq. inches (approx. 22g. S.W.G.), and shall be covered with a layer of high grade vulcanised rubber of thickness not less than 1/64in., and an outer covering of durable braided cotton, or with a layer of high grade vulcanised rubber of thickness not less than 1/32in.

ii. Shall withstand a voltage test of 1000 volts R.M.S. after 24 hours immersion in water; the test voltage shall be applied gradually and maintained continuously at the full voltage for fifteen minutes and shall be carried out with alternating current of approximately sine wave form at any frequency between 25 and 100 cycles per sec.

16. **Special Aerials.**

Special aerials, such as for the elimination of interference in which an outer screen or one conductor of the "lead in" requires to be earthed for efficient operation, shall comply generally with the conditions specified for aerials in this Code, including insulation specified in Clause 15 of this Code; the total cross section of the conductor and insulation shall comply with Clause 15.

The screen or conductor to be earthed shall not be connected to the frame or case of the apparatus except under the conditions of installation specified in 5 (i) of this code; however, it may be connected to the radio earth terminal of the apparatus.

17. **Additions and Alterations.**

Every addition to or alteration of an existing installation shall be deemed to be a new installation and all the provisions of Codes CC.3 and C.69 shall apply to such alteration or addition.

Victorian Wiring Rules

THE State Electricity Commission of Victoria have formulated a complete set of regulations for the installation of all electrical equipment connected to their supply mains. In general, these rules follow those of the Standards Association of Australia very closely, but there are some minor points of difference.

For a general guidance of manufacturers and dealers supplying radio equipment for use in Victoria we present herewith those sections of the Victorian rules which apply directly to radio. Full particulars of the remainder of the rules are embodied in a handbook entitled "Provisional Wiring Regulations, 1934" which is available from the Government Printing Office, Melbourne.

Radio Equipment

452. (a) This regulation shall apply to all radio receiving and transmitting equipment. The provisions of Clauses (b), (c) and (d) shall also apply to all electro-acoustic equipment and to all rectifying apparatus not exceeding 1,200 volt amperes rated input which is to be used for charging storage batteries and similar purposes, and for the purposes of these Clauses the term "radio equipment" shall be deemed to include electro-acoustic equipment and such rectifying apparatus. (See also regulation 2452).

(b) Electricity from supply mains shall be conveyed to radio equipment only through permanent wiring or through an outlet, such as a plug socket or other connecting device, complying with the requirements of these Regulations.

(c) Every exposed part (including earth connections and connections to external speakers) shall be completely isolated from the supply mains by suitable insulation, condensers, or transformers.

(d) In all earthed situations, exposed metal containing cases, covers, and frames (including transformer frames) shall be effectively connected to earth through suitable terminals provided on the case, cover, or frame for that purpose. Such terminals shall be distinctly marked "Earth."

Except where the earthing of the radio equipment is carried out in a manner which complies with the requirements of regulation 513 (o), earthing conductors shall be of stranded copper not smaller than 7/.029 inch (7/22 S.W.G.) and shall comply in all respects with the requirements of the relevant clauses of regulations 511-517 inclusive, except that where they are exposed to personal contact within buildings they shall be covered with insulation of not less than 250 volt grade.

(e) Antennae within buildings shall be so placed and constructed that they cannot come into contact with wires or apparatus (other than the radio equipment) connected to supply mains.

(f) Both inside and outside of buildings, a distance of not less than 12 inches shall be maintained between antennae or leading-in wires and electric light and power conductors unless a continuous and firmly fixed non-conductor maintains permanent separation between them. This non-conductor shall be in addition to any insulation on the conductors.

(g) Antennae and leading-in wires shall be covered with insulation of not less than 250 volt grade—

(i.) within buildings; and

(ii.) within a distance of 6 feet from radio equipment where they are external to buildings.

(h) Leading-in wires shall be brought into a building through a non-combustible, non-absorptive, insulating bushing, so arranged as to prevent the entry of moisture. Each leading-in wire shall be provided with a lightning protective device (lightning arrester) of approved pattern, which shall be fixed outside the building near the point where such wire is brought into the building. The protective device shall be mounted on a non-combustible base away from inflammable material, and shall include an air gap not exceeding 0.005 inch between aerial and earth connections.

(i) The use of an antennae earthing switch shall not obviate the necessity for the protective device required by Clause (h) of this regulation. If such a switch is installed it shall form, in its closed position, a shunt round the protective device. If separate from the protective device, it may be placed within the building. Where situated within reach of the radio apparatus, such earthing switch shall be of the all-insulated type.

(j) Any cut-out inserted in the antenna circuit shall be placed so that it cannot interrupt the circuit from the antenna to ground.

Radio and Electro-Acoustic Equipment and Small Rectifying Apparatus

2452. (a) The provisions of this regulation shall apply to every rectifying apparatus not exceeding 1,200 volt amperes rated input, which is to be used for charging storage batteries and similar purposes, and to all radio receiving or transmitting and electro-acoustic equipment connected or to be connected to supply mains.

(b) Live parts connected to supply mains shall be isolated by means of—

(i.) Insulation; or

(ii.) one or more condensers; or

(iii.) one or more transformers having independent primary and secondary windings,

from all exposed metal, and from metal which is not completely covered by insulating material adequate to withstand satisfactorily, at all times, the supply pressure.

(c) Where isolation as required by Clause (b) hereof is obtained by means of insulation or transformers, the apparatus shall be capable of satisfactorily withstanding for two minutes the application of a pressure of 1,500 volts a.c. between the supply connections and any exposed or inadequately insulated metal, and where such isolation is obtained by means of condensers, the apparatus shall be capable of satisfactorily withstanding for two minutes a d.c. pressure of 1,500 volts, and, for one hour, an a.c. pressure of 50 cycles, equal to 1.5 times the supply pressure, the pressure in each case being applied as aforesaid.

VICTORIAN WIRING RULES—(Continued)—

(d) Where a metal chassis or framework is to be at any time in connection with a supply main, it shall be enclosed within a non-conducting case of such construction that personal contact cannot be made with the chassis or framework while the apparatus is connected to such supply main.

(e) Where the maximum voltage at any terminals exceeds 100, such terminals shall be of insulated pattern, and shall have the extreme voltage distinctly marked thereat. All live terminals directly connected to supply mains, or energised directly or indirectly from supply mains to a pressure exceeding 100 volts, shall either be enclosed or be protected by a cover.

(f) All radio equipment shall be provided with a suitably worded danger notice, which shall be permanently fixed on the inside of the lid, cover, or door by which access is obtained to the interior of the radio equipment. This notice shall contain the heading "DANGER" in bold letters, and the words, "This equipment operates at a dangerous electrical pressure. No adjustment to the interior apparatus is to be made unless disconnected from the supply mains."

(g) Where a terminal is provided for the connexion of any portion of the apparatus to earth, it shall be distinctly marked "Earth."

Electric Supply Systems Throughout Australia

The Town or District is given first, then voltage and frequency. The owners or suppliers to the various districts are not shown, as generally the radio industry is chiefly interested in the voltage and frequency for possible business with all-electric or battery sets. This list has been compiled and further checked at great trouble and cost, and should be the most up-to-date list available. No responsibility is accepted for any errors or omissions as in some cases the supply authority failed to supply the information.

Adelaide City (not including North Adelaide) is being converted from 200 volts 50 cycles to 240 volts 50 cycles. The changeover is expected to be completed by the end of 1937. Some portions of Adelaide City have already been changed, and precaution must be taken accordingly to ascertain correct voltage. Sydney City is also in process of being changed from 240 D.C. to 240 A.C. 50 cycles.

A

ABERDARE, N.S.W., 240v., 50c.
ABERDEEN, N.S.W., 240v. D.C.
ABERMAIN, N.S.W., 240v. 50c.
ABERNETHY, N.S.W., 240v. 50c.
ADAMSTOWN, N.S.W., 240v. 50c.
ADELAIDE, S.A., 200v. 50c. (During 1935 to 1938 Adelaide will be changed to 240v. 50c. excluding North Adelaide.)
ADELONG, N.S.W., 240v. 50c.
ALBANY, W.A., 220v. D.C.
ALBION PARK, N.S.W., 240v. 50c.
ALBURY, N.S.W., 240v. 50c.
ALDGATE, S.A., 200v. 50c.
ALEXANDRA, Vic., 230v. 50c.
ALEXANDRIA, N.S.W., 240v. 50c.
ALLANSFORD, Vic., 230v. 50c.
ALTONA, Vic., 230v. 50c.
ALVIE, Vic., 230v. 50c.
AMBLESIDE, S.A., 200v. 50c.
ANGASTON, S.A., 200v., 50c.
ANNANDALE, N.S.W., 240v. 50c.
ANTHILL PONDS, Tas., 240v. 50c.
APOLLO BAY, Vic., 230v. D.C.
APPLECROSS, W.A., 250v. 40c.
ARARAT, Vic., 230v. 50c.
ARDMONA, Vic., 230v. 50c.
ARDROSSAN, S.A., 220v. D.C.
ARIAH PARK, N.S.W., 240v. D.C.
ARMADALE, W.A., 250v. 40c.
ARMIDALE, N.S.W., 240v. 50c.
ARNCLIFFE, N.S.W., 240v. 50c.
ASHFIELD, N.S.W., 240v. 50c.
ASHTON, S.A., 200v. 50c.
ASPENDALE, Vic., 230v. 50c.
ASQUITH, N.S.W., 240v. 50c.
ATHERTON, Qld., 240v. 50c.
ATTUNGA, N.S.W., 240v. 50c.
AUBURN, N.S.W., 240v. 50c.
AUBURN, S.A., 240v. 50c.
AUSTINMER, N.S.W., 240v. 50c.
AVALON, N.S.W., 240v. 50c.
AVOCA, Vic., 230v. D.C.
AVOCA, Tas., 240v. 50c.
AVONDALE, N.S.W., 240v. 50c.
AVON DAM, N.S.W., 240v. 50c.
AYR, Qld., 220v. D.C.

B

BACCHUS MARSH, Vic., 230v. 50c.
BAGDAD, Tas., 240v. 50c.
BAIRNSDALE, Vic., 230v. 50c.
BALAKLAVA, S.A., 200v. 50c.
BALGOWNIE, N.S.W., 240v. 50c.
BALHANNAH, S.A., 240v. A.C
BALINGUP, W.A., 220v. D.C.
BALLAN, Vic., 230v. 50c.
BALLARAT, Vic., D.C. 220v., A.C. 230v. 50c.
BALLINA, N.S.W., 240v. 50c.
BALMAIN, N.S.W., 240v. 50c.
BALRANALD, N.S.W., 240v. D.C.
BANGALOW, N.S.W., 240v. 50c.
BANKSTOWN, N.S.W., 240v. 50c.
BARCALDINE, Qld., 240v. D.C.
BARGO, N.S.W., 80v. D.C.
BARMEDMAN, N.S.W., 240v. 50c.
BARHAM, N.S.W., 230v. 50c.
BARMERA, S.A., 240v. 50c.
BARNAWARTHA, Vic., 230v. 50c.
BARRON FALLS, Q'land, 240v. 50c.
BARRABA, N.S.W., 240v. D.C.
BARWON HEADS, Vic., 230v. 50c.
BASKET RANGE, S.A., 200v. 50c.
BASSENDEAN, W.A., 250v. 40c.
BASKERVILLE, W.A., 240v. 40c.
BATHURST, N.S.W., 240v. 50c.
BATLOW, N.S.W., 240v. 50c.
BAULKHAM HILLS, N.S.W., 240v. 50c.
BAYSWATER, Vic., 230v. 50c.
BAYSWATER, W.A., 250v. 40c.
BEACONSFIELD, Tas., 240v. 50c.
BEACONSFIELD, Vic., 230v. 50c.
BEADON POINT, W.A., 220v. D.C.
BEAUDESERT, Qld., 240v. D.C.
BEAUFORT, Vic., 230v. 50c.
BEAUTY POINT, Tas., 240v. 50c.
BEEAC, Vic., 230v. 50c.
BEECHBORO, W.A., 250v. 40c.
BEECHWORTH, Vic., 230v. 50c.
BEECROFT, N.S.W., 240v. 50c.
BEGA, N.S.W., 240v. 50c.
BELAIR, S.A., 200v. 50c.
BELGRAVE, Vic., 230v. 50c.
BELLAMBI, N.S.W., 240v. 50c.

BELLBIRD, N.S.W., 240v. 50c.
BELLINGEN, N.S.W., 240v. 50c.
BELMONT, N.S.W., 240v. 50c.
BENA, Vic., 230v. 50c.
BENALLA, Vic., 230v. 50c.
BENCUBBIN, W.A., 220v. D.C.
BENDIGO, Vic., 230v. 50c. 220v. D.C.
BERRI, S.A., 220v. D.C.
BERRIGAN, N.S.W., 240v. 50c.
BERRIMA, N.S.W., 240v. 50c.
BERRY, N.S.W., 240v. 50c.
BERWICK, Vic., 230v. 50c.
BEULAH, Vic., 230v. D.C.
BEVERLEY, W.A., 220v. D.C.
BEXLEY, N.S.W., 240v. 50c.
BICKLEY, W.A., 250v. 40c.
BINALONG, N.S.W., 240v. 50c.
BINGARA, N.S.W., 240v. D.C.
BIRCHIP, Vic., 230v. D.C.
BIRDWOOD, S.A., 200v. 50c.
BIREGURRA, Vic., 230v. 50c.
BISHOPBOURNE, Tas., 240v. 50c.
BLACKALL, Qld., 240v. D.C.
BLACKALLS, N.S.W., 240v. 50c.
BLACKBURN, Vic., 230v. 50c.
BLACKHEATH, N.S.W., 240v. 50c.
BLAKISTON, S.A., 200v. 50c.
BLACKTOWN, N.S.W., 240v. 50c.
BLACKWALL, N.S.W., 240v. 50c.
BLACKWOOD, S.A., 200v. 50c.
BLAYNEY, N.S.W., 240v. 50c.
BLYTH, S.A., 200v. 50c.
BOAT HARBOUR, Tas.. 240v. 50c.
BOGGABRI, N.S.W., 230v. 50c.
BOLWARRA, N.S.W., 240v. 50c.
BOMADERRY, N.S.W., 240v. 50c.
BOMBALA, N.S.W., 240v. 50c.
BOMBO, N.S.W., 240v. 50c.
BOOKER BAY, N.S.W., 240v. 50c.
BOOLAROO, N.S.W., 240v. D.C.
BOOLEROO CENTRE, S.A., 240v. 50c.
BOOLARRA, Vic., 230v. 50c.
BOOLONG, N.S.W., 240v. 50c.
BOONAH, Qld., 220v. D.C.
BOOROWA, N.S.W., 240v. 50c.
BOORT, Vic., 230v. D.C.
BORDERTOWN, S.A., 240v. 50c.
BORONIA, Vic., 230v. 50c.
BOSTOCK CREEK, Vic., 230v. 50c.
BOTANY, N.S.W., 240v. 50c.
BOURKE, N.S.W., 240v. 50c.
BOTHWELL, Tas., 240v. 50c.
BOWEN, Qld., 240v. 50c.
BOWNING, N.S.W., 240v. 50c.
BOWRAL, N.S.W., 240v. 50c.
BOWRAVILLE, N.S.W., 240v. 50c.
BOWTHORNE, N.S.W., (see West Maitland).
BOX HILL, Vic., 230v. 50c.
BOYA, W.A., 250v. 40c.
BRACKNELL, Tas., 240v. 50c.
BRAESIDE, Vic., 230v. 50c.
BRANXTON, N.S.W. (see Greta).
BREWARRINA, N.S.W., 240v. D.C.
BRIAR HILL, Vic., 230v. 50c.
BRICKENDON, Tas., 240v. 50c.
BRIDGETOWN, W.A., 220v. D.C.
BRIDGEWATER, S.A., 200v. 50c.
BRIDGEWATER, Tas., 240v. 50c.
BRIGHT, Vic., 230v. 50c.
BRIGHTON, Tas., 240v. 50c.
BRIGHTON, Vic., 200v. 50c.
BRINKWORTH, S.A., 200v. 50c.
BRISBANE, Qld., 240v. 50c.
BROADFORD, Vic., 230v. D.C.
BROKEN HILL, N.S.W., 220/110v. A.C. 100c.
BROOKTON, W.A., 220v. D.C.
BROOKVALE, N.S.W., 240v. 50c.
BROOME, W.A., 220v. D.C.
BROWNSVILLE, N.S.W., 240v. 50c.
BRUCE ROCK, W.A., 220v. D.C.
BRUNGLE, N.S.W., 240v. 50c.
BRUNSWICK, W.A., 220v. D.C.
BRUNSWICK, Vic., 230v. 50c.
BRUNSWICK HEADS, N.S.W., 240v., 50c.
BRUTHEN, Vic., 230v. 50c.
BUCKLAND HILL, W.A. (formerly Cottesloe Beach), 250v. 40c.
BULLI, N.S.W., 240v. 50c.
BULN BULN, Vic., 230v. 50c.
BUNBURY, W.A., 220v. D.C.
BUNDABERG, Qld., 240v. D.C.
BUNDANOON, N.S.W., 240v. 50c.
BUNYIP, Vic., 230v. 50c.
BURNIE, Tas., 240v. 50c.
BURRA, S.A., 240v. 50c.
BURRADOO, N.S.W., 240v. 50c.
BURRAWA, N.S.W., 240v. 50c.
BURRAWANG, N.S.W. (see Bundanoon).
BURWOOD, N.S.W., 240v. 50c.
BUSSELTON, W.A., 220v. D.C.
BUTE, S.A., 230v. D.C.
BYFORD, W.A., 250v. 40c.
BYRON BAY, N.S.W., 240v. 50c.

C

CABRAMATTA, N.S.W., 240v. 50c.
CAIRNS DISTRICT, Qld., 240v. 50c.
CALTOWIE, S.A., 200v. 50c.
CAMBERWELL, Vic., 200v. 50c.
CAMBRIDGE, Tas., 240v. 50c.
CAMDEN, N.S.W., 240v. 50c.
CAMPANIA, Tas., 240v. 50c.
CAMPBELLTOWN, N.S.W., 240v. 50c.
CAMPBELLTOWN, Tas., 240v. 50c.
CAMPERDOWN, Vic., 230v. 50c.
CANBERRA, F.C.T., 240v. 50c.
CANLEY VALE, N.S.W. (Included in Cabramatta).
CANNING BRIDGE DISTRICT, W.A., 250v. 40c.
CANNINGTON, W.A., 250v. 40c.
CANNING VALE, W.A., 250v. 40c.
CANOWINDRA, N.S.W., 240v. D.C. and 240v. 50c.
CANTERBURY, N.S.W., 240v. 50c.
CAPEL, W.A., 250v. 40c.
CARDIFF, N.S.W., 240v. 50c.
CARDUP, W.A., 250v. 40c.
CARLINGFORD, N.S.W. (see Dundas).
CARMEL, W.A., 250v. 40c.
CARNAMAGH, W.A., 220v., D.C.
CARNARVON, W.A., 220v. D.C.
CARRATHOOL, N.S.W., 240v. 50c.
CARRINGTON, N.S.W., 240v. 50c.
CARRUM, Vic., 230v. 50c.
CAREY'S GULLY, S.A., 200v. 50c.
CASINO, N.S.W., 240v. 50c.
CASTERTON, Vic., 230v. D.C.
CASTLE FORBES BAY, Tas., 240v. 50c.
CASTLEMAINE, Vic., 230v. 50c.
CAULFIELD, Vic., 200v. 50c. and 230v. 50c.
CAVERSHAM, W.A., 250v. 40c.
CEDUNDA, S.A., 220v. D.C.
CENTRAL ILLAWARRA, N.S.W., 240v. 50c.
CESSNOCK, N.S.W., 240v. 50c.
CHAIN OF PONDS, S.A., 200v. 50c.
CHARLESTOWN, N.S.W., 240v. 50c.
CHARLESTON, S.A., 240v. 50c.
CHARLEVILLE, Qld., 240v. D.C.
CHARLTON, Vic., 230v. D.C.
CHELTENHAM, N.S.W., 240v. 50c.
CHELTENHAM, Vic., 200v. 50c.
CHELSEA, Vic., 230v. 50c.
CHILDERS, Qld., 220v. D.C.
CHILTERN, Vic., 230v. 50c.
CIRCULAR HEAD, Tas., 240v. 50c.
CLARE, S.A., 240v. 50c.
CLAREMONT, W.A., 250v. 40c.
CLARENCE RIVER COUNTY COUNCIL, N.S.W., 240v. 50c.

CLARENCE POINT, Tas., 240v. 50c.
CLAREVILLE, N.S.W., 240v. 50c.
CLAYTON, Vic., 230v. 50c.
CLEMATIS, Vic., 230v. 50c.
CLEVE, S.A., 220v. D.C.
CLIFTON, N.S.W., 240v. 50c.
CLOVERLEA, Vic., 230v. 50c.
COALCLIFF, N.S.W., 240v. 50c.
COCKBURN, N.S.W., 240v. 50c.
COBAR, N.S.W., Supply ceased
COBDEN, Vic., 230v. 50c.
COBRAM, Vic., 230v. D.C.
COBURG, Vic., 230v. 50c.
COFF'S HARBOUR, N.S.W., 240v. 50c.
COHUNA, Vic., 230v. D.C.
COLAC, Vic., 230v. 50c.
COLEDALE, N.S.W., 240v. 50c.
COLDSTREAM, N.S.W., 240v. 50c.
COLDSTREAM, Vic., 230v. 50c.
COLERAINE, Vic., 230v. D.C.
COLLAROY, N.S.W., 240v. 50c.
COLLIE, W.A., 250v. D.C.
COLLINGWOOD, Vic., 230v. 50c.
CONARA, Tas., 240v. 50c.
CONCORD, N.S.W., 240v. 50c.
CONDOBOLIN, N.S.W., 240v. 50c.
CONNISTON, N.S.W., 240v. 50c.
COOLAH, N.S.W., 240v. 50c.
COOEE, Tas., 240v. 50c.
COOLAMON, N.S.W., 230v. 50c.
COOLANGATTA, Qld., 240v. 50c.
COOMA, N.S.W., 240v. D.C.
COONABARABRAN, N.S.W., 240v. 50c.
COONAMBLE, N.S.W., 240v. 50c.
COOROW, W.A., 220v. D.C.
COOTAMUNDRA, N.S.W., 240v. 50c.
COPMANHURST, N.S.W., 240v. 50c.
CORA LYNN, Vic., 230v. 50c.
CORAKI, N.S.W., 240v. 50c.
CORAGULAE, Vic., 230v. 50c.
CORDEAUX DAM, N.S.W., 240v. 50c.
CORNWALL, Tas., 240v. 50c.
COROMANDEL VALLEY, S.A., 200v. 50c.
COROROOKE, Vic., 230v. 50c.
COROWA, N.S.W., 240v. 50c.
CORRIGIN, W.A., 220v. D.C.
CORRIMAL, N.S.W., 240v. 50c.
CORRYONG, Vic., 230v. 50c.
CORINDHAP, Vic., 230v. 50c.
COTTESLOE, W.A., 250v. 40c.
COUTTS CROSSING, N.S.W., 240v. 50c.
COWELL, S.A., 220v. D.C.
COWRA, N.S.W., 240v. 50c.
COWWARR, Vic., 230v. 50c.
CRAFERS, S.A., 200v. 50c.
CRANBOURNE, Vic., 230v. 50c.
CRESSY, Tas., 240v. 50c.
CRIB POINT, Vic., 230v. 50c.
CRONULLA, N.S.W., 240v. 50c.
CROOKWELL, N.S.W., 240v. D.C.
CROYDON, N.S.W., 240v. 50c.
CROYDEN, Vic., 230v. 50c.
CRYSTAL BROOK, S.A., 240v. 50c.
CUE, W.A., 220v. D.C.
CULCAIRN, N.S.W., 240v. 50c.
CURRAMULKA, S.A., 110v. D.C.
CULLEN BULLEN, N.S.W., 240v. 50c.
CUNDERDIN, W.A., 220v. D.C.
CUNNAMULLA, Qld., 240v. 50c.
CYGNET, Tas., 240v. 50c.

D

DALBY, Qld., 220v. D.C.
DALWALLINU, W.A., 220v. D.C.
DANDENONG, Vic., 230v. 50c.
DAPTO, N.S.W., 240v. 50c.
DARBY'S FALLS, N.S.W., 240v. 50c.
DARLINGTON, W.A., 250v. 40c.
DARLINGTON, N.S.W., 240v. 50c.
DARNUM, Vic., 230v. 50c.
DARWIN, N.T., 415/240v. 50c.
DAVENPORT, S.A., 220v. D.C.
DAYLESFORD, Vic., 230v. D.C.
DEER PARK, Vic., 230v. 50c.
DEE WHY, N.S.W., 240v. 50c.
DEMONDRILLE, N.S.W., 240v. 50c.
DELORAINE, Tas., 240v. 50c.
DENILIOUIN, N.S.W., 240v. 50c.
DENMARK, W.A., 220v. D.C.
DENNINGTON, Vic., 230v. 50c.
DERWENT VALLEY, Tas., 240v. 50c.
DEVONPORT, Tas., 240v. 50c.
DIAMOND CREEK, Vic., 230v. 50c.
DIGGER'S REST, Vic., 230v. 50c.
DIMBOOLA, Vic., 230v. D.C.
DINGLEY, Vic., 230v. 50c.
DON, Tas., 240v. 50c.
DONALD, Vic., 230v. D.C.
DONCASTER, Vic., 200v. 50c.
DONNYBROOK, W.A., 220v. D.C.
DOOKIE, Vic., 230v. 50c.
DOONSIDE, N.S.W., 240v. 50c.
DORA CREEK, N.S.W., 240v. 50c.
DORRIGO, N.S.W., 240v. 50c.
DOVER, Tas., 240v. 50c.
DOWERIN, W.A., 220v. D.C.
DROMANA, Vic., 230v. 50c.
DROMEDARY, Tas., 240v. 50c.
DROUIN, Vic., 230v. 50c.
DRUMMOYNE, N.S.W., 240v. 50c.
DRYSDALE, Vic., 230v. 50c.
DUBBO, N.S.W., 240v. 50c.
DUDLEY, N.S.W., 240v. 50c.
DULWICH HILL, N.S.W., 240v. 50c.
DUMBLEYUNG, W.A., 220v. D.C.
DUNDAS, N.S.W., 240v. 50c.
DUNGOG, N.S.W., 240v. D.C.
DUNOLLY, Vic., 230v. 50c.
DYSART, Tas., 240v. 50c.

E

EAGLEHAWK, Vic., 230v. D.C.
EAST CANNINGTON, W.A., 250v. 40c.
EAST OAKLEIGH, Vic., 230v. A.C.
EASTWOOD, N.S.W. (see Dundas). 240v. 50c.
EAST GRETA, N.S.W., 240v. 50c.
EAST MAITLAND, N.S.W. (see West Maitland).
ECHUCA, Vic., 230v. 50c.
EDEN HILLS, S.A., 200v. 50c.
EDENHOPE, Vic., 230v. D.C.
EDITHBURG, S.A., 220v. D.C.
ELECTRONA, Tas., 240v. 50c.
ELLIMINYT, Vic., 230v. 50c.
ELLIOTT, Tas., 240v. 50c.
ELMORE, Vic., 230v. D.C.
ELTHAM, Vic., 230v. 50c.
ENFIELD, N.S.W., 240v. 50c.
EMERALD, Vic., 230v. 50c.
EPPING, N.S.W. (see Dundas).
ERINA SHIRE, N.S.W., 240v. 50c.
ERMINGTON, N.S.W. (see Dundas). 240v. 50c.
ERSKINEVILLE, N.S.W., 240v. 50c.
ESSENDON, Vic., 230v. 50c.
ESPERANCE, Tas., 240v. 50c.
ESPERANCE, W.A., 220v. D.C.
ESTELVILLE, N.S.W., 240v. 50c.
ETTALONG, N.S.W., 240v. 50c.
EUDUNDA, S.A., 240v. 50c.
EUROA, Vic., 230v. D.C.
EVANDALE, Tas., 240v. 50c.
EVELYN, Vic. (see Silvan).
EXETER, N.S.W. (see Bundanoon).
EXTON, Tas., 240v. 50c.

F

FAIRFIELD, N.S.W., 240v. 50c.
FAIRY MEADOW, N.S.W., 240v. 50c.
FALCONBRIDGE, N.S.W., 240v. 50c.
FASSIFERN, N.S.W., 240v. 50c.
FERN HILL, N.S.W., 240v. 50c.

FERNTREE GULLY, Vic., 230v. 50c.
FERNY CREEK, Vic., 230v. 50c.
FIGTREE, N.S.W., 240v. 50c.
FINGAL, Tas., 240v. 50c.
FINLEY, N.S.W., 240v. 50c.
FITZROY, Vic., 230v. 50c.
FLEMINGTON, Vic., 230v. 50c.
FLOWERDALE, Tas., 240v. 50c.
FOOTSCRAY, Vic., 230v. 50c.
FORBES, N.S.W., 240v. 50c.
FORDS, S.A., 200v. 50c.
FOREST, Tas., 240v. 50c.
FORREST, W.A., 220v. D.C.
FORTH, Tas., 240v. 50c.
FORSTER, N.S.W., 240v. 50c.
FOSTER, Vic., 230v. 50c.
FRANKLIN, Tas., 240v. 50c.
FRANKSTON, Vic., 230v. 50c.
FREELING, S.A., 200v. 50c.
FREMANTLE, W.A., 250v. 40c.

G

GALONG, N.S.W., 240v. 50c.
GARDNERS BAY, Tas., 240v. 50c.
GARFIELD, Vic., 230v. 50c.
GAWLER, S.A., 200v. 50c.
GAWLER, Tas., 240v. 50c.
GAWLER RIVER, S.A., 200v. 50c.
GAYNDAH, Qld., 240v. D.C.
GEELONG, Vic., 230v. 50c. and 220v. D.C.
GEEVESTON, Tas., 240v. 50c.
GEORGETOWN, Tas., 240v. 50c.
GEORGETOWN, S.A., 200v. 50c.
GERALDTON, W.A., 220v. D.C.
GERRINGONG, N.S.W., 240v. 50c.
GILGANDRA, N.S.W., 240v. D.C.
GIRRAWEEN, N.S.W., 240v. 50c.
GISBORNE, Vic., 230v. 50c.
GLADSTONE, Qld., 240v. D.C.
GLADSTONE, S.A., 200v. 50c.
GLADSTONE, Tas., 200v. 50c.
GLEBE, N.S.W., 240v. 50c.
GLEN EWIN, S.A., 200v. 50c.
GLEN FOREST, W.A., 250v. 40c.
GLEN GARRY, Vic., 230v. 50c.
GLEN HUON, Tas., 240v. 50c.
GLEN INNES, N.S.W., 240v. 50c.
GLENORA, Tas., 240v. 50c.
GLENORMISTON, Vic, 230v. 50c.
GLENBROOK, N.S.W., 240v. 50c.
GLEN WAVERLEY, Vic., 230v. 50c.
GLOUCESTER, N.S.W., 240v. 50c.
GNOWANGERUP, W.A., 220v. D.C.
GNOTUK, Vic., 230v. 50c.
GOOLWA, S.A., 240v. 50c.
GOONDIWINDI, Qld., 240v. D.C.
GOOSEBERRY HILL, W.A., 250v. 40c.
GORDON, Tas., 240v. 50c.
GORMANSTONE, Tas., 235v. 50c.
GOROKE, Vic., 230v. D.C.
GOSFORD, N.S.W., 240v. 50c.
GOSNELLS, W.A., 250v. 40c.
GOULBURN CITY, N.S.W., 240v. D.C.
GOULBURN, N.S.W. (Outer City), 240v. 50c.
GRAFTON, N.S.W., 240v. 50c.
GRANTON, Tas., 240v. 50c.
GRANVILLE, N.S.W. (see Parramatta).
GREAT MARLOW, N.S.W., 240v. 50c.
GREENMOUNT, W.A., 250v. 40c.
GREENOCK, S.A., 200v. 50c.
GREEN PONDS, Tas., 240v. 50c.
GREENSBOROUGH, Vic., 230v. 50c.
GRENFELL, N.S.W., 230v. 50c.
GRETA, N.S.W., 240v. 50c.
GRETNA, Tas., 240v. 50c.
GRIFFITH, N.S.W. (Irrigation Com.), 240v. 50c.
GROVE, Tas., 240v. 50c.
GROVEDALE, Vic., 230v. 50c.
GUILDFORD, N.S.W., 240v. 50c.
GUILDFORD, W.A., 250v. 40c.
GULGONG, N.S.W., 240v. 50c.
GUMERACHA, S.A., 200v. 50c.
GUNDAGAI, N.S.W., 240v. 50c.
GUNDURIMBA, N.S.W., 240v. 50c.
GUNNEDAH, N.S.W., 240v. D.C.
GUNNING, N.S.W., 240v. D.C.
GUYRA, N.S.W., 240v. 50c.
GYMPIE, Qld., 250v. D.C.

H

HABERFIELD, N.S.W., 240v. 50c.
HACKHAM, S.A., 200v. 50c.
HAGLEY, Tas., 240v. 50c.
HALBURY, S.A., 200v. 50c.
HAITON, N.S.W. (see West Maitland).
HAMILTON, Vic., 230v. D.C.
HAMILTON, N.S.W., 240v. 50c.
HAMILTON, S.A., 240v. 50c.
HAMLEY BRIDGE, S.A., 200v. 50c.
HAMPDEN, S.A., 240v. 50c.
HARBORD, N.S.W., 240v. 50c.
HARCOURT, Vic., 230v. A.C.
HARDEN, N.S.W., 240v. 50c.
HARRIS PARK, N.S.W., 240v. 50c.
HARVEY, W.A., 220v. D.C.
HARWOOD, N.S.W., 240v. 50c.
HASTINGS, Vic., 230v. 50c.
HAWTHORN, Vic., 200v. 50c.
HAY, N.S.W., 240v. 50c.
HAYES, Tas., 240v. 50c.
HAZELBROOK, N.S.W., 240v. 50c.
HEALESVILLE, Vic., 230v. 50c.
HERNE HILL, W.A., 250v. 40c.
HEATHCOTE, Vic., 230v. D.C.
HEDDON GRETA, N.S.W., 240v. 50c.
HEIDELBURG, Vic., 230v. 50c.
HELENSBURGH, N.S.W., 240v. 50c.
HENTY, N.S.W., 240v. D.C.
HEPBURN, Vic., 230v. 50c.
HEXHAM, N.S.W., 240v. 50c.
HEYFIELD, Vic., 230v. 50c.
HIGHERCOMBE, S.A., 200v. 50c.
HILLSTON, N.S.W., 240v. 50c.
HOBART, Tas., 240v. 50c.
HOLBROOK, N.S.W., 240v. D.C.
HOLMESVILLE, N.S.W., 240v. 50c.
HOLROYD, N.S.W., 240v. 50c.
HOMEBUSH, N.S.W., 240v. 50c.
HOME HILL, Qld., 240v. 50c.
HOMEVILLE, N.S.W., 240v. 50c.
HOPETOUN, Vic., 230v. D.C.
HOPE VALLEY, S.A., 200v. 50c.
HORNSBY, N.S.W., 240v. 50c.
HORSHAM, Vic., 230v. D.C.
HOUGHTON, S.A., 200v. 50c.
HUGHENDEN, Qld., 240v. D.C.
HUNTER'S HILL, N.S.W., 240v. 50c.
HUON, Tas., 240v. 50c.
HUONVILLE, Tas., 240v. 50c.
HURSTVILLE, N.S.W., 240v. 50c.

I

INGLEBURN, N.S.W., 240v. 50c.
INGLEWOOD, S.A., 200v. 50c.
INGLEWOOD, Vic., 230v. D.C.
INNISFAIL, Qld., 240v. 50c.
INVERELL, N.S.W., 240v. 50c.
IVERLOCH, Vic., 230v. 50c.
IPSWICH, Qld., 240v. 50c
IRISHTOWN, Tas., 240v. 50c.
IRON KNOB, S.A., 230v. 50c.
IRREWARRA, Vic., 230v. 50c.

J

JAMBUNNA, Vic., 230v. 50c.
JAMBEROO, N.S.W., 240v. 50c.
JAMESTOWN, S.A., 200v. 50c.
JASPERS BRUSH, N.S.W., 240v. 50c.

JEIR, N.S.W., 240v. 50c.
JEPARIT, Vic., 230v. D.C.
JERICHO, Tas., 240v. 50c.
JERILDERIE, N.S.W., 240v. 50c.
JUDBURY, Tas., 240v. 50c.
JUGIONG, N.S.W., 240v. 50c.
JUNEE, N.S.W., 240v. 50c.
JUMBUNNA, Vic., 230v. 50c.

K

KADINA, S.A., 220v. D.C.
KALAMUNDA, W.A., 250v. 40c.
KALGOORLIE, W.A., 220v. D.C. Also 110v. 40c.
KALIMNA, Vic. 230v. 50c.
KALLISTA, Vic., 230v. 50c.
KANDOS, N.S.W., 240v. 50c.
KANGAROO FLAT, Vic., 230v. 50c.
KANIVA, Vic., 230v. 50c.
KAPUNDA, S.A., 200v. 50c.
KAROONDA, S.A., 220v. D.C.
KATANNING, W.A., 220v. D.C.
KATOOMBA, N.S.W., 240v. 50c.
KEARSLEY, N.S.W. 240v. 50c.
KEIRAVILLE, N.S.W., 240v. 50c.
KELLERBERRIN, W.A., 220v. D.C.
KELMSCOTT, W.A., 250v. 40c.
KEMBLA GRANGE, N.S.W., 240v. 50c.
KEMPSEY, N.S.W., 240v. D.C.
KELSO, Tas., 240v. 50c.
KEMPTON, Tas., 240v. 50c.
KENMORE, N.S.W., 240v. 50c.
KENTISH, Tas., 240v. 50c.
KENWICK, W.A., 250v. 40c.
KERANG, Vic., 230v. D.C.
KERSLEY, N.S.W. (see West Maitland).
KETTERING, Tas., 240v. 50c.
KEW, Vic., 200v. 50c.
KIAMA, N.S.W., 240v. 50c.
KILMORE, Vic., 230v. D.C.
KILSYTH, Vic., 230v. 50c.
KINGAROY, Qld., 240v. D.C.
KINGBOROUGH, Tas., 240v. 50c.
KINGSTON, Tas., 240v. 50c.
KITCHENER, N.S.W., 240v. 50c.
KOGARAH, N.S.W., 240v. 50c.
KOJONUP, W.A., 110v. D.C.
KOLORA, Vic., 230v. 50c.
KONGWAK, Vic., 230v. 50c.
KONDININ, W.A., 220v. D.C.
KOOLUNGA, S.A., 110v. D.C.
KOONDROOK, Vic., 230v. 50c.
KOORDA, W.A., 220v. D.C.
KOO-WEE-RUP, Vic., 230v. 50c.
KOROIT, Vic., 230v. 50c.
KORONGVALE, Vic., 230v. 50c.
KORUMBURRA, Vic., 230v. 50c.
KULIN, W.A., 220v. D.C.
KUNONOPPIN, W.A., 220v. D.C.
KURING-GAI, N.S.W., 240v. 50c.
KURRI KURRI, N.S.W., 240v. 50c.
KYABRAM, Vic., 230v. 50c.
KYNETON, Vic., 230v. 50c.
KYOGLE, N.S.W., 240v. D.C.

L

LAKE BOGA, Vic., 230v. 50c.
LAKE CARGELLICO, N.S.W., 240v. 50c.
LAKE GRACE, W.A., 220v. D.C.
LAKE MACQUARIE, N.S.W., 240v. 50c.
LAKES ENTRANCE, Vic., 230v. 50c.
LAMBTON, N.S.W., 240v. 50c.
LAMEROO, S.A., 220v. D.C.
LANCEFIELD, Vic., 230v. 50c.
LANE COVE, N.S.W., 240v. 50c.
LARA, Vic., 230v. 50c.
LARA LAKE, Vic., 230v. 50c.
LARPENT, Vic., 230v. 50c.
LATROBE, Tas., 240v. 50c.
LAUNCESTON, Tas., 240v. 50c.
LAURA, S.A., 220v. D.C.
LAWSON, N.S.W., 240v. 50c.
LEASINGHAM, S.A., 240v. 50c.
LEETON, N.S.W. (Irrigation Com.), 240v. 50c.
LEICHHARDT, N.S.W., 240v. 50c.
LEONGATHA, Vic., 230v. 50c.
LEONARA, W.A., 220v. D.C.
LEOPOLD, Vic., 230v. 50c.
LESMURDIE, W.A., 250v. 40c.
LEURA, N.S.W., 240v. 50c.
LEVEN, Tas., 240v. 50c.
LIDCOMBE, N.S.W., 240v. 50c.
LILYDALE, Vic., 230v. 50c.
LINDEN, N.S.W., 240v. 50c.
LINDENOW, Vic., 230v. 50c.
LISMORE, N.S.W., 240v. 50c.
LITHGOW, N.S.W., 240v. 50c.
LITTLEHAMPTON, S.A., 200v. 50c
LIVERPOOL, N.S.W., 240v. 50c.
LOCH, Vic., 230v. 50c.
LOCKHART, N.S.W., 240v. D.C.
LOCKINVAR, N.S.W., 240v. 50 c.
LONGFORD, Tas., 240v. 50c.
LONGLEY, Tas., 240v. 50c.
LONGREACH, Qld., 240v. D.C.
LONGWARRY, Vic., 230v. 50c.
LORN, N.S.W. (see West Maitland).
LOWER FERNTREE GULLY, Vic., 230v. 50c.
LORNE, Vic., 230v. D.C.
LOWER LONGLEY, Tas., 240v. 50c.
LOWER PLENTY, Vic., 230v. 50c
LOXTON, S.A., 220v. D.C.
LUCASTON, Tas., 240v. 50c.
LUCKNOW, 230v. 50c.
LYMINGTON, Tas., 240v. 50c.
LYNDOCH, S.A., 200v. 50c.

M

MACEDON, Vic., 230v. 50c.
MACKAY, Qld., 240v. 50c.
MACKSVILLE, N.S.W., 240v. 50c.
MACLEAN, N.S.W., 240v. 50c.
MACQUARIE FIELDS, N.S.W., 240v. 50c.
MACQUARIE PLAINS, Tas., 240v. 50c.
MADDINGTON, W.A., 250v. 40c.
MAFFRA, Vic., 230v. 50c.
MAIDA VALE, W.A., 250v. 40c.
MAITLAND, S.A., 230v. D.C.
MAITLAND WEST, N.S.W., 240v. 50c.
MALLALA, S.A., 200v. 50c.
MALVERN, Vic., 200v. 50c. and 230v. 50c.
MANANGATANG, Vic., 230v. D.C.
MANDURAH, W.A., 220v. D.C.
MANDOWA SHIRE, N.S.W., 240 v. 50c.
MANILLA, N.S.W., 240v. 50c.
MANJIMUP, W.A., 220v. D.C.
MANLY, N.S.W., 240v. 50c.
MANLY VALE, N.S.W., 240v. 50c.
MANNUM, S.A., 230v. D.C.
MANSFIELD, Vic., 230v. 50c.
MARGATE, Tas., 240v. 50c.
MARRABEL, S.A., 240v. 50c.
MAREEBA, Q'land, 240v. 50c.
MARRICKVILLE, N.S.W., 240v. 50c.
MARULAN, N.S.W., 240v. 50c.
MARYBOROUGH, Qld., 240v. 50c.
MARYBOROUGH, Vic., 230v. 50c.
MASCOT, N.S.W., 240v. 50c.
MAYFIELD, N.S.W. (see West Maitland).
McLAREN VALE, S.A., 200v. 50c.
McLAREN FLAT, S.A., 200v. 50c.
MECKERING, W.A., 220v. D.C.
MEDLOW BATH, N.S.W. (see Blackheath).
MEEKATHARRA, W.A., 220v. D.C.
MELBOURNE CITY, Vic., 230v. 50c. and 230 D.C.
MELTON MOWBRAY, Tas., 240v. 50c.
MELVILLE, W.A., 250v. 40c.
MENTONE, Vic., 200v. 50c.
MERBEIN, Vic., 230v. 50c.

MEREWETHER, N.S.W., 240v. 50c.
MERREDIN, W.A., 220v. D.C.
MERRIGUM, Vic., 230v. 50c.
MERRYLANDS, N.S.W., 240v. 50c.
MIDDLE SWAN, W.A., 250v. 40c.
MIDDLETON, Tas., 240v. 50c.
MIDLAND JUNCTION, W.A., 250v. 40c.
MILDURA, Vic., 230v. D.C. and 230v. 50c.
MILLENDON, W.A., 250v. 40c.
MILLER'S FOREST, N.S.W., 240v. 50c.
MILLICENT, S.A., 230v. D.C.
MILLTHORPE (See Blayney), N.S.W.
MILTON, N.S.W., 110v. D.C.
MINGENEW, W.A., 220v. D.C.
MINLATON, S.A., 220v. D.C.
MINNAMURRA, N.S.W., 240v. 50c.
MINTARO, S.A., 240v. 50c.
MINYIP, Vic., 230v. D.C.
MIRBOO NORTH, Vic., 230v. 50c.
MITCHAM, Vic., 230v. 50c.
MITTAGONG, N.S.W., 240v. 50c.
MOAMA, N.S.W., 240v. 50c.
MOANA, S.A., 200v. 50c.
MOE, Vic, 230v. 50c.
MOLONG, N.S.W., 240v. 50c.
MONA VALE, N.S.W., 240v. 50c.
MONEGEETA, Vic., 230v. 50c.
MONTMORENCY, Vic. 230v. 50c.
MONTROSE, Vic., 230v. 50c.
MOOLAP, Vic., 230v. 50c.
MOONTA, S.A., 230v. D.C.
MOORA, W.A., 220v. D.C.
MOORABIN, Vic., 200v. 50c. and 230v. 50c.
MOORE CREEK, N.S.W., 240v. 50c.
MOOROOPNA, Vic., 230v. 50c.
MOOROODUC, Vic., 230v. 50c.
MORDIALLOC, Vic., 200v. 50c.
MOREE, N.S.W., 240v. 50c.
MORGAN, S.A., 220v. D.C.
MORISSET, N.S.W., 240v. 50c.
MORNINGTON, Vic., 230v. 50c.
MOROWA, W.A., 220v. D.C.
MORPETH, N.S.W. (see West Maitland).
MORPHETT VALE, S.A., 200v. 50c.
MORTDALE, N.S.W., 240v. 50c.
MORTLAKE, Vic., 230v. 50c.
MORUYA, N.S.W., 240v. 50c.
MORWELL, Vic., 230v. 50c.
MORWELL BRIDGE, Vic., 230v. 50c.
MOSMAN, N.S.W., 240v. 50c.
MOSSIFACE, Vic., 230v. 50c.
MOSS VALE, N.S.W., 240v. 50c.
MOULAMAIN, N.S.W., 240v. 50c.
MOUNT BARKER, S.A., 200v. 50c.
MOUNT BARKER, W.A., 220v. D.C.
MOUNT COLAH, N.S.W., 240v. 50c.
MOUNT DANDENONG, Vic., 230v. 50c.
MOUNT ELIZA, Vic., 230v. 50c.
MOUNT EVELYN, Vic., 230v. 50c.
MOUNT GAMBIER, S.A., 230v. D.C.
MOUNT KEIRA, N.S.W., 240v. 50c.
MOUNT KEMBLA, N.S.W., 240v. 50c.
MOUNT LOFTY, S.A., 200v. 50c.
MOUNT MAGNET, W.A., 220v. D.C.
MOUNT MARTHA, Vic., 230v. 50c.
MOUNT NICHOLAS, Tas., 240v. 50c.
MOUNT PLEASANT, S.A., 200v. 50c.
MOUNT PLEASANT, N.S.W., 240v. 50c.
MOUNT TORRENS, S.A., 240v. 50c.
MOUNT VICTORIA, N.S.W., 240v. 50c.
MOUNT WAVERLEY, Vic., 230v. 50c.
MUDGEE, N.S.W., 240v. 50c.
MULBRING, N.S.W., 240v. 50c.
MULGRAVE, Vic., 230v. 50c.
MULLEWA, W.A., 220v. D.C.
MULLUMBIMBY, N.S.W., 240v. 50c.
MUNDARING, W.A., 220v. D.C.
MURCHISON, Vic., 230v. 50c.
MURGON, Qld., 240v. 50c.
MURRAY BRIDGE, S.A., 220v. D.C.
MURRAYVILLE, Vic., 230v. 50c.
MURRUMBIDGEE IRRIGATION AREAS, 240v. 50c.
MURRUMBURRAH, N.S.W., 240v. 50c.
MURRURUNDI, N.S.W., 230v. 50c.
MURTOA, Vic., 230v. D.C.
MURWILLUMBAH, N.S.W., 240v. 50c.
MUSWELLBROOK, N.S.W., 240v. 50c.
MYLOR, S.A., 200v. 50c.
MYRTLEFORD, Vic., 230v. 50c.

N

NAGAMBIE, Vic., 230v. D.C.
NAIRNE, S.A., 200v. 50c.
NALANGIL, Vic., 230v. 50c.
NAMBOUR, Qld., 240v. 50c.
NAMBUCCA, N.S.W., 240v. 50c.
NANNUP, W.A., 220v. D.C.
NARRACOORTE, S.A., 220v. D.C.
NAREMBEEN, W.A., 220v. D.C.
NAR-NAR-GOON, Vic., 230v. 50c.
NARRABEEN, N.S.W., 240v. 50c.
NARRABRI, N.S.W., 240v. D.C.
NARRANDERA, N.S.W., 240v. 50c.
NARRE WARREN, Vic., 230v. 50c.
NARROGIN, W.A., 250v. 40c.
NARROMINE, N.S.W., 240v. 50c.
NATHALIA, Vic., 230v. 50c.
NATIMUK, Vic., 230v. 50c.
NAYOOK, Vic., 230v. 50c.
NEPEAN DAM, N.S.W., 240v. 50c.
NEATH, N.S.W., 240v. 50c.
NEERIM, Vic., 230v. 50c.
NEERIM SOUTH, Vic., 230v. 50c.
NEWCASTLE & DISTRICT, N.S.W., 240v. 50c.
NEW GISBORNE, Vic., 230v. 50c.
NEW LAMBTON, N.S.W., 240v. 50c.
NEWPORT, N.S.W., 240v. 50c.
NEW NORFOLK, Tas., 240v. 50c.
NEWTOWN, N.S.W., 240v. 50c.
NEWRY, Vic., 230v. 50c.
NHILL, Vic., 230v. D.C.
NICHOLLS RIVULET, Tas., 240v. 50c.
NICHOLSON, Vic., 230v. 50c.
NILMA, Vic., 230v. 50c.
NYMBOIDA, N.S.W., 240v. 50c.
NOARLUNGA, S.A., 200v. 50c.
NOBLE PARK, Vic., 230v. 50c.
NOOJEE, Vic., 230v. 50c.
NOORAT, Vic., 230v. 50c.
NORMANHURST, N.S.W., 240v. 50c.
NORTHAM, W.A., 220v. D.C.
NORTHAMPTON, W.A., 220v. D.C.
NORTHCOTE, Vic., 230v. 50c.
NORTH FREMANTLE, W.A., 2[illegible]v. 40c.
NORTH ILLAWARRA, N.S.W., 240v. 50c.
NORTH MANLY, N.S.W., 240v. 50c.
NORTH PARRAMATTA, N.S.W. (see Dundas).
NORTH SHORE, Vic., 230v. 50c.
NORTH SYDNEY, N.S.W., 240v. 50c.
NORTON'S SUMMIT, S.A., 200v. 50c.
NORTH WOLLONGONG, N.S.W., 240v. 50c.
NOTTING HILL, Vic., 230v. 50c.
NOWRA, N.S.W., 240v. 50c.
NUMURKAH, Vic., 230v. 50c.
NURIOOTPA, S.A., 200v. 50c.
NYAH, Vic., 230v. 50c.
NYNGAN, N.S.W., 240v. D.C.

O

OAKBANK, S.A., 240v. 50c.
OAKLEIGH, Vic., 230v. 50c.
OATLANDS, Tas., 240v. 50c.
OCEAN BEACH, N.S.W., 240v. 50c.
OCEAN GROVE, Vic., 230v. 50c.
OFFICER, Vic., 230v. 50c.
OLINDA, Vic., 230v. 50c.
OMEO, Vic., 230v. 50c.
ORANGE, N.S.W., 240v. 50c.
ORANGE GROVE, N.S.W., 240v. 50c.

ORARA, N.S.W., 240v. 50c.
ORBOST, Vic., 230v. D.C.
ORROROO, S.A., 230v. D.C.
OUYEN, Vic., 230v. D.C.
OWEN, S.A., 200v. 50c.
OYSTER COVE, Tas., 240v. 50c.

P

PADDINGTON, N.S.W., 240v. 50c.
PAKENHAM, Vic., 230v. 50c.
PALM BEACH, N.S.W., 240v. 50c.
PAMBULA, 240v. 50c.
PARACOMBE, S.A., 200v. 50c.
PARKES, N.S.W., 240v. 50c.
PARRAMATTA, N.S.W., 240v. 50c.
PARRA WIRRA, S.A., 200v. 50c.
PARATTAH, Tas., 240v. 50c.
PARA-WIRRA, S.A., 200v. 50c.
PATERSON, N.S.W. (see West Maitland).
PATONGA, N.S.W., 240v. 50c.
PATRICK'S PLAINS, N.S.W. (see Singleton).
PAXTON, N.S.W., 240v. 50c.
PEAK HILL, N.S.W., 240v. 50c.
PEEL SHIRE, N.S.W., 240v. 50c.
PELAW MAIN, N.S.W., 240v. 50c.
PENDLE HILL, N.S.W., 240v. 50c.
PENGUIN, Tas., 240v. 50c.
PENOLA, S.A., 220v. D.C.
PENNANT HILLS, N.S.W., 240v. 50c.
PENRITH, N.S.W., 240v. 50c.
PENWORTHAM, S.A., 240v. 50c.
PEPPERMINT GROVE, W.A., 250v. 40c.
PERTH, Tas., 240v. 50c.
PERTH, W.A., 250v. 40c.
PETERBOROUGH, S.A., 230v. D.C.
PETERSHAM, N.S.W., 240v. 50c.
PHEGAN'S BAY, N.S.W., 240v. 50c.
PHILLIP ISLAND, Vic., 230v. 50c.
PIALBA, Qld., 240v. 50c.
PICCADILLY, S.A., 200v. 50c.
PICTON, N.S.W., 240v. 50c.
PINNAROO, S.A., 230v. 50c.
PINGELLY, W.A., 220v. D.C.
PINJARRA, W.A., 220v. D.C.
PITTSWORTH, Qld., 240v. 50c.
PLENTY, Tas., 240v. 50c.
POINT LONSDALE, Vic., 230v. 50c.
POMBORNEIT, Vic., 230v. 50c.
PONTVILLE, Tas., 240v. 50c.
POOWONG, Vic., 230v. 50c.
PORTARLINGTON, Vic., 230v. 50c.
PORT AUGUSTA, S.A., 220v. D.C.
PORT AUGUSTA WEST, S.A., 220v. D.C.
PORT BROUGHTON, S.A., 230v. D.C.
PORT ELLIOT, S.A., 240v. 50c.
PORT FAIRY, Vic., 230v. 50c.
PORT HUON, Tas., 240v. 50c.
PORTLAND, N.S.W., 240v. 50c.
PORTLAND, Vic., 230v. 50c.
PORT KEMBLA, N.S.W., 240v. 50c.
PORT LINCOLN, S.A., 240v. 50c.
PORT MACQUARIE, N.S.W., 230v. 50c.
PORT MACDONNELL, S.A., 220v. D.C.
PORT MELBOURNE, Vic., 23ov. 50c.
PORT NOARLUNGA, S.A., 200v. 50c.
PORT PIRIE, S.A., 240v. 50c.
PORTSEA, Vic., 230v. 50c.
PORT STEPHENS, N.S.W., 240v. 50c.
PORT VICTORIA, S.A., 220v. D.C.
PORT VINCENT, S.A., 220v. D.C.
PRAHRAN, Vic., 200v. 50c. and 230v. 50c.
PRESTON, Vic., 230v. 50c.
PROSERPINE, Qld., 240v. 50c.
PROSPECT, N.S.W., 240v. 50c.
PYRAMID, Vic., 230v. 50c.

Q

QUAIRADING, W.A., 220v. D.C.
QUAMBATOOK, Vic., 230v. D.C.
QUEANBEYAN, N.S.W., 240v. 50c.
QUEENSCLIFF, Vic., 230v. 50c.
QUEENSCLIFFE, N.S.W., 240v. 50c.
QUEEN'S PARK, W.A., 250v. 40c.
QUEENSTOWN, Tas., 220v. 50c.
QUIRINDI, N.S.W., 240v. 50c.
QUORN, S.A., 230v. D.C.

R

RAILTON, Tas., 240v. 50c.
RAINBOW, Vic., 230v. D.C.
RANDWICK, N.S.W., 240v. 50c.
RANELAGH, Tas., 240v. 50c.
RAYMOND TERRACE, N.S.W., 240v. 50c.
RAYWORTH, N.S.W. (see West Maitland).
READ TOWN, N.S.W., 240v. 50c.
REDCLIFFE, Qld., 240v. 50c.
REDFERN, N.S.W., 240v. 50c.
RED HILL, S.A., 220v. D.C.
REGENTS PARK, N.S.W., 240v. 50c.
RENMARK, S.A., 230v. D.C.
RENMARK IRRIGATION SETTLEMENT, 240v. 50c.
REYNELLA, S.A., 200v. 50c.
RHYNIE, S.A., 240v. 50c.
RICHMOND, N.S.W., 240v. 50c.
RICHMOND, Vic., 230v. 50c.
RICHMOND, Tas., 240v. 50c.
RIDDELL, Vic., 230v. 50c.
RINGWOOD, Vic., 230v. 50c.
RIVERTON, S.A., 240v. 50c.
ROBE, S.A., 230v. D.C.
ROBERTSON, N.S.W., 240v. 50c.
ROCHESTER, Vic., 230v. 50c.
ROCKDALE, N.S.W., 240v. 50c.
ROCKHAMPTON, Qld., 240v. 50c.
ROCKINGHAM, W.A., 110v. D.C.
ROMA, Qld., 220v. D.C.
ROMSEY, Vic., 230v. 50c.
ROOKWOOD, Tas., 240v. 50c.
ROSEBERY, Tas., 230v. 50c.
ROSEBUD, Vic., 230v. 50c.
ROSEDALE, Vic., 230v. 50c.
ROSEWORTHY, S.A., 200v. 50c.
ROSEWORTHY COLLEGE, S.A., 200v. 50c.
ROSS, Tas., 240v. 50c.
ROTTNEST, W.A., 220v. D.C.
ROZELLE, N.S.W., 240v. 50c.
ROWLANDS FLAT, S.A., 200v. 50c.
RUBY, Vic., 230v. 50c.
RUPANYUP, Vic., 230v. D.C.
RUSHWORTH, Vic., 230v. D.C.
RUTHERFORD, N.S.W. (see West Maitland).
RUTHERGLEN, Vic., 230v. 50c.
RYDE, N.S.W., 240v. 50c.
RYE, Vic., 230v. 50c.
RYLSTONE, N.S.W., 240v. 50c.

S

SADDLEWORTH, S.A., 240v. 50c.
SALE, Vic., 230v. 50c.
SALISBURY, S.A., 200v. 50c.
SANDFLY, Tas., 240v. 50c.
SANDRINGHAM, Vic., 200v. 50c.
SARINA, Q'land, 240v. 50c.
SASSAFRAS, Tas., 240v. 50c.
SASSAFRAS, Vic., 230v. 50c.
SCARBOROUGH, N.S.W., 240v. 50c.
SCONE, N.S.W., 240v. D.C.
SCOTTSDALE, Tas., 240v. 50c.
SEAFORD, Vic., 230v. 50c.
SEAFORTH, Vic., 230v. 50c.
SEA LAKE, Vic., 230v. D.C.
SEFTON, N.S.W., 240v. 50c.
SEVEN HILLS, S.A., 240v. 50c.
SEVEN HILLS, N.S.W., 240v. 50c.
SELBY, Vic., 230v. 50c.
SELMOUR, Vic., 230v. 50c.
SEYMOUR, Vic., 230v. 50c.
SHEFFIELD, Tas., 240v. 50c.
SHELLHARBOUR, N.S.W., 240v. 50c.
SHEPPARTON, Vic., 230v. 50c.
SHERBROOKE, Vic., 230v. 50c.

SHERWOOD, N.S.W., 240v. 50c.
SILVAN, Vic., 230v. 50c.
SINGLETON, N.S.W., 240v. 50c.
SMITHFIELD, S.A., 200v. 50c.
SMITHFIELD, N.S.W., 240v. 50c.
SMITHTON, Tas., 240v. 50c.
SNOWTOWN, S.A., 220v. D.C.
SNUG, Tas., 240v. 50c.
SOMERSET, Tas., 240v. 50c.
SOMERVILLE, Vic., 230v. 50c.
SORELL, Tas., 240v. 50c.
SORRENTO, Vic., 230v. 50c.
SOUTHERN CROSS, W.A., 250v. D.C.
SOUTHGATE, N.S.W., 240v. 50c.
SOUTH GRAFTON, N.S.W., 240v. 50c.
SOUTH GUILDFORD, W.A., 250v. 40c.
SOUTH MELBOURNE, Vic., 230v. 50c. and 200v. 50c.
SOUTH PERTH, W.A., 250v. 40c.
SOUTHPORT, Qld., 240v. 50c.
SPEAR'S POINT, N.S.W., 240v. 50c.
SPION KOP, N.S.W., 240v. 50c.
SPREYTON, Tas., 240v. 50c.
SPRINGHURST, Vic., 230v. 50c.
SPRINGVALE, Vic., 230v. 50c.
SPRINGTON, S.A., 110v. D.C.
SPRINGWOOD, N.S.W., 240v. 50c.
STANFORD MERTHYR, N.S.W., 240v. 50c.
STANLEY, Tas., 240v. 50c.
STANTHORPE, Qld., 240v. 50c.
STAWELL, Vic., 230v. 50c.
STANWELL PARK, N.S.W., 240v. 50c.
ST. ALBANS, Vic., 230v. 50c.
ST. ARNAUD, Vic., 230v. 50c.
ST. GEORGE COUNTY COUNCIL, N.S.W., 240v. 50c.
ST. GEORGE, Qld., 230v. D.C.
ST. KILDA, Vic., 200v. 50c. and 230v. 50c.
ST. MARY'S, N.S.W., 240v. 50c.
ST. PETERS, N.S.W., 240v. 50c.
STIRLING, East and West, S.A., 200v. 50c.
STOCKINBINGAL, N.S.W., 240v. 50c.
STOCKTON, N.S.W., 240v. 50c.
STRATFORD, Vic., 230v. 50c.
STRATHALBYN, S.A., 220v. D.C.
STRATHBLANE, Tas., 240v. 50c.
STRATHFIELD, N.S.W., 240v. 50c.
STRATHMERTON, Vic., 230v. 50c.
STREAKY BAY, S.A., 220v. D.C.
SUBIACO, W.A., 250v. 40c.
SUMMER HILL, N.S.W., 240v. 50c.
SUMMERLEAS, Tas., 240v. 50c.
SUMMERTOWN, S.A., 200v. 50c.
SUNBURY, Vic., 230v. 50c.
SUNSHINE, Vic., 230v. 50c.
SUTHERLAND, N.S.W., 240v. 50c.
SWAN HILL, Vic., 230v. 50c.
SWAN REACH, Vic., 230v. 50c.
SWANSEA, N.S.W., 240v. 50c.
SWAN VIEW, W.A., 250v. 40c.
SYDNEY (City), N.S.W., 240/480v. D.C., 240 A.C. 50c.
SYDNEY, METROPOLITAN, N.S.W., 240v. 50c.
SYMMONS PLAINS, Tas., 240v. 50c.

T

TABLE CAPE, Tas., 240v. 50c.
TAILEM BEND, S.A., 220v. D.C.
TALLANGATTA, Vic., 230v. 50c.
TALLYGAROOPNA, Vic., 230v. 50c.
TALLY HO, Vic., 230v. 50c.
TALUNGA, S.A., 200v. 50c.
TAMMIN, W.A., 220v. D.C.
TAMBELLUP, W.A., 220v. D.C.
TAMWORTH, N.S.W., 240v. 50c.
TANUNDA, S.A., 220v. D.C.
TAREE, N.S.W., 240v. 50c.
TARRAWANNA, N.S.W., 240v. 50c.
TARRO, N.S.W., 240v. 50c.
TATURA, Vic., 230v. 50c.
TECOMA, Vic., 230v. 50c.
TEA TREE, Tas., 240v. 50c.
TEA TREE GULLY, S.A., 200v. 50c.
TELARAH, N.S.W., 240v. 50c.
TELOPEA, N.S.W., 240v. 50c.
TEMORA, N.S.W., 240v. 50c.
TENAMBIT, N.S.W., 240v. 50c.
TENANDRA, N.S.W., 240v. 50c.
TENTERFIELD, N.S.W., 240v. 50c.
TERALBA, N.S.W., 240v. 50c.
TERANG, Vic., 230v. 50c.
TERANIA, N.S.W., 240v. 50c.
TERRIGAL, N.S.W. (Erina Shire), 240v. 50c.
THARGOMINDAH, Qld., 220v. D.C.
THE ENTRANCE, N.S.W. (Erina Shire), 240v. 50c.
THE ROCK, N.S.W., 240v. D.C.
THEODORE, Qld., 240v. D.C.
THIRROUL, N.S.W., 240v. 50c.
THOMASTOWN, Vic., 230v. 50c.
THORNLEIGH, N.S.W., 240v. 50c.
THORNTON, N.S.W., 240v. 50c.
THORNTON, Vic., 230v. 50c.
THREE SPRINGS, W.A., 220v. D.C.
TINAMBA, Vic., 230v. 50c.
TINTENBAR, N.S.W., 240v. 50c.
TOCUMWAL, N.S.W., 240v. 50c.
TOLGA, Q'land, 240v. 50c.
TONGALA, Vic., 230v. 50c.
TOODYAY, W.A., 220v. D.C.
TOOGOOLAWAH, Qld., 240v. 50c.
TOOMBUL, Qld., 240v. 50c.
TOONGABBIE, N.S.W., 240v. 50c.
TOONGABBIE, Vic., 230v. 50c.
TOORA, Vic., 230v. 50c.
TOOWOOMBA, Qld., 240v. D.C.
TORONTO, N.S.W., 240v. 50c.
TORQUAY, Vic., 230v. 50c.
TOWNSVILLE, Qld., 240v. 50c.
TRAFALGAR, Vic., 230v. 50c.
TRANGIE, N.S.W., 240v. 50c.
TRARALGON, Vic., 230v. 50c.
TREMONT, Vic., 230v. 50c.
TRENTHAM, Vic., 230v. 50c.
TULLY, Qld., 240v. 50c.
TUMBARUMBA, N.S.W., 240v. 50c.
TUMBY BAY, S.A., 220v. D.C.
TUMUT, N.S.W., 240v. 50c.
TUNBRIDGE, Tas., 240v. 50c.
TUNCURRY, N.S.W., 240v. 50c.
TWEED HEADS, N.S.W., 240v. 50c.
TWEED VALE, S.A., 240v. 50c.
TWO WELLS, S.A., 200v. 50c.
TYABB, Vic., 230v. 50c.
TYERS, Vic., 230v. 50c.
TYNONG, Vic., 230v. 50c.

U

ULMARRA, N.S.W., 240v. 50c.
ULTIMA, Vic., 230v. 50c.
ULVERSTONE, Tas., 240v. 50c.
UNANDERRA, N.S.W., 240v. 50c.
UNDALYA, S.A., 240v. 50c.
UNDERBOOL, Vic., 230v. D.C.
UPPER MACEDON, Vic., 230v. 50c.
UPPER SWAN, W.A., 250v. 40c.
UPPER BEACONSFIELD, Vic., 230v. 50c.
UPWEY, Vic., 230v. 50c.
URAIDLA, S.A., 200v. 50c.
URALLA, N.S.W., 240v. D.C.

V

VAUCLUSE, N.S.W., 240v. 50c.
VERDUN, S.A., 200v. 50c.
VICTOR HARBOUR, S.A., 240v. 50c.
VIOLET TOWN, Vic., 230v. 50c.
VIRGINIA BLOCKS, S.A., 200v. 50c.

W

WAITARA, N.S.W., 240v. 50c.
WAGGA WAGGA, N.S.W., 240v. 50c.
WAGIN, W.A., 220v. D.C.

WAHGUNYAH, Vic., 230v. 50c.
WAHROONGA, N.S.W., 240v. 50c.
WAIKERIE, S.A., 240v. 50c.
WALCHA, N.S.W., 240v. D.C.
WALGETT, N.S.W., 240v. D.C.
WALLACIA, N.S.W., 110v. D.C.
WALLAROO, S.A., 240v. 50c.
WALLA WALLA, N.S.W., 240v. D.C.
WALLENDBEEN, N.S.W., 240v. 50c.
WALLERAWANG, N.S.W., 240v. 50c.
WALLSEND, N.S.W., 240v. 50c.
WALPA, Vic., 230v. 50c.
WANGARATTA, Vic., 230v. 50c.
WARATAH, N.S.W., 240v. 50c.
WARBURTON, Vic., 230v. D.C. and 230v. 50c.
WARIALDA, N.S.W., 240v. D.C.
WARNCOORT, Vic., 230v. 50c.
WARRACKNABEAL, Vic., 230v. 50c.
WARRAGUL, Vic., 230v. 50c.
WARREN, N.S.W., 240v. 50c.
WARRIMOO, N.S.W., 240v. 50c.
WARRINGAH, N.S.W., 240v. 50c.
WARRION, Vic., 230v. 50c.
WARRNAMBOOL, Vic., 230v. 50c.
WARWICK, Qld., 220v. D.C.
WASLEYS, S.A., 200v. 50c.
WATERLOO, N.S.W., 240v. 50c.
WATERLOO, Tas., 240v. 50c.
WATERVALE, S.A., 240v. 50c.
WATERVIEW, N.S.W., 240v. 50c.
WATSONIA, Vic., 230v. 50c.
WATTLE GROVE, W.A., 250v. 40c.
WATTLE GROVE, Tas., 240v. 50c.
WAUCHOPE, N.S.W., 240v. 50c.
WAVERLEY, N.S.W., 240v. 50c.
WEDDERNBURN, Vic., 230v. 50c.
WEERITE, Vic., 230v. 50c.
WEE WAA, N.S.W., 240v. 50c.
WELLINGTON, N.S.W., 240v. 50c.
WELSHPOOL, W.A., 250v. 40c.
WENTWORTH, N.S.W., 240v. 50c.
WENTWORTH FALLS, N.S.W., 240v. 50c.
WENTWORTHVILLE, N.S.W., 240v. 50c.
WERRIBIE, Vic., 230v. 50c.
WERRIS CREEK, N.S.W., 240v. 50c.
WESTBURY, Tas., 240v. 50c.
WESTERN JUNCTION, Tas., 240v. 50c.
WESTERWAY, Tas., 240v. 50c.
WEST MAITLAND, N.S.W., 240v. 50c.
WESTMEAD, N.S.W., 240v. 50c.
WESTON, N.S.W., 240v. 50c.
WEST SWAN, Vic., 250v. 40c.
WEST WALLSEND, N.S.W., 240v. 50c.
WEST WYALONG, N.S.W., 240v. D.C.
WHEELERS HILL, Vic., 230v. 50c.
WHITTON, N.S.W., 240v. 50c.
WHYALLA, S.A., 230v. 50c.
WICKEPIN, W.A., 230v. D.C.
WICKHAM, N.S.W., 240v. 50c.
WILLASTON, S.A., 200v. 50c.
WILLIAMSFORD, Tas., 230v. 50c.
WILLIAMSTOWN, Vic., 230v. 50c.
WILLOUGHBY, N.S.W., 240v. 50c.
WILLUNGA, S.A., 200v. 50c.
WILMINGTON, S.A., 220v. D.C.
WILUNA, W.A., 250v. 50c.
WINCHELSEA, Vic., 230v. 50c.
WINDSOR, N.S.W., 240v. 50c.
WINGHAM, N.S.W., 240v. 50c.
WINTON, Qld., 240v. D.C.
WIVENHOE, Tas., 240v. 50c.
WODONGA, Vic., 230v. 50c.
WOLLONGONG, N.S.W., 240v. 50c.
WOMBARRA, N.S.W., 240v. 50c.
WONGAN HILLS, W.A., 220v. D.C.
WONTHAGGI, Vic., 240v. 50c.
WOODBRIDGE, Tas., 240v. 50c.
WOODBURN SHIRES, N.S.W., 240v. 50c.
WOODBURY, N.S.W., 240v. 50c.
WOODBURY, Tas., 240v. 50c.
WOODEND, Vic., 230v. 50c.
WOODFORD, N.S.W., 240v. 50c.
WOODSIDE, S.A., 240v. 50c.
WOODVILLE, N.S.W. (see West Maitland).
WOOLLAHRA, N.S.W., 240v. 50c.
WOOLMERS, Tas., 240v. 50c.
WOOL WOOL, Vic., 230v. 50c.
WOONONA, N.S.W., 240v. 50c.
WOORALOO, W.A., 220v. D.C.
WOY WOY BAY, N.S.W., 240v. 50c.
WOY WOY SHIRE, N.S.W., 240v. 50c.
WUNGHNE, Vic., 230v. 50c.
WYALCATCHEM, W.A., 220v. D.C.
WYALONG WEST, N.S.W., 240v. 50c.
WYANGALA, N.S.W., 240v. 50c.
WYCHEPROOF, Vic., 230v. D.C.
WYNDHAM, W.A., 220v. D.C.
WYNYARD, Tas., 240v. 50c.
WYONG, N.S.W., 240v. 50c.

Y

YACKA, S.A., 200v. 50c.
YALGOO, W.A., 220v. D.C.
YALINGUP, W.A., 220v. D.C.
YALLOURN, Vic., 230v. 50c.
YALUMBA, S.A., 200v. 50c.
YANCO, N.S.W., 240v. 50c.
YANKALILLA, S.A., 240v. 50c.
YARRA GLEN, Vic., 230v. 50c.
YARRAGON, Vic., 230v. 50c.
YARRAM, Vic., 230v. 50c.
YARRAWONGA, Vic., 230v. 50c.
YASS, N.S.W., 240v. 50c.
YEA, Vic., 230v. 50c.
YENDA, N.S.W. (Irrigation Com.), 240v. 50c.
YERING, Vic., 230v. 50c.
YERINGBERG, Vic., 230v. 50c.
YINNAR, Vic., 230v. 50c.
YALLA, Tas., 240v. 50c.
YORK, W.A., 220v. D.C.
YORKETOWN, S.A., 220v. D.C.
YOUNG, N.S.W., 240v. 50c.

Z

ZEEHAN, Tas., 240v. 50c.

Fundamental Electrical Formulae

THERE are quite a number of people who are inclined to think that "Ohm's Law" belongs to the crystal set days of radio, and, therefore, not worthy of serious attention in these days of ultra-short waves and multi-electrode valves.

However, Ohm's Law is as important to-day as it ever was, and we make no apology for again prefacing the Technical Section of the "Radio Trade Annual" with details of this Law and some examples of its application.

Direct Currents

OHM'S Law indicates the relationship between voltage current and resistance in any direct current circuit. It has three general forms, depending on which of the three factors is unknown.

$$E = IR \qquad (1)$$

$$I = \frac{E}{R} \qquad (2)$$

$$R = \frac{E}{I} \qquad (3)$$

where E = Voltage
I = Current in amperes
R = Resistance in ohms.

This law is of paramount importance in calculating the value of voltage-dropping resistors. For example, the anode-grid (i.e., oscillator plate) of a 2A7 draws 4mA at a maximum voltage of 200. If the high tension supply is 250 volts, it is obvious that we require to drop 50 volts at 4mA. Using formula (3) above, we have—

$$R = \frac{50}{.004} = 12{,}500 \text{ ohms.}$$

It will also be desired to know the wattage which will be dissipated in the resistance so that one of sufficient rating may be obtained. From first principles,

Watts = Voltage × Current
or $W = EI \qquad (4)$

But from formula (1) above, $E = IR$

Therefore $W = IR \times I = I^2 R \qquad (5)$

Similarly, from formula (2), $I = \frac{E}{R}$

Hence $W = E \times \frac{E}{R} = \frac{E^2}{R} \qquad (6)$

Having found the wattage dissipation, a resistance of the desired value, but having the nearest **larger** wattage rating is chosen. If the resistance value required is an odd one, it may be necessary to build it up with two or more resistors, rated according to the wattage calculated for each resistance.

Occasionally, if high wattage resistors are not obtainable, it is possible to improvise these by using two or more lower-wattage resistors in parallel, as indicated in fig. 1.

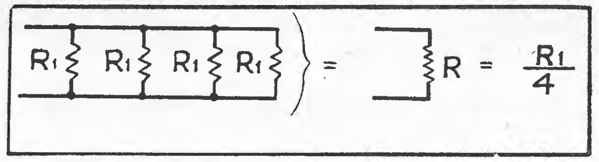


Fig. 1

Resistors in Parallel

In general, if there are "n" resistors, each of resistance "R,"

$$\text{Effective Resistance} = \frac{R}{n} \qquad (7)$$

Each resistor will carry an equal share of the total current flowing into the bank of resistors. If the individual resistances are not equal but are of values R_1 and R_2 (fig. 2) then the effective resistance R is given by

$$R = \frac{R_1 R_2}{R_1 + R_2} \qquad (8)$$

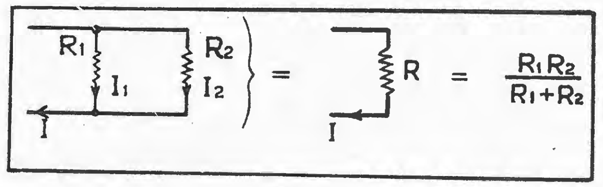


Fig. 2

If we put $R_1 = R_2$ this boils down to $\frac{R_1}{2}$ On the other hand if we have more than two resistors R is given by

$$R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots} \qquad (9)$$

DIRECT CURRENTS—(Continued)—

Unequal resistors carry unequal currents. In the case of two resistors, the currents in each is directly proportional to the value of the other resistor. Referring to fig. 2

$$I_1 = I \frac{R_2}{R_1 + R_2} \qquad (10)$$

Safe Current

Suppose we have a 5,000 ohm 10 mA resistor and a 3,000 ohms 15 mA resistor in parallel to give 1,875 ohms. What total current will this combination then pass without damage? Reversing formula (10) we have

$$I = I_1 \frac{R_1 + R_2}{R_2} \qquad (11a)$$

and we find that the total current which flows when the maximum rated current 10 mA(I_1), is flowing in the 5,000 ohm resistor, is given by

$$I = 10 \times \frac{8000}{3000} = 26.6 \text{ mA.}$$

Similarly—

$$I = I_2 \frac{R_1 + R_2}{R_1} \qquad (11b)$$

and when I_2 is at its maximum value of 15 mA then

$$I = 15 \times \frac{8000}{5000} = 24 \text{ mA}$$

It is thus not safe to exceed the lower of these two figures, 24 mA. The combination given above is an efficient one since each resistor is carrying practically its maximum rated current.

Screen Voltage Supply

Another case which often crops up is the calculation of the correct resistance network to obtain screen voltages. One of the usual methods of supplying screen voltage is shown in fig. 3. First let us fix a suitable value for the bleed current Ib flowing through R_1. If we choose a value of 20,000 ohms for R_1, and since there is a drop across R_1 equal to the screen voltage of 100, then the current flowing through R_1 is 5 mA.

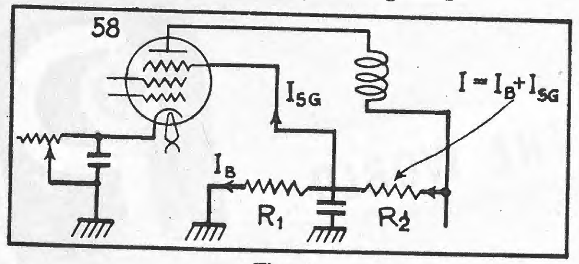


Fig. 3

The screen current of a 58 is 2.0 mA, so that the current flowing through R_2 is equal to the sum of these two, or 7.0 mA. If the power voltage is 300 volts (on load) this necessitates a drop of 200 volts across R_2. Substituting these values in formula (3), R_2 is found to be approximately 30,000 ohms. If we want to supply several tubes the calculations are similar but a larger bleed current is desirable, for as the volume control grid bias of the variable mu tubes is increased to reduce volume, the screen currents will diminish and consequently the voltage across R_1 increases.

This is, however, counteracted to some extent by the fact that the cathode becomes more positive with respect to chassis and the increase in actual screen volts (from cathode to screen), is lessened.

Voltage Dividers

The design of the voltage divider shown in fig. 4 is illustrated in the table below. The procedure follows that given above. A bleed current of 10 mA through R_1 is our initial assumption.

Section	Current (mA.)	Voltage Drop	Resistance (Ohms)
R_1	10	100	10,000
R_2	14	150	10,700
R_3	24.2	70	2,900
Total		320	23,600

A 25,000 ohm divider set at 10,600, 11,300 and 3,100 would be suitable. It is however, usually more convenient to adjust voltage dividers after installation in a set, measurements being taken with a high resistance voltmeter.

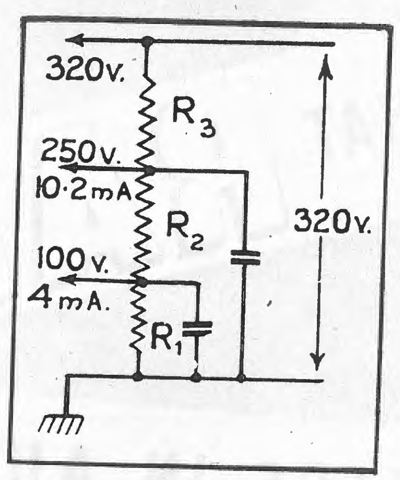


Fig. 4

Alternating Currents

AN alternating current is one which periodically changes its direction by passing from a maximum in one direction to a maximum in the other direction and back again. This process completes one cycle and the frequency of an alternating current is the number of cycles occurring per second. The simplest or sinusoidal form of alternating current is shown in fig. 5 in

(Continued on next page)

ALTERNATING CURRENTS—(Continued)—

the form of a sine wave, and is obtained from the rotating radius OP, one revolution or 360° corresponding to one cycle. All A.C. currents are not sinusoidal, many having a very distorted wave form. It is, however, always possible to express any periodic wave form as the sum of a fundamental sine wave and a number of harmonic or multiple frequency sine waves.

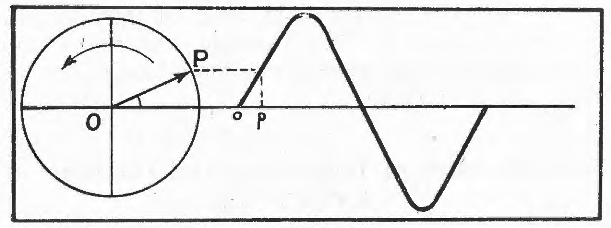


Fig. 5

All the formula and examples given above on D.C. flowing through resistors apply equally well to the passage of A.C., provided that the resistors are non-inductive. However, all circuits contain at least a small amount of inductance and capacity, and thus Ohm's Law has to be modified by substituting for the resistance R an analogous quantity known as the impedance and denoted by Z. Ohm's Law for A.C. states that

$$E = ZI \qquad (12)$$
$$I = E/Z \qquad (13)$$
$$Z = E/I \qquad (14)$$

Following will be found particulars of inductance and capacity insofar as they affect the application of Ohm's Law in A.C. circuits. Details of their determination and other particulars, especially with regard to radio receivers, will be found in later sections.

Inductance

Inductance is the property of a circuit which tends to retard the building up of a current when an E.M.F. is established and to retard the decay of an already existing current if the E.M.F. is removed. Thus in the flow of A.C. through an inductance the current will always lag behind the voltage by an amount (the phase difference) which is equal to a quarter cycle or 90° for a pure inductance and is less than 90° when resistance is present.

The unit of inductance is the Henry, and, if this is known, it is possible to compute the reactance, and from this, the impedance of any inductor at any given frequency. The reactance "X_L" in ohms of an inductance is given by

$$X_L = 2\pi fL \qquad (15)$$

where "π" is 3.14; "f" is the frequency of operation and "L" is the inductance in henries.

If there were no resistance present the reactance and impedance would be equal, but a certain amount of resistance is unavoidable.

The impedance "Z" in ohms is given by

$$Z = \sqrt{R^2 + X_L^2} \qquad (16)$$

where "R" is the D.C. resistance of the windings of the inductor, or, for radio frequency circuits, the R.F. resistance of the windings.

Capacity

Capacity is the property of a circuit which tends to retard the building-up of a voltage across a circuit due to a current which suddenly commences to flow. For this reason the current through a capacity will always lead the voltage by 90° for a pure capacity or by some angle less than 90° when resistance is present. The reactance "X_c" in ohms of a condenser is given by

$$X_c = \frac{10^6}{2\pi fC} \qquad (17)$$

"C" is in microfarads and "10^6" represents 1,000,000. "π" and "f" are as previously enumerated for equation (16).

The impedance "Z" of the condenser will be very close to the value of "X_c" as calculated above, as, for all ordinary purposes, the series resistance of a condenser may be disregarded.

It is due to these properties of inductance and capacity—namely, that they cause voltage and current to get out of step, that Ohm's law cannot be applied directly to alternating current calculations.

However, once the impedance of a condenser or inductor has been calculated, Ohm's Law may be applied in accordance with equations (12), (13) and (14).

Combinations of Inductance and Capacity

It will be seen from the above that inductance and capacity act in opposite directions when they are present in an A.C. circuit, or in other words, their effects are in "phase opposition."

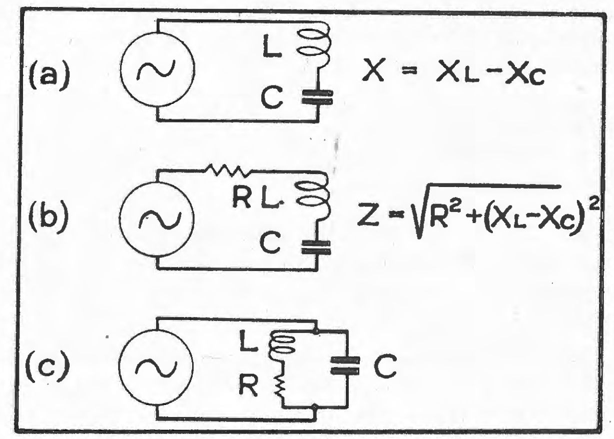


Fig. 6

Fig. 6 shows several combinations of resistance, inductance and capacity which might be encountered in practice. As pointed out before, the effects of induc-

(Continued on next page)

INDUCTANCE & CAPACITY—(Continued)—

tance and capacity are in opposite directions, so that in fig. 6 (a) the reactance of the combined quantities will be given by the expression shown alongside th~ diagram. (Refer to (15) and (17) for values of X_L and X_c).

Obviously, there must always be some resistance present in the circuit in the form of the D.C. resistance of the inductor and the series resistance of the condenser (see later sections for full treatment of this factor). These two resistances may be lumped togethe with any other series resistance in the circuit and shown as "R" in fig. 6 (b).

The impedance of the **combination is** then giv the expression shown alongside the diagram of 6 (b). An interesting point is reached when $X_L = X_c$. These two factors will then cancel out and the impedance of the combination is equal to "R." When this condition is reached, the circuit is said to be in resonance with the frequency of the A.C. voltage.

These are "series" combinations. A "parallel" combination is shown in fig. 6 (c), the resistance "R" being the D.C. resistance of the inductor. The series resistance of the condenser may be neglected for the purpose of this discussion as it will, in the majority of cases, be small compared to that of the inductor. The impedance of the network is given in by the following formula:—

$$Z = X_c \sqrt{\frac{R^2 + X_L{}^2}{R^2 + (X_L - X_c)^2}} \quad \ldots\ldots\ldots\ldots (18)$$

Where "Z" is the overall impedance in ohms; "X_c" is the reactance of the condenser (formula 17); "X_L" is the reactance of the inductor (formula 15), and "R" is the D.C. resistance of the windings plus any other series resistance which might be present. This applies when the frequency of the applied E.M.F. is different from the resonant frequency of the combination. Resonance is reached when $X_L = X_c$, and under these conditions, quite a lot of cancellations may be affected. The formula then becomes:—

$$Z = \frac{L}{RC} \text{ ohms} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (19)$$

where "Z" is the impedance of the combination in ohms; "L" is the inductance in microhenries; "R" is the resistance in circuit and "C" is the capacity in microfarads.

The evaluation of "R" as the direct-current resistance of the inductor in the above circuits and formulae only applies when the series or shunt network is used on low-frequency alternating currents. For radio-frequency work "R" must be evaluated as the R.F. resistance of the winding of the inductance, i.e., the D.C. resistance plus the increase brought about by skin effect, or this figure plus the R.F. value of any other resistance which is in circuit.

For purposes of completeness in this discussion it is as well to deal with the effect of a shunt resistance on the impedance of a series or parallel inductance-capacity network. The overall impedance of a combination such as this may be obtained by first calculating the impedance of the inductance-capacity network (fig. 6 (b) if in series; formula (18) if in parallel) and then treating the impedance thus obtained as one leg of a parallel resistance combination and the shunt resistance as the other. Equation (8), in the section on Ohm's Law for D.C., will then give the final value of impedance for the shunted network. This example is another instance of the universal importance of Ohm's Law in the solution of radio problems.

Applications of Inductance and Capacity in A.C. Circuits

IN order to establish the functions of C. and L. in A.C. circuits, it will be advisable to detail one or two examples, whereby the inter-relations of the various quantities may be demonstrated.

Inductance

Referring back to formulae (15) and (16), it will be seen that the reactance (and impedance) of an inductor are **directly** proportional to both the frequency of the applied E.M.F. and the inductance, and, consequently, the amount of A.C. flowing in a circuit will be dependent on these factors also. Use is made of this fact in filter circuits, and reactors for controlling the input to A.C. operated devices. In these instances, it is quite evident that, as the frequency and applied voltages are both constant, the amount of A.C. flowing in the circuit can be controlled by varying the inductance of the choke or reactor. This can also be done by means of a resistance, but a resistance will also affect any D.C. flowing in the circuit. This might not be desirable, and, on this count, the inductor scores, for unless it is very badly designed, the Z/R ratio of an inductor is extremely high, and, as a result, a high degree of A.C. attenuation is effected, with very little accompanying D.C. attenuation.

By applying Ohm's Law for A.C. (equation (12)) to formula (15) it is quite obvious that, given a fixed value of frequency and E.M.F. for the applied voltage, it is quite possible to determine the inductance value of any winding by ascertaining the current flow when the E.M.F. is applied to it. Similarly, given a fixed E.M.F. and value of inductance, the frequency may be determined from the current flowing in the circuit.

For these determinations the combined equations (12) and (15) become :—

$$E = 2\pi f L I \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (20)$$

Transposing for the purpose of inductance determination this becomes—

(Continued on next page)

INDUCTANCE & CAPACITY—(Continued)—

$$L = \frac{E}{2\pi f I} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (21)$$

and for frequency determination it becomes—

$$f = \frac{E}{2\pi L I} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (22)$$

The constant "π" in these examples is equal to 3.14 (approx.); "f" is in cycles per second; "E" is in R.M.S. volts; "L" is in **henries,** and "I" is in **amperes.**

Application of (21)

If any fixed supply of A.C. is available, such as from normal A.C. mains, formula (21) may be applied to the construction of a very simple test meter for the determination of the inductance of iron core chokes and transformer windings.

Assuming that the mains available are 240 volts 50 cycles it will be seen that as "π", "f" and "E" are constants, quite a lot of cancellation can be effected. The formula then becomes—

$$L = \frac{0.764}{I} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (23)$$

where "L" is in **henries** and "I" is in **amperes.** A similar cancellation process may be adopted for mains of any other frequency and voltage.

If a 7.5 henry choke is used as a current limiter in series with an 0-100 mA. A.C. meter it will be, by application of formula (21), possible to calibrate the scale of the meter with readings from one to about 100 henries. The 7.5 henry choke will be necessary to prevent damage to the meter by accidental short circuits. When calibrating the meter it should be remembered that 50 mA. (for instance) is 0.05 ampere, and also that the indications of current shown on the meter are those which flow with a value of inductance in circuit which is equal to the value of inductance being tested **plus** the inductance of the limiting choke. The inductance value calibrated on the meter should be that of the test inductance, however, as the current limiter is permanently in circuit. For example:—

If a 10 henry choke is connected in the circuit, the total value of inductance in series with the meter is 17.5 henries and this will result in a current flow of 43 mA. (approx.). This reading on the meter will indicate that an **external** inductance of 10 henries is connected in circuit, and should be calibrated as such. Repetition of this procedure for external values of 20, 30 henries, and so on, will result in a complete meter scale calibration being effected.

Even if it is not desired to make up a permanent meter for the purpose of testing inductances, the principle may still be applied, and will prove useful if it is necessary to ascertain the inductance value of an odd choke or transformer winding. In this case, the meter and choke (in series) are connected directly across the 240 volt A.C. mains. A 30 henry choke will pass about 25 mA., and a 50 henry choke about 15 mA.

Application of (22)

The frequency of any alternating current supply may be very easily determined by means of (22).

The essentials will be an inductor of known value, an A.C. milliammeter, and an R.M.S. reading A.C. voltmeter. As the main application where frequency measurement is required (outside of radio-frequency work) will be the measurement or checking of the frequency developed by a rotary converter or alternator, it can be assumed that the voltage will be constant. If this is so, and a value of inductance for the purposes is decided upon, formula (22) may be simplified until the current flow can be converted directly into terms of frequency. Assuming the supply voltage is 240 volts and a 15 henry inductor is used, the formula becomes—

$$f = \frac{2.44}{I} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (24)$$

where "f" is in cycles per second and "I" is in **amperes.** A similar cancellation may be effected for any other value of inductance and applied E.M.F.

Under these conditions, 49 mA. (approx.) will flow, if the frequency of the supply is 50 cycles. An increase of the frequency by 5 cycles will cause the current to drop to about 44 mA., and a decrease of the frequency by 5 cycles will cause the current to increase to about 54 mA. Many types of commercial frequency meters work on this principle.

These examples will serve to show how the intelligent application of the fundamental principle of Ohm's Law may be used to solve problems concerning the application of inductance which, on the surface, do not appear to be related to the basic $E = I R$ law in any way.

Capacity

Referring back to formula (17), which gives the reactance of any reasonably efficient condenser we see that the reactance in this case is **inversely** proportional to both the frequency of the applied E.M.F. and the capacity of the condenser. This means that a reverse state of affairs applies, when considering the current flow in a condenser, to that in the consideration of inductance. This has already been mentioned before, and it has been shown that, when both inductance and capacity are present in a circuit, the effects of the two may cancel out.

The applications of capacity in A.C. circuits are, in some respects, similar to those of inductance, and we find that both can be used for the purposes of filtration and attenuation.

(Continued on next page)

INDUCTANCE & CAPACITY—(Continued)—

The filtering action of a condenser is only employed where D.C. and A.C. are both present in a circuit, and in this case the condenser is shunted across any portion of a circuit where A.C. is not required. The action of the condenser is exactly opposite to that of an inductance. Whereas, an inductance presents a very high impedance to the flow of A.C. and does not affect D.C. to any appreciable extent, a condenser presents an extremely high resistance to D.C. (for the purposes of this discussion the D.C. resistance of a condenser may be regarded as infinite, being the insulation resistance of the dielectric used. This resistance is usually termed the "shunt" resistance of the condenser and must not be confused with the "series" resistance, which is usually only evident on R.F.) and a comparatively low resistance or impedance to A.C.

Reverting back to the original discussion on Ohm's Law as applied to D.C. it will be remembered that if two resistances are in parallel the total current flowing will be distributed between them in inverse proportion to their respective resistances. Therefore, if we wish to prevent A.C. from entering into any circuit, we can do so by shunting the circuit by a condenser which has a low reactance to A.C. (compared to the circuit). Careful consideration of this point, bearing in mind the functioning of an inductance will show how a "brute force" filter circuit, of the type usually used in a radio receiver, operates. To particularise: We will consider the condenser which immediately follows the rectifier It is desired to prevent A.C. from entering the receiver amplifying circuits. The A.C. referred to here is the percentage of A.C. which is delivered by the rectifier along with its D.C. output. We will assume that the condenser has a capacity of 8 mfd. and the choke an inductance of 50 henries. By calculation, we find that the respective reactances of these two components are 400 ohms and 15,700 ohms. Disregarding the A.C. reactance of the receiver circuit for the time being, which in any case will be in series with the choke, we can regard these two reactances as being in parallel. Referring once again to Ohm's Law for resistances in parallel, we find that approximately 98% of any A.C. present will flow through the condenser and only 2% through the choke to the receiver. This will also explain why it is essential that a condenser used as a by-pass across a bias resistance, for instance, must have a low resistance, or impedance, compared to the resistance if it is to be at all effective. In both of these instances, the effect of the condenser on the D.C. present will be inappreciable, due to the extremely high shunt resistance presented to D.C.

Although a condenser is very rarely used as an attenuator, it can be so used and its application in this case is merely another matter of reactance proportioning. Obviously, if a condenser having a reactance of 10,000 ohms is connected in series with an appliance, which also has a reactance of 10,000 ohms, and an E.M.F. is applied to the two, this E.M.F. will be equally divided between the condenser and the appliance. The reactance of the condenser will vary inversely with frequency, and this effect is sometimes made use of where it is necessary to compensate for other changes in circuit conditions caused by frequency.

The well-known "blocking" application of a condenser is an excellent example of the use which may be made of the extremely high R/Z ratio which is evidenced by a good condenser. In this case it is necessary to stop D.C. and allow A.C. to pass with very little attenuation. This operation appears to be the exact opposite of that where a condenser is used for filter purposes.

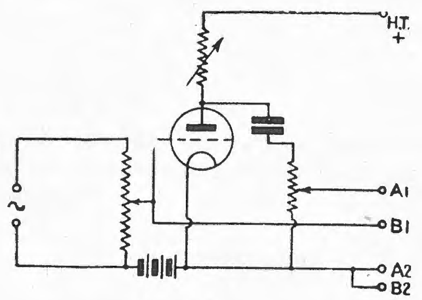


Fig. 7

Strictly speaking, however, the action is exactly the same, as reference to fig. 7 will show. The skeleton circuit shown is that of a resistance-capacity coupled amplifier. The condenser connected to the plate of the valve is the coupling condenser and also serves to block the passage of any D.C. into a circuit fed by A1. From the circuit it can be seen that the condenser, in series with the potentiometer which feeds A1, is actually shunted between the plate of the valve and earth. The R/Z ratio of the condenser effectually prevents any interference with the D.C. voltage being fed to the plate through the plate resistance, and at the same time, ensures that any A.C. voltage developed at the plate of the valve is by-passed to earth. Before this A.C. reaches earth, however, it has to pass through the impedance presented by the potentiometer which is in series with the condenser, and, consequently, a proportion of the A.C. voltage will appear across its terminals, and can be tapped off by the slider for feed to the circuit connected to A1. Although this is neither the time nor place to enter into a discussion upon resistance-capacity coupled amplifier design, it is evident that the reactance (or impedance) of the condenser, at any frequency under consideration, must be low compared to the resistance of the potentiometer winding, if any useful proportion of the A.C. voltage is to be made available for use at A1. So once again it will be seen that Ohm's Law enters into the problem, and once again it has been demonstrated that Ohm's Law is **the** fundamental law upon which practically all radio and electrical problems rest for their solution.

Getting back to the inverse relationship of reactance to capacity and frequency, once again we find that formula (17) can be combined with equation (12) in a similar manner to that employed in the consideration of inductance. Thus we can determine both "C" and "f" by means of a fixed source of E.M.F. (as long as it is sinusoidal A.C. in character) and an A.C. milliammeter.

Combining (17) and (12)—

$$E = \frac{10^6}{2\pi f C} \times I \quad \ldots\ldots\ldots\ldots \quad (25)$$

(Continued on next page)

INDUCTANCE & CAPACITY—(Continued)—

Transposing for the purpose of capacity determination, this becomes—

$$C = \frac{10^6 \times I}{2\pi f E} \quad \ldots\ldots\ldots\ldots \quad (26)$$

and if the capacity is known, but the frequency is required, it becomes—

$$f = \frac{10^6 \times I}{2\pi C E} \quad \ldots\ldots\ldots\ldots \quad (27)$$

In each of these examples "E" is the applied E.M.F. in R.M.S. volts; "I" is the current flowing in **amperes;** "π" is equal to 3.14; "f" is in cycles per second, and "C" is the capacity in **microfarads.**

These formulae may be applied to any alternating current circuits, but, as far more convenient means of capacity and frequency determination are available for use at radio frequencies, their maximum usefulness is found when dealing with frequencies below two or three hundred cycles. In any case, such factors as dielectric losses and series condenser resistance require consideration at frequencies much above the limits mentioned, and, as these factors introduce serious inaccuracies, the formulae will not be of much use. Even at low frequencies they are not particularly accurate unless the wave form of the A.C. supply is good and the condenser under test, or in use, is fairly efficient. However, providing an A.C. supply from mains is available and the condensers under consideration are of the paper type, they can be very useful and some examples of the application will be given.

Application of (26)

If a standard mains supply of 240 volts 50 cycles A.C. is available, a very useful capacity tester can be built up with the aid of an A.C. milliammeter and the application of (26).

Under these conditions (26) may be simplified considerably and then becomes:—

$$C = 13.26\ I \quad \ldots\ldots\ldots\ldots \quad (28)$$

where "I" is the current flowing in **amperes** when the condenser is connected across 240 volt 50 cycle A.C. mains. Here again it will be necessary to provide some means of current limitation, and, if an 0-150 mA. A.C. meter is used, a 2 mfd. paper condenser connected in series with the meter will do the job nicely. This combination will enable the capacity of any condenser from 0.1 mfd. to about 8 mfd. to be determined with reasonable accuracy.

When calibrating a meter of this description it must be remembered that the total capacity of the test condenser and the current limiting condenser will be the reciprocal of the two capacities. This is a point which must always be remembered when dealing with condensers. Whereas resistances or inductors in series give a final value of resistance or inductance which is equal to the sum of the two (or more) respective values, condensers work the opposite way around and give a final value of capacity, which, as pointed out before, is equal to the reciprocal of the two (or more), capacities. It will be remembered that this is the case when resistances are connected in parallel, and the same equations (8) and (9) apply.

To recapitulate, in terms of capacity:—

$$C_s = \frac{C_1 \times C_2}{C_1 + C_2} \quad \ldots\ldots\ldots\ldots \quad (29)$$

where "C_s" is the final value of capacity and "C_1" and "C_2" denote the respective values of the two condensers which are in series.

Under these conditions it will be seen that once the effective value of the test condenser and current limiting condenser in series have been determined by means of the current flow and formula (28), it will be necessary to effect a transposition of (29) in order to obtain the actual capacity of the test condenser.

This is quite a simple procedure, and, if we denote the final value of capacity by "C_s" and the current limiting condenser by "C_1," the value of "C_2" (the test condenser) may be found by the following:—

$$C_2 = \frac{C_1 \times C_s}{C_1 - C_s} \quad \ldots\ldots\ldots\ldots \quad (30)$$

Application of this principle to suitable current values (transferred into terms of capacity) spread over the scale of the meter will soon result in sufficient calibration points being established to enable direct calibration of the meter scale in microfarads.

Of course, it is possible to connect the condenser to be tested directly in series with the meter and connect the two to the mains supply, but such procedure is not advisable, owing to the risk of a condenser short and the fact that in most cases the condenser capacity will be unknown. The use of a 2 mfd. condenser permanently connected in series with the 0-150 mA. meter, will prevent any possibility of damage being done due to a faulty test condenser, and, in addition, it is easily seen that even if a 16 or 24 mfd. condenser is connected into circuit, the final value of capacity cannot exceed the 2 mfd. limit and, as a result, the meter will never be overloaded. Electrolytic condensers cannot be tested by this means, as it is essential that condensers of the type be operated on a uni-directional source of potential. A D.C. bridge type of tester is used for electrolytic condensers, and details of this method of condenser testing and capacity measurement will be given in a later section.

(Continued on next page)

INDUCTANCE & CAPACITY—(Continued)—

Application of (27)

Formula (27) may be applied to a frequency meter in exactly the same manner as was done with the inductance formulae. Quite considerable error may be introduced if the wave-form of the applied E.M.F. is bad, but, if it is reasonably sinusoidal in form, a very useful frequency meter for use with small alternators may be built up which is both compact and light in weight. On these counts the capacity type of frequency meter is somewhat better than the inductor type.

We will assume for the moment that the alternator, with which the meter is to be used, has an output E.M.F. of 240 volts. The capacity in series may be 1 mfd. and if the mean frequency is 50 cycles, the current flow will be approximately 75 mA. An 0-150 mA. A.C. meter should thus be used, in order to bring the mean frequency setting to somewhere near the centre of the scale.

Under these conditions, (27) can be simplified somewhat and becomes: —

$$f = 666\,I \qquad (31)$$

where "f" is the frequency in cycles per second; "I" is the current in **amperes** and the applied voltage and series condenser are as specified above.

As mentioned above, the meter indication at 50 cycles will be approximately 75 mA. (0.075 amp.). A frequency drop of 5 cycles will cause the current indication to drop by about 7 mA. and a frequency increase of 5 cycles will cause the current to increase by about the same amount. The condenser used should have a working voltage rating considerably in excess of the voltage it is actually operating on. Several current values at about the centre of the meter scale may be converted into terms of frequency and the meter calibrated accordingly. The meter will then serve as quite a reliable frequency indicator on any 240 volt A.C. supply within the limits of about 40 and 60 cycles.

The above examples together with these dealing with inductance should serve to demonstrate the respective functions of "L" and "C" in A.C. circuits, and show how quite a number of everyday problems can be solved by the practical application of the fundamental principles involved.

Inductance and Capacity

Their Combined Application in Resonant Circuits

ONE example has already been given of the application of both inductance and capacity in one circuit, but, in this case, the functions of each were entirely separate and not in any way dependent upon the operation of the other, even though the final result (i.e., effective filtration) was dependent upon both factors. To explain; the function of the condenser was purely to act as a low-impedance path for any A.C. which might be present, that of the choke, merely as a means of increasing the impedance of the shunt circuit so that the major portion of any A.C. present would pass through the condenser.

Many other applications are possible, however, where inductive and capacitative reactance are combined to produce **resonance.**

Circuit combinations of the type may be either of the "series" or "parallel" type, and the general factors governing the overall impedance of such circuits have already been detailed.

"Resonance" in a circuit is reached when the frequency of the applied E.M.F. is such that the inductive and capacitative reactances in the circuit are equal, i.e., "X_L" = "X_c."

"Series" Resonant Circuits

It has already been shown that "X_L" and "X_c" cancel out when resonance is reached in a "series" circuit, and that, as a result, the reactance, or impedance, of the network is then equal to the value of any series resistance which is present in the circuit. Such a circuit is shown in fig. 6 (b).

From this it can be seen that if no resistance is present the impedance of the circuit will be nil, and, as a result, a very large A.C. current will flow. At frequencies "off" resonance, however, the impedance will be dependent on the ratio of "X_L" and "X_c," and as these change in opposite directions for any given frequency change, it is fairly obvious that the increase in impedance for even a small change in frequency in either direction from resonance will be fairly large and the corresponding current reduction large also. This means that the ratio of resonant to non-resonant currents will be very high and, as a result, the resonant point will be very definite, or, in other words, "sharp." Such a circuit is said to be very **selective.**

Taking the discussion a step further, it is obvious that the presence of any resistance at all will reduce the current flow at resonance to quite a considerable extent, but will not affect the current flow at "off resonance" points to anywhere near the same extent. As a result, of this, the ratio of resonant, to non-resonant current will be much lower than if no resistance were present. This means that the resonant point will be less clearly defined and the circuit will not be so selective.

The above outline should serve to indicate the properties of a series resonant circuit fairly clearly, but as there are one or two others which are not immediately obvious, no harm will be caused by recapitulation.

To commence with, a series resonant circuit is one in which the effects of inductance and capacity cancel out. It follows from this that the current and voltage will be in step when resonance is reached. Secondly, the current is limited only by the resistance of the inductor, so that the A.C. impedance of the network will be considerably lower than that of the condenser alone if a well-designed inductor is used. Another pro-

(Continued on page 168)

INDUCTANCE & CAPACITY—(Continued)—

perty of a series resonant circuit is that the counter-voltage (back E.M.F.) developed by the inductor is always greater than the impressed voltage, providing that no other resistance than that of the inductor itself is in circuit. A fourth property, or perhaps we should say advantage, of the circuit is that all of these effects are confined to a band of frequencies, the width of which is directly controllable by the resistance in circuit. Furthermore, the magnitude of the second and third "properties" is also a function of the resistance in the circuit.

Applications of "Series" Resonance

Such a circuit has many applications. Voltage amplification may be obtained by using the countervoltage developed across the inductor or attenuation of any particular frequency may be effected by shunting the entire network across a portion of a circuit which contains the unwanted frequency.

The question of voltage amplification by means of a series resonant circuit is one which calls for some explanation. As pointed out before, the current flowing in the circuit at resonance, is many times that which would flow through either the condenser or the inductor alone with the same applied E.M.F. At the same time, however, "X_L" and "X_c" still retain their original values, even though they cancel out with reference to the applied E.M.F. This means then that the voltages across the condenser and inductor (regarded separately) will be "IX_c" and "IX_L" respectively if we denote the current flowing at resonance by "I." As "X_c" and "X_L" are nearly 180 degrees out of phase, these voltages will cancel out along with the reactances, when the entire network is regarded, but this does not prevent us from using the voltage developed across the inductor, alone as long as no appreciable load is imposed by doing so. It will be of interest to determine the exact magnitude of the voltage developed and, in doing so, to discover the effect of series resistance on this voltage.

We have already shown that the impedance (or reactance) of the circuit at resonance is equal to the resistance present. It follows from this that the current flowing ("I") must be equal to E/R. Therefore, the voltage developed across "$_L$" (and also "$_c$") will be—

$$E_L = X_L\,\frac{E}{R} = E\,\frac{X_L}{R} \qquad (32)$$

where "E_L" is the voltage developed across the inductor; "E" is the applied E.M.F.; "R" is the series resistance of the circuit and "X_L" is the reactance of the inductor.

The second term of the equation shows clearly that the magnitude of the voltage developed across the inductor is X_L/R times the impressed voltage. The importance of "R" as a factor in controlling the magnification obtainable by means of a series resonant circuit is thus amply demonstrated, and some idea of the improvement in the efficiency of a resonant circuit which may be effected by reducing "R" may be gained. This is a fundamental point in all A.C. circuit design and should always be borne in mind.

Determination of "Q" Factor

The ratio X_L/R may be regarded as an indicator of the efficiency of a condenser or an inductor operating in an A.C. circuit (whether low- or radio-frequency) and is termed the "Q" of the component or circuit. Since $X_L = 2\pi f L$ it is more usual to express the "Q" value of an inductor in the basic terms and the following expression may be accepted as the standard of reference in this matter.

$$Q = \frac{2\pi f L}{R} \qquad (33)$$

All of these remarks apply equally to the efficiency of a condenser. In the case of a condenser, the factor "R" is the series resistance of the condenser itself, and the top half of the expression is equation (17) which gives the reactance of a condenser.

"Series" Resonant Frequency

Before dealing with the application of series resonant circuits for the attenuation of unwanted frequencies, it will be advisable to show how the resonant frequency of such a circuit is determined.

The following expression gives the resonant frequency for a series inductance/capacity combination—

$$F_r = \frac{1}{2\pi\sqrt{LC}} \qquad (34)$$

where "F_r" is the resonant frequency in **cycles per second;** "π" is 3.14 (or 3.1416 if greater accuracy is required); "L" is the inductance in **henries** and "C" is the capacity in **farads.** These values for "L" and "C" will be found convenient when dealing with low-frequency circuits but some simplification is desirable when working at radio-frequencies. A more convenient expression for R.F. applications is given by the following:

$$F_r = \frac{159}{\sqrt{LC}} \qquad (35)$$

where "F_r" is the resonant frequency in **kilocycles per second;** "L" is the inductance in **microhenries** and "C" is the capacity in **microfarads.**

A very wide application for series resonant networks is found in the attenuation of unwanted bands of frequencies, and, as the degree of frequency discrimination exercised may be controlled by the amount of resistance present in the circuit, some of these applications are of great value in electrical and radio engineering. The fact that the degree of attenuation also varies with

(Continued on next page)

INDUCTANCE & CAPACITY—(Continued)—

the amount of resistance in circuit, is no disadvantage and proves very useful under some circumstances.

It is not proposed to go into the theory regarding the band width affected and the degree of attenuation for varying resistance values in the discussion, as these factors call for much wider treatment than is possible here and, in any case, are fully covered in numerous standard text-books readily available to those interested. A general treatment of the applications possible for series resonant networks will serve the purpose much more satisfactorily and provide a basis of practical data which will not only be of more general interest, but can be easily elaborated upon by those engineers who are desirous of employing any of the systems outlined.

Equaliser Networks

Foremost among the applications possible for series resonant networks is that of response equalisation. In this case the network is shunted across a line carrying a band of audio-/or radio-frequencies, some of which have a greater amplitude than the mean level, i.e., some portions of the band are "peaked" with relation to the others. A series network which contains some means of varying the resistance present is connected across the line and tuned by varying "$_L$" or "$_C$," until its resonant frequency is situation in the centre of one of the peaks. Adjustment of the series resistance in the network will result in any required degree of attenuation of the frequencies around the resonant point. Careful adjustment of the resistance value will result in the peaked frequencies, being attenuated until their amplitude coincides with the mean level of the entire band. Such a network is known as an **equaliser.** The circuit employed is similar to that shown in 6 (b), the only difference being that "$_r$" is variable. The two points shown connected to the source of E.M.F. are those which are connected across the line.

"Band elimination" is only another step on from this, and the circuit in this case consists of inductance and capacity only (or as nearly as possible). The network is again shunted across a line carrying a band of frequencies, some of which are unwanted. By tuning the network to the unwanted frequencies these can be eliminated. The width of the band eliminated and the completeness of elimination will depend on the amount of resistance present. Careful inductor design and the use of a good "low-loss" condenser will result in the band-width affected being only a few hundred cycles wide, at radio frequencies and proportionately smaller at low-frequencies. Normal applications for this type of network are for "scratch-filters," to operate in conjunction with gramophone pick-ups, and wave-traps in radio receivers. Another application is found when it is desired to "cut-off" the response of an amplifier at a certain point. In this case the filter is made fairly "broad" in its operation and is tuned to a point somewhat past the actual "cut-off" frequency required, so that by the time the response is back to "normal" again the frequency is well past the reproduction capabilities of the amplifier. A scratch-filter network is designed in this way if no frequencies above the peak "scratch" level are required. A scratch-filter of this type is probably more common than one of the "band elimination" type, and a suitable circuit with constants and attenuation characteristics is shown in fig. 8.

"Tuned" Power Filters

Series resonant networks form the basis of some very interesting filter circuits for use in radio receiver power units. It will be remembered that, in a previous example dealing with filters, it was mentioned that the reactance of an 8 mfd. condenser was about 400 ohms. Even this value gave excellent filtering efficiency, but it is easy to imagine how much better the filtering would be if a choke were connected in series with the condenser and the pair tuned to 50 cycles. The resultant reactance in this case would only be the D.C. resistance of the choke (probably no more than 100 ohms).

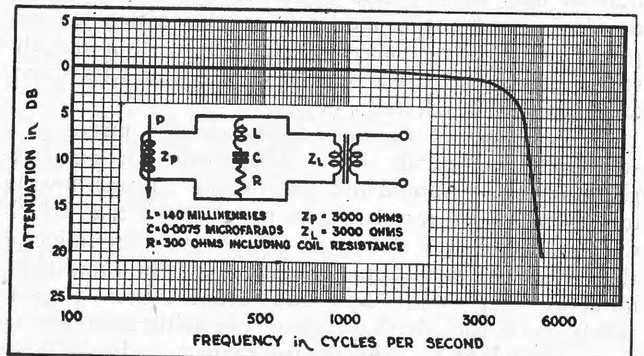


Fig. 8

Unfortunately, a combination of this kind does not lend itself to rectifier efficiency if used immediately following the rectifier, even though the filtering efficiency is undoubted. (The relative merits of choke-input and condenser-input filters are sufficiently well-known and require no elaboration here). However, the system can be used as the centre leg of a two section filter and its use is well worth while in the power supply units of high-gain amplifiers. The main frequency which requires attenuation at this point is 100 cycles. This is the pulsation which results from full-wave rectification of 50 cycles A.C., and although it is not pure A.C., is sufficiently alternating in character to be amenable to treatment by A.C. methods. The circuit of the completed filter is shown in fig. 9. The series network, composed of "$_L$" and "$_C$" should resonate at 100 cycles and, if this is done the shunt impedance presented to the 100 cycle component by the series network will be equal to the D.C. resistance of the choke. In order to do this there is no necessity to effect transpositions in the resonance formulae (34) and (35). We already know that $X_L = X_C$ when resonance is reached and if a reactance chart is available it is only necessary to look up values of inductance and capacity which have corresponding reactances at 100 cycles. If these two values are connected in series, resonance will be established.

Use of Reactance Charts

In order to simplify the job still further, two charts are presented, in figs. 10 and 11, which not only provide these figures but also show several alternative values of

(Continued on next page)

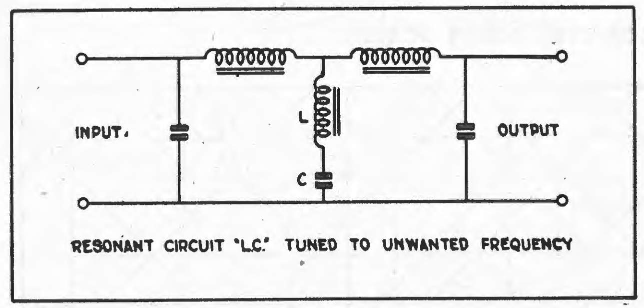


Fig. 9.

inductance and capacity, which will resonate at any required frequency. Full instructions for the use of these charts are printed below them, and no difficulty should be experienced in finding the required information.

Referring to fig. 10. Looking at the bottom of the chart, we see that there are two rows of frequency readings. 100 cycles is in the top row and this fact must be borne in mind when reading the chart. Following the line from 100 cycles vertically it will be seen that diagonal inductance and capacity lines intersect it at a number of points. The inductance lines slope upwards to the right, and the capacity lines upwards to the left. Each of these lines corresponds to two values of inductance or two values of capacity. The alternative values are arranged on top of one another and the value to be used is that which corresponds in position to the frequency row in use (e.g. top frequency row, top "$_L$" or "$_C$" value). The spaces between all major tabulation lines are divided up into logarithmic proportions, so that the unmarked line between major tabulations indicates that the value of inductance, capacity, reactance or frequency at the point is half of that at the **succeeding** tabulation. For example : Referring back to the 100 cycles line again, the next major tabulation is 1 KC/sec. (or 1000 cycles), therefore, the vertical line between these two is half of 1000 cycles, that is, 500 cycles. The same thing applies on all other ordinates, and the intervening spaces are divided into similar proportions. Under some circumstances this will make it a little difficult to obtain exact readings, but fig. 11 (chart No. 2) comes in at this point as it gives an enlarged section of a single decade of fig. 10 (chart No. 1). This chart does not concern us at the moment, so we will leave a description of its application until later.

Following the 100 cycles line vertically it is quite evident that there is an infinite number of combinations of "$_L$" and "$_C$" which will resonate at 100 cycles. This is indicated by the fact that wherever an inductance line and a capacity line intersect on the 100 cycle vertical the respective values of "$_L$" and "$_C$" have the same value of reactance at that frequency. The value of reactance for each may be ascertained by taking a horizontal line to the reactance column from the point where the "$_L$" or "$_C$" lines intersect the vertical frequency line. As both the "$_L$" and "$_C$" lines under consideration intersect the vertical at the same point it follows that the respective values of "$_L$" and "$_C$" must have the same reactance. This, of course, applies to the undrawn "$_L$" and "$_C$" lines between the major tabulations as well as the drawn lines.

Actually, however, we are only interested in "standard" values of "$_L$" and "$_C$" as it is of no use contemplating the construction of a tuned filter if we have to get special inductors and condensers made up. By inspection of the chart we find that two fairly standard combinations of "$_L$" and "$_C$" will resonate at 100 cycles. These are 5 henries — 0.5 mfd. and 0.5 henries — 5 mfd. respectively and the lines for these respective pairs both intersect on the 100 cycle line. Either of these pairs will do the job and provide a satisfactory filter for use in the centre leg of fig. 9. The values used in the first pair are readily obtainable and as a 5 henry choke can be made with a D.C. resistance of only 20 or 30 ohms it will be seen that the filtering efficiency with this combination will be far greater than that obtainable with even a 16 mfd. condenser, of which the reactance is somewhere near 200 ohms. The second pair will be even more efficient as a 0.5 henry choke could be made with a resistance of under 10 ohms. However, a 5 mfd. condenser will be difficult to obtain and would have to be made up by connecting a 4 mfd. and a 1 mfd. condenser in parallel. However, the values given will be useful examples of the application of the reactance charts to such problems and will show how the resonant frequency of any series network may be determined.

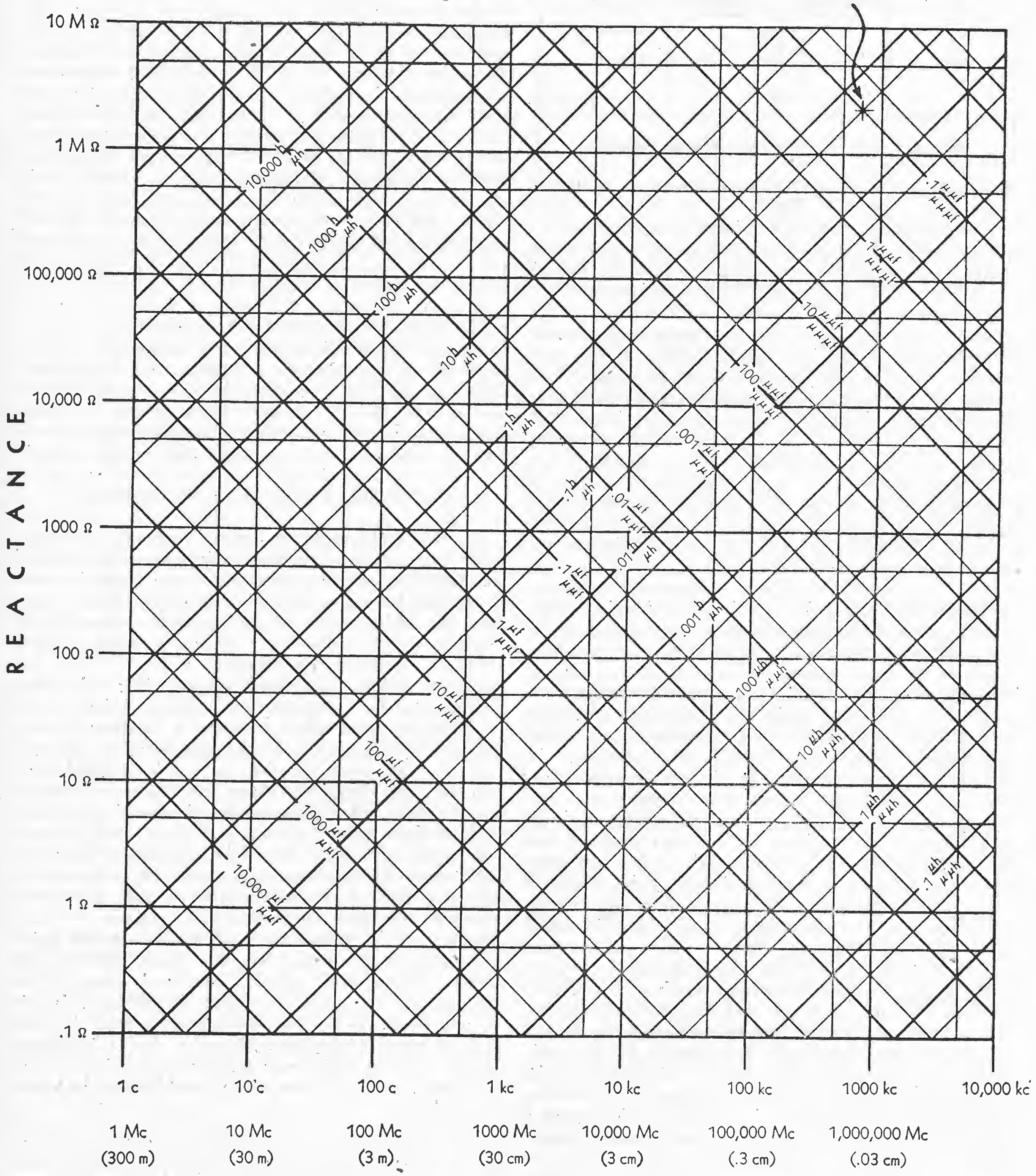
Back-E.M.F. Precautions in Tuned Filters

A point which must be remembered when working with series resonant networks, is that quite a large countervoltage will be developed across both the condenser and the choke, and that this voltage will be considerably higher than that of the A.C. voltage being by-passed. The actual value of this back-voltage may easily be determined by reference to the "Q" formulae presented earlier. This back-voltage will not be very important as far as the choke is concerned, but should be borne in mind when choosing a condenser rating for use in the circuit. An example based on the first pair of components specified for use in a tuned filter will make this clear. The values specified were 5 henries and 0.5 mfd. Reference to the chart will show that both of these have a reactance of about 1300 ohms at 100 cycles. 25 ohms would be somewhere near the final value of impedance of the network at resonance, so it can be seen, by reference to formula (33), that the "Q" of either component will be about 55. Assuming a peak ripple voltage of one volt at the point where the filter is connected, this means that 55 peak volts counter-E.M.F. will be developed across either component. This will not affect the choke, unless it is very poorly made, but the condenser must be capable of standing this in addition to the D.C. voltage already present. Although trouble from this source is not common, it is a factor which should always be borne in mind

This dissertation on series resonant circuits may perhaps have been rather longer than was strictly necessary, in order to cover the ground, but the data presented has been quite important and should prove of assistance in the solution of many radio problems. In addition, many of the statements apply equally well to parallel resonant circuits and reference will be made to them in the course of the next section.

(Continued on page 170)

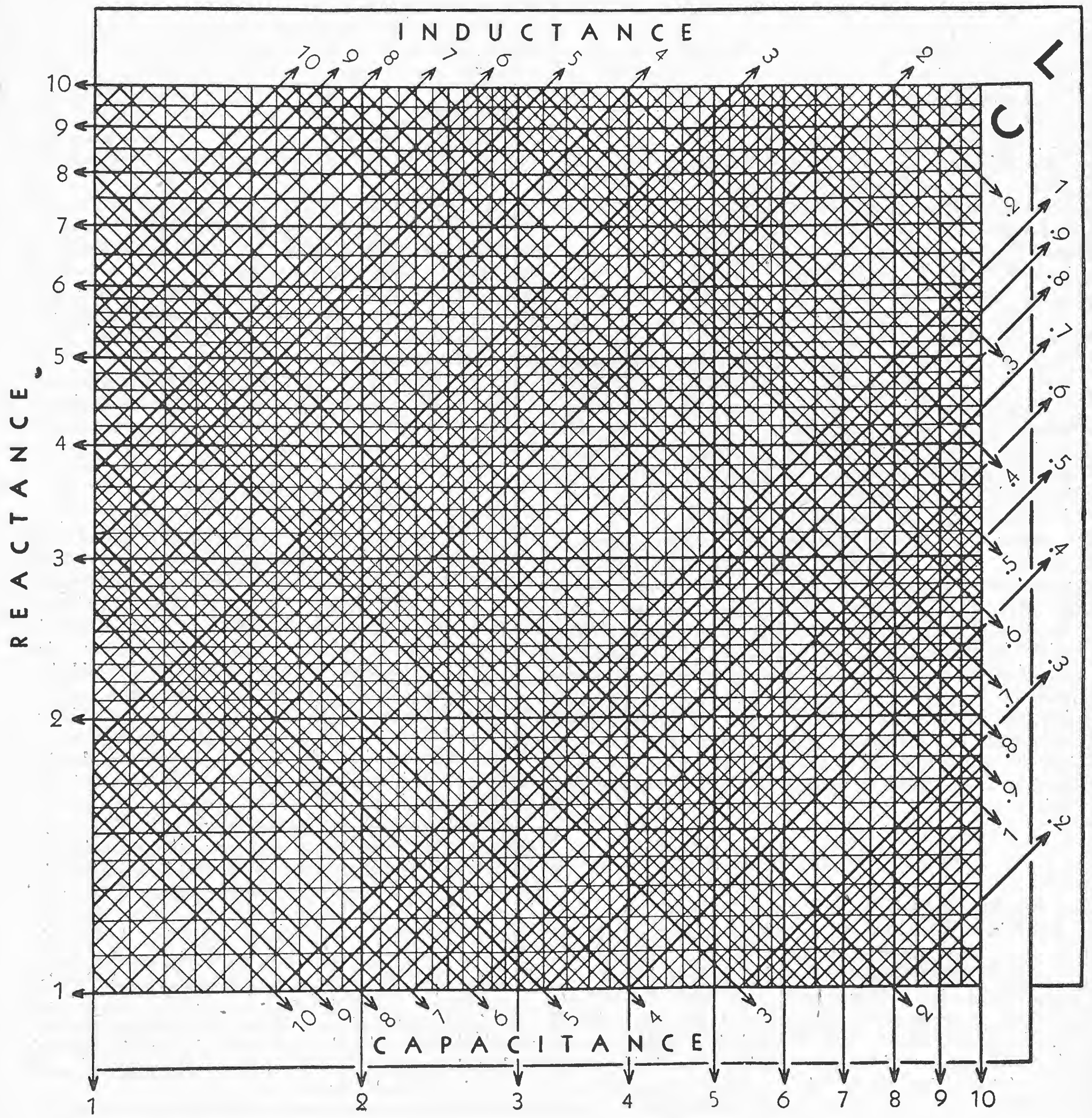
Always use corresponding scales



FREQUENCY

Fig. 10 (Table I.)—See Instructions for use on page 169

Always obtain approximate value from Figure 1 before using Figure 2



FREQUENCY (Fig. 11, Table 2)

INSTRUCTIONS FOR THE USE OF FIGS. 10 AND 11.

The accompanying charts may be used to find: (1) the reactance of a given inductance or condenser at a given frequency; (2) The resonant frequency of a given inductance and condenser.

In order to determine the quantities involved to two or three significant figures the chart is divided into two parts. Table 1, is the complete chart (containing 100 sections) to be used for rough calculations, while table 2 (one of the sections of table 1 enlarged approximately 7 times) is to be used where the significant two or three figures are to be determined.

(Continued bottom of page 170)

INDUCTANCE & CAPACITY—(Continued)—

Parallel Resonant Circuits

It has already been shown, in the preliminary data on parallel resonant circuits given in connection with fig. 6 (c), that resonance is reached in this type of circuit when $X_L = X_c$ that is, under the same conditions applying when resonance is reached in a series circuit.

In addition, it has been shown that under these conditions, the resonant impedance may be obtained directly from the actual values of resistance, inductance and capacity in the circuit, and the relations existing may be expressed as $Z = {}_L/_{rc}$ (equation (19)). This is only correct when the value of "R" (see fig. 6 (c)) is low compared to the impedance of the inductive leg of the network. As this is nearly always the case, we need not concern ourselves with any other conditions.

From equation (19) we can see that the impedance of the network at resonance varies inversely with both "$_r$" and "$_c$" and is directly proportional to "$_L$." Consequently the value of impedance will be high compared to that of a series network, assuming that the constants are the same in each case, as this set of relationships is exactly opposite to that appearing in the impedance formula for a series network.

Apart from this basic difference, the two types of network exhibit very similar characteristics. Both act as a pure resistance when resonance is reached and therefore, the current is in phase with the voltage. The resonant frequency of a parallel network may be determined by the same formulae and charts ((34) and (35) and figs. 10 and 11) as are used for a series network and the "Q" values of the components used are subject to the same limitations. This will explain the paragraph at the end of the section on series resonant circuits which referred to the amount of matter in that section which could be applied to parallel resonant circuits.

"Parallel" Resonant Impedance

The high impedance property of a parallel resonant circuit is explained by the fact that two paths are open to any voltage applied to the network. The current conductances of these two paths are equal, but are opposite in sign. Consequently, the net conductance of the network is zero and no current will flow. Actually some current does flow, but this is only because of the small amount of resistance which is inevitably present. This resistance, in effect, sets up a state of unbalance between the two paths and, consequently, a small amount of current is able to pass through the network. The behaviour of the network is really considerably more complicated than the above description might imply, but, as has been pointed out before, it is not proposed to go very deeply into theory in the course of this discussion, and a salient presentation of the general features of each circuit is all that is being attempted.

As a result of this increasing resistance characteristic exhibited by a parallel circuit at resonance, the actual current which will pass at the resonant frequency is very small. The circuit exhibits the same "selective" characteristics as are shown by the series circuit, and the selectivity and resonant/non-resonant impedance ratios are controlled by the amount of resistance present, in the same manner.

As the majority of radio receiver tuning circuits are of the parallel-resonant type, it can easily be seen that any resistance present in the circuit detracts very largely from the performance in more ways than one.

Vacuum-Tube Circuits

Parallel resonant circuits are particularly valuable in any applications where vacuum-tubes are concerned, on account of the fact that high input and output impedances are usually essential for the efficient operation of such tubes. The value of parallel-resonant circuits in this connection is not only on account of the relative ease with which high impedances may be attained, but also because the D.C. resistance is invariably only a very small fraction of the resonant impedance. Consequently, little or no effect on the static operating potentials of the tubes is evident. This in itself is a decided advantage, as it means there is no power wastage in the resonant circuits.

Parallel resonant circuits find many valuable applications in equalisers and wave filters, the procedure in such circuits being to place the network in series with the remainder of the circuit. The insertion loss caused by the filter is usually somewhat higher than that of a "series" network shunted across the line, but as the filtering efficiency is also somewhat higher, the system finds many applications where extremely good filtration is required. Occasionally both types of network are used in the same circuit. This is done in cases where a high degree of band-response equalisation is required, and it is necessary to take advantage of the special properties of each system.

TO FIND REACTANCE: Read the charts vertically from the bottom (frequency) and along the lines slanting upward to the left (inductance) or to the right (capacitance). Project horizontally to the left from the intersection and read reactance. Note that there are two sets of calibration values used throughout this table, and that the upper values on the scales correspond to the upper set of values at the bottom of the complete table and vice versa.

TO FIND RESONANT FREQUENCY: Read the slanting lines for the given inductance and capacitance. Project downward to the bottom scale. **Example:** The sample point, indicated at right hand top of table 1, corresponds to a frequency of about 700 k.c. and an inductance of 0.5 henry, or a capacitance of 0.1 $\mu\mu$f, giving in either case a reactance of about 2,000,000 ohms. The resonant frequency of a circuit containing these values of inductance and capacitance is 700 k.c., approximately.

USE OF TABLE 2: Table 2 is used to obtain additional precision of reading but does not place the decimal point, which must be located from a preliminary entry on table 1. Since the chart necessarily requires two logarithmic decades for inductance and capacitance for every single decade of frequency and reactance, unless the correct decade for L and C is chosen, the calculated values of reactance and frequency will be in error by a factor of 3.16. **Example:** (Continued) The reactance corresponding to 0.5 henry or 0.1 $\mu\mu$f. is 2,230,000 ohms at 712 k.c., their resonant frequency.

For further information on the use of these charts refer to the paragraph entitled "Use of Reactance Charts" in the section dealing with inductance and capacity under the heading "Fundamental Electrical Formulae."

FUNDAMENTALS OF A.C.—(Continued)—

"Tuned" Power Filters

Another application of this type of filter is found in the power supply units of radio receivers, and in this case, the first filter choke of a two section filter is tuned, instead of a series network being used to replace the second filter condenser, as in fig. 9.

Some idea of the increase in filtering efficiency which results from this procedure may be gained from the following.

We will assume that the first filter choke in a two-section filter has an inductance of 50 henries. Reference to fig. 10 will show that a choke of this inductance has an impedance of approximately 30,000 ohms at 100 cycles. Reference to fig. 10 again will show that this choke can be tuned to 100 cycles by connecting a 0.05 mfd. condenser in parallel with it. In order to determine the resultant impedance of the tuned circuit it will be necessary to first ascertain the D.C. resistance of the choke and then apply equation (19) ($Z = {}_L/_{rc}$). This equation specifies that "$_L$" shall be expressed in microhenries and "$_c$" in microfarads. "$_c$", being 0.05 mfd., is in order, but it will be necessary to multiply "$_L$", which is in henries, by one million. "$_r$" we can assume to have a resistance of 200 ohms. The expression then becomes

$$Z = \frac{50{,}000{,}000}{200 \times 0.05} = 5{,}000{,}000 \text{ ohms}$$

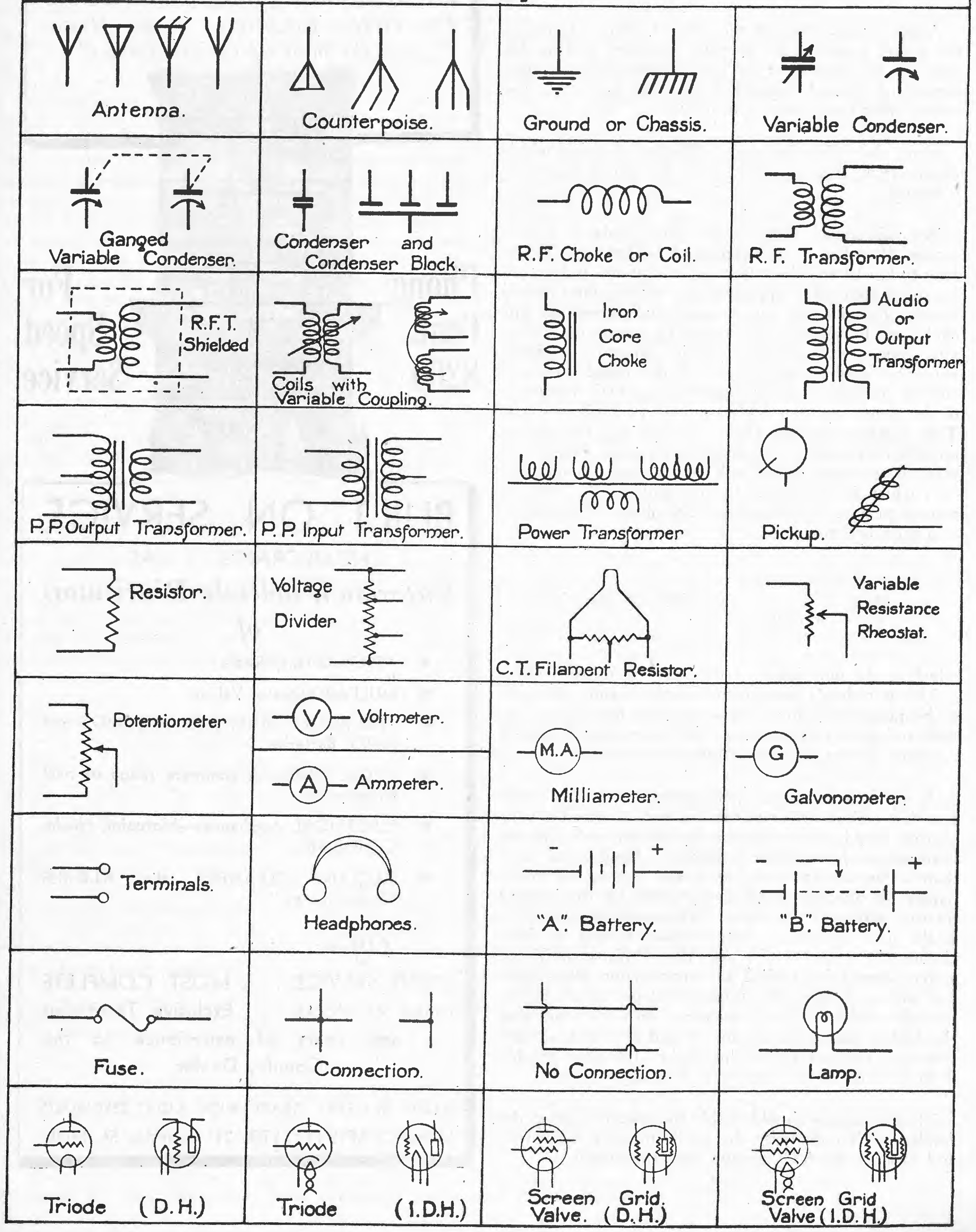
which is the impedance of the network to 100 cycles.

This is rather a phenomenal increase, and may seem to be rather ridiculous. However, the figures are correct, and serve to demonstrate the properties of parallel resonant circuits in no uncertain manner.

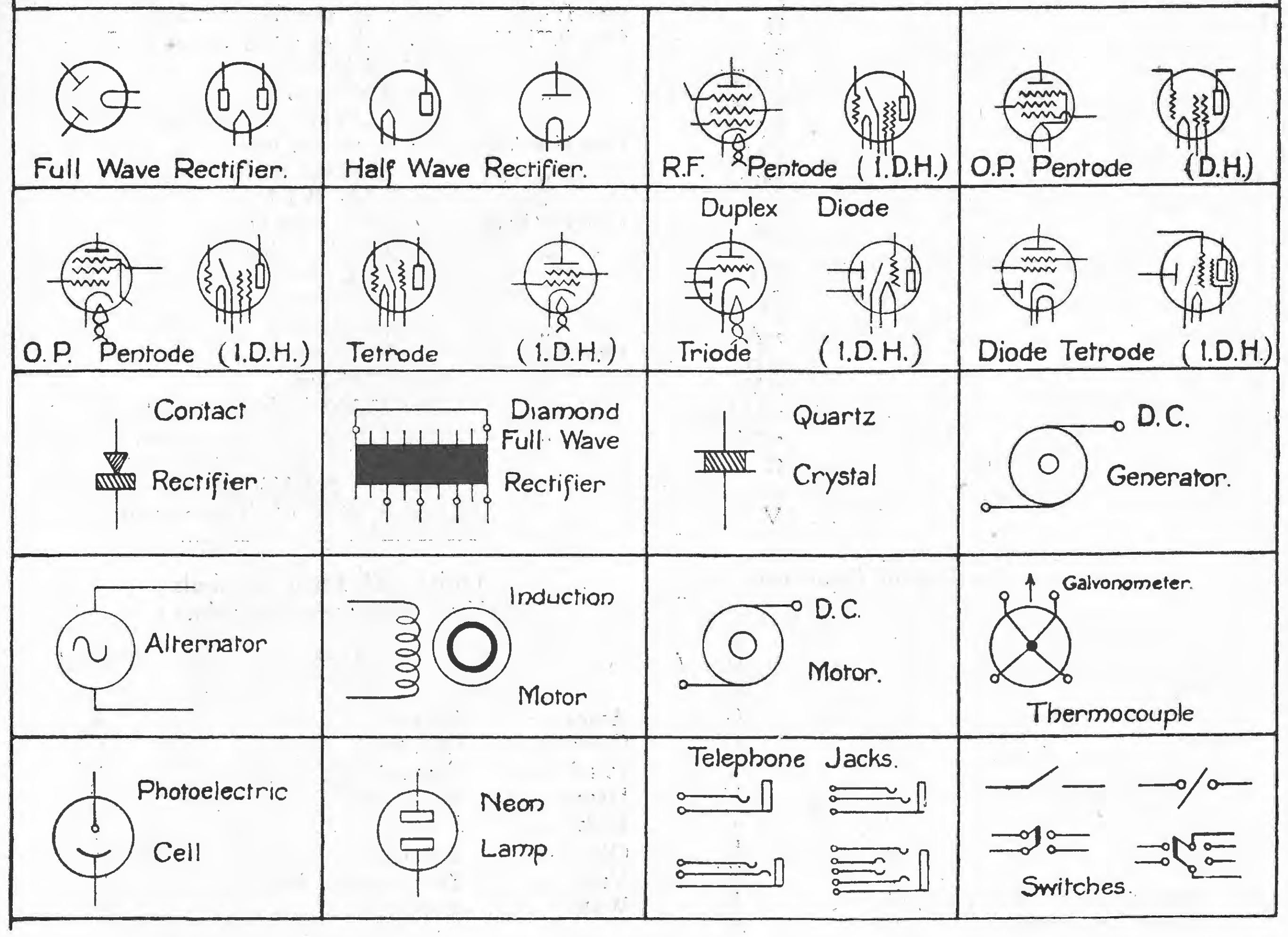
A point that must be remembered, however, is the fact that a filter similar to the one just described is very sharply tuned, and maximum attenuation will only be exercised at the resonant frequency. Frequencies more than a few cycles above or below 100 cycles would hardly be affected at all, other than by the normal filtering action of the choke. However, as 100 cycles is the main frequency which causes trouble in filter circuits, the system is of great value. Unfortunately, the system cannot be applied to single-section filters with any success, because the tuning-condenser tends to bypass the choke at high frequencies, with the result that the higher harmonics of the 50 and 100 cycles pulsations are shunted across the choke and cause trouble if there is no second section to look after them.

These examples should enable the reader to grasp the fundamentals underlying the applications of inductance and capacity to A.C. circuits very thoroughly.

Radio Symbols.



Radio Symbols.



Abbreviations and Symbols

THE list given below indicates the main abbreviations used for radio and electrical terms or units. Those referring more particularly to electrical terms follow the recommendations of the International Electro-Technical Commission which have been adopted by the British Standards Institute (vide B.S. Spec. No. 423, 1931, "British Standard Letter Symbols for use in Electro-Technics").

The major units are denoted by capital letters, while prefixes appear in small letters, i.e., the symbol for milliwatt is mW. The exception is the use of M for "meg" or "mega" to avoid confusion with the sub-multiple "m". The symbols remain the same regardless of the numerical value of the unit involved. We may have 0.1A, 1A, or 10A.

With regard to abbreviations for such terms as "alternating current," "intermediate frequency," etc., either as nouns or adjectives, there seems no standard usage. British practice is to use capitals followed by stops in either case, although the American method of using small letters, hyphenated for adjectival use and with stops for noun use, seems more justified and this has been used below.

It should be noted that symbols are NOT followed by full stops when appearing in text, although abbreviations are punctuated as such. All terms should preferably appear fully spelled out, as the use of symbols or abbreviations in running text is deprecated.

The pictorial representations of components, etc., as shown on this and the preceding page indicate those commonly used in this country and which may be taken as standard, although there are several cases where alternative versions exist.

Term	Abbreviation or letter symbol.
Alternating-current (adjective)	a-c
Alternating current	a.c.
Ampere	A
Audio-frequency (adjective)	a-f
Continuous waves	C.W.
Cycles per second	~
Decibel	db
Direct-current (adjective)	d-c

(Continued on page 174)

RADIO SYMBOLS—(Continued from page 173)—

Direct current	d.c.
Electromotive force	e.m.f.
Frequency	f.
Henry	H
Intermediate-frequency (adjective)	i-f
Interrupted continuous waves	I.C.W.
Kilocycles per second	kc/sec.
Kilowatt	kW
Kilowatt-hour	kWh
Megohm	MΩ
Microfarad	μF
Microhenry	μH
Micromicrofarad (= picofarad)	μμF
Microvolt	μV
Microvolt per meter	μV/m
Milliampere	mA
Millihenry	mH
Millivolt	mV
Millivolt per meter	mV/m
Milliwatt	mW
Ohm	Ω
Radio-Frequency (adjective)	r-f
Volt	V

International Symbols of Quantities

Acceleration of gravity	g
Angles	φ ψ θ
Capacity	C
Conductance	G
Current	I
Dielectric constant	K
Difference of potential	V
Efficiency	η
Electromotive force	E
Energy or work	W
Flux density (electrostatic)	D
Flux density (magnetic)	B
Frequency	f
Impedance	Z
Intensity of magnetisation	J
Length	l
Mass	m
Magnetic field	H
Magnetic flux	Φ
Magnetomotive force	F
Mutual inductance	M
Permeability	μ
Phase displacement	φ
Power	P
Quantity of electricity	Q
Reactance	X
Reluctance	S
Resistance	R
Resistivity	ρ
Self-inductance	L
Susceptibility	κ
Temperature	T
Time	t
Work	A

Units and Their Equivalents

This table shows the relation between electrical and mechanical units. It enables any conversion to be made.

One ft.-lb.	= 1 lb. raised 1 foot high.
One B.Th.U.	= 1 lb. of water raised 1° F.
"	= 778.8 ft.-lb.
"	= 1,005 joules.
"	= 0.252 kilogram calories.
One H.P. Hour	= 0.746 kw. hour.
"	= 1,980,000 ft.-lb.
"	= 2,545 B.T.U.'s.
One kw. hour	= 1,000 watt hours.
"	= 1.34 H.P. hours.
"	= 3,412 B.T.U.'s.
"	= 2,654,200 ft.-lb.
"	= 3,600,000 joules.
One H.P.	= 746 watts.
"	= 0.746 kw.
"	= 33,000 ft.-lb. per minute.
"	= 550 ft.—lb. per second.
"	= 2,545 B.T.U.'s per hour.
"	= 42.4 B.T.U.'s per minute.
"	= 0.707 B.T.U.'s per second.

Units and Their Symbols

(Used after numerical values.)

	Unit of	Symbol
Ampere	Current	A
Coulomb	Quantity	C
Farad	Capacity	F
Henry	Inductance	H
Joule	Energy	J
Ohm	Resistance	Ω
Volt	Electromotive Force	V
Watt	Power	W

Multiples and Their Symbols

Multiple	Name	Symbol
1,000,000	Mega	M
1,000	Kilo	k
100	Hecto	—
.001	Milli	m
.000,001	Micro	μ

Prefixes

The prefixes milli-, micro- and micromicro- denote that the term to which they are attached (e.g. amps or farads) must be divided by 1,000 or 1,000,000 or 1,000,000,000,000 respectively, e.g., one milliamp is $\frac{1}{1000}$ amps, while a condenser of .0005 mfd capacity may be spoken of as a 500 mmfd. condenser. Milli- is denoted by m. and micro- should be denoted by the Greek letter "mu" but is often printed as m. due to the

(Continued on page 176)

RADIO SYMBOLS—(Continued from page 174)—

printer's limitations. The prefixes kilo- and meg- or mega- denote that the term to which they are attached (e.g., volts or ohms) must be multiplied by 1,000 or 1,000,000 respectively, e.g., one megacycle is 1,000,000 cycles. They are denoted by k and M respectively.

Handy Factors

π	3.14159
π^2	9.8696
$\pi/4$	.7854
$1/\pi$	.3183
1 radian	57.3°
e	2.718
$\log_{10}e$	2.3026

Inches and Fractions as Decimal Equivalents of One Foot

Inches.	Fraction. 0	¼	½	¾
0	.0000	.0208	.0417	.0625
1	.0833	.1042	.125	.1458
2	.1667	.1875	.208	.229
3	.250	.270	.291	.312
4	.333	.354	.375	.395
5	.416	.437	.458	.479
6	.500	.520	.541	.562
7	.583	.604	.625	.645
8	.666	.687	.708	.729
9	.750	770	.791	.812
10	.833	.854	.875	.895
11	.916	.937	.958	.979

Decimal Equivalents of Sixteenths

1 sixteenth	=	.0625
2 ,,	=	.125
3 ,,	=	.1875
4 ,,	=	.25
5 ,,	=	.3125
6 ,,	=	.375
7 sixteenths	=	.4375
8 ,,	=	.5
9 ,,	=	.5625
10 ,,	=	.625
11 ,,	=	.6875
12 ,,	=	.75
13 ,,	=	.8125
14 ,,	=	.875
15 ,,	=	.9375

Whitworth Threads

Diam.	Diam. at Bottom of Thread.	Threads per inch.
¼ in.	.186	20
⅜ in.	.295	16
½ in.	.393	12
⅝ in.	.508	11
¾ in.	.622	10
1 in.	.840	8
1¼ in.	1.067	7
1½ in.	1.286	6
1¾ in.	1.494	5
2 in.	1.715	4½
2½ in.	2.180	4
3 in.	2.634	3½

Drills for Tapping and Clearing B.A. Sizes

B.A. Size.	Tapping (ins.).	Clearing (ins.).
0	$\frac{13}{64}$	$\frac{17}{64}$
1	$\frac{11}{64}$	$\frac{7}{32}$
2	$\frac{5}{32}$	$\frac{13}{64}$
3	$\frac{9}{64}$	$\frac{3}{16}$
4	$\frac{1}{8}$	$\frac{5}{32}$
5	$\frac{3}{32}$	$\frac{1}{8}$
6	$\frac{5}{64}$	$\frac{5}{64}$
8	$\frac{3}{64}$	$\frac{5}{64}$

Specific Resistances of Metals and Alloys at Ordinary Temperatures

Substance	Specific Resistance Microhms per cm.	Relative conductance	Substance	Specific Resistance Michrohms per cm.	Relative conductance
Aluminium	2.94	54	Lead	20.8	6.64
Brass	6.9	26.17	Manganin ..	43	3.7
Climax	87	1.83	Mercury ..	95.7	1.66
Cobalt	9.7	16.3	Molybdenum	4.8	33.2
Constantan ..	49	3.24	Nickel	10.5	11.8
Copper, annealed ..	1.59	100	Nichrome ..	110	1.45
Ger. Silver (18X) ..	30-40	5.3-4	Platinum ..	10.8	14.6
Iron, pure ..	9	17.7	Silver	1.5	106
Iron, wrought	13.9	11.4	Tungsten ..	5.4	28.9

Wire Tables

B.E.S.A. STANDARD SIZES OF ANNEALED COPPER WIRES

Superseded S.W.G. Size	Standard Diameter		Calculated Sectional Area		Weight per. 1,000 yards Pounds	Standard Resistance at 60° F.		Current rating Amperes @
	Inch	M/m.	Square Inch	Square M/m.		Ohms. Per 1000 yds.	Per lb. Ohms.	1,000 per Sq. Inch
50	.0010	.0254	.0000007854	.0005067	.009083	30570	3365000	.0008
49	.0012	.0305	.0000011310	.0007297	.013079	21230	1623000	.0011
48	.0016	.0406	.000002011	.0012972	.02325	11941	513500	.0020
47	.0020	.0508	.000003142	.002027	.03633	7642	210300	.0031
46	.0024	.0610	.000004524	.002019	.05232	5307	101440	.0045
45	.0028	.0711	.000006158	.003973	.07121	3899	54750	.0062
44	.0032	.0813	.000008042	.005189	.09301	2985	32090	.0080
43	.0036	.0914	.000010179	.006567	.11772	2359	20040	.0101
42	.0040	.1016	.000012566	.008107	.14533	1910.5	13146	.0126
41	.0044	.1118	.000015205	.009810	.17585	1578.9	8979	.0152
40	.0048	.1219	.000018096	.011675	.2093	1326.7	6340	.0181
39	.0052	.1321	.00002124	.013701	.2456	1130.5	4603	.0212
38	.0060	.1524	.00002827	.018241	.3270	849.1	2597	.0283
37	.0068	.1727	.00003632	.02343	.4200	661.1	1574.0	.0363
36	.0076	.1930	.00004536	.02927	.5246	529.2	1008.7	.0454
35	.0084	.2134	.00005542	.03575	.6409	433.2	676.0	.0554
34	.0092	.2337	.00006648	.04289	.7688	361.2	469.8	.0665
33	.0100	.2540	.00007854	.05067	.9083	305.7	336.5	.0785
32	.0108	.2743	.00009161	.05910	1.0594	262.1	247.4	.0916
31	.0116	.2946	.00010568	.06818	1.2222	227.2	185.87	.1057
30	.0124	.3150	.00012076	.07791	1.3966	198.80	142.35	.1208
29	.0136	.3454	.00014527	.09372	1.6800	165.27	98.37	.1453
28	.0148	.3759	.00017203	.11099	1.9895	139.55	70.14	.1720
27	.0164	.4166	.0002112	.13628	2.443	113.65	46.52	.2112
26	.018	.4572	.0002545	.16417	2.943	94.35	32.06	.2545
25	.020	.5080	.0003142	.2027	3.633	76.42	21.03	.3142
24	.022	.5588	.0003801	.2453	4.396	63.16	14.366	.3801
23	.024	.6096	.0004524	.2919	5.232	53.07	10.144	.4524
22	.028	.7112	.0006158	.3973	7.121	38.99	5.475	.6158
21	.032	.8128	.0008042	.5189	9.301	29.85	3.209	.8042
20	.036	.9144	.0010179	.6567	11.772	23.59	2.004	1.0179
19	.040	1.0160	.0012566	.8107	14.533	19.105	1.3146	1.2566
18	.048	1.2192	.0018096	1.1675	20.93	13.267	.6340	1.8096
17	.056	1.4224	.002463	1.5890	28.48	9.747	.3422	2.463
16	.064	1.6256	.003217	2.0755	37.20	7.463	.2006	3.217
15	.072	1.8288	.004072	2.6268	47.09	5.897	.12523	4.072
14	.080	2.0320	.005027	3.2429	58.13	4.776	.08216	5.027
13	.092	2.3368	.006648	4.2888	76.88	3.612	.04698	6.648
12	.104	2.6416	.008495	5.4805	98.24	2.826	.02877	8.495
11	.116	2.9464	.010568	6.8183	122.22	2.272	.018587	10.568
10	.128	3.2512	.012868	8.3019	148.82	1.8657	.012537	12.868
9	.144	3.6576	.016286	10.5071	188.34	1.4741	.007827	16.286
8	.160	4.0640	.02011	12.9717	232.5	1.1941	.005135	20.11
7	.176	4.4704	.02433	15.6958	281.4	.9868	.003507	24.33
6	.192	4.8768	.02895	18.6792	334.8	.8292	.002476	28.95
5	.212	5.3848	.03530	22.7734	408.2	.6801	.0016661	35.30
4	.232	5.8928	.04227	27.2730	488.9	.5679	.0011617	42.27
3	.252	6.4008	.04988	32.1780	576.8	.4814	.0008345	49.88
2	.276	7.0104	.05983	38.5990	691.9	.4013	.0005800	59.83
1	.300	7.6200	.07069	45.6037	817.5	.3396	.0004155	70.69
1/0	.324	8.2296	.08245	53.1921	953.5	.2912	.0003054	82.45
2/0	.348	8.8392	.09511	61.3643	1100.0	.2524	.0002295	95.11
3/0	.372	9.4488	.10869	70.1202	1256.9	.2209	.00017574	108.69
4/0	.400	10.1600	.12566	81.0732	1453.3	.19105	.00013146	125.66
5/0	.432	10.9728	.14657	94.5638	1695.1	.16379	.00009663	146.57
6/0	.464	11.7856	.16909	109.0921	1955.5	.14198	.00007260	169.09
7/0	.500	12.7000	.19635	126.6769	2271.0	.12227	.00005385	196.35

NICKEL CHROME RESISTANCE WIRE

Size S.W.G.	Approximate Resistance per 1,000 yards. Standard Ohms.			Approximate Amperes at—			per 1,000 yards.
	200° C.	400° C.	600° C.	200° C.	400° C.	600° C.	lbs.
16	452	494	538	7.1	12	18	37.6
17	591	646	703	6.0	9.6	14	28.9
18	802	879	957	4.3	7.7	11	21.2
19	1154	1266	1378	3.7	5.7	8.4	14.8
20	1426	1590	1700	3.3	4.7	6.8	12.0
21	1809	1978	2151	2.7	4.2	6.2	9.41
22	2360	2583	2820	2.2	3.5	5.1	6.71
23	3237	3535	3860	1.8	2.8	4.1	5.31
24	3828	4187	4555	1.6	2.4	3.3	4.46
25	4732	5061	5505	1.4	2.1	3.1	3.69
26	5720	6250	6870	1.1	1.9	2.6	2.98
27	6890	7535	8400	1.0	1.6	2.4	2.48
28	8460	9250	10070	.93	1.4	2.0	1.95
29	10000	10950	11920	.78	1.3	1.8	1.69
30	12040	13170	14320	.68	1.1	1.6	1.42
31	13760	15040	16370	.61	.88	1.3	1.246
32	15880	17360	18900	.55	.80	1.2	1.076
33	18530	20250	22050	.50	.72	1.1	.924
34	21880	23920	26100	.43	.63	.93	.781
35	26250	28700	31500	.37	.56	.83	.651
36	32200	35070	38380	.32	.49	.72	.532
37	40100	43800	49000	.29	.43	.63	.424
38	51400	56300	61270	.21	.34	.49	.331
39	68500	74900	81500	.17	.26	.39	.250
40	80200	87900	95700	.16	.24	.35	.2

EUREKA RESISTANCE WIRE.

Cu rrent Necessary to Maintain Given Temperature Rise. Wire Coiled in Air with Free Radiation.

Size S.W.G.	Diam. Inch.	M/m.	Amperes for a Temperature rise of			Resistance per 1,000 yards at 60°F Ohms.	Weight per 1,000 yards lbs
			100° C.	200° C	300° C.		
8	.160	4.06	33.0	52	58.5	33.5	233 5
9	.144	3.65	26.0	43	50	41.3	189.0
10	.128	3.25	22.8	36	41.5	52.3	149.2
11	.116	2.94	19.0	30	35.5	63.7	122.8
12	.104	2.64	16.8	24	29.5	79.3	98.6
13	.092	2.33	12.7	20	24.2	101.3	77.1
14	.080	2.03	9.5	15	19.5	133.9	58.4
15	.072	1.82	7.4	12.6	16.8	165.3	47.3
16	.064	1.62	6.0	10.4	14.3	209.4	37.4
17	.056	1.42	5.3	8.8	11.3	273.3	28.6
18	.048	1.21	4.3	7.0	9.1	371.8	21.0
19	.040	1.01	3.7	5.5	6.8	535.6	14.6
20	.036	.91	3.0	4.7	5.9	661.3	11.8
21	.032	.81	2.8	4.0	5.0	837.2	9.35
22	.028	.71	2.2	3.2	4.1	1093	7.16
23	.024	.60	1.8	2.6	3.3	1487	5.24
24	.022	.55	1.5	2.3	2.8	1770	4.41
25	.020	.50	1.25	2.0	2.5	2142	3.64
26	.018	.45	1.00	1.7	2.1	2645	2.96
27	.0164	.41	.90	1.5	1.9	3186	2.46
28	.0148	.37	.76	1.4	1.6	3914	2.00
29	.0186	.34	.68	1.2	1.5	4634	1.69
30	.0124	.31	.59	1.0	1.3	5575	1.40
31	.0116	.29	.52	.90	1.00	6370	1.23
32	.0108	.27	.47	.81	.95	7350	1.06
33	.0100	.25	.42	.74	.85	8571	.912
34	.0092	.23	.37	.64	.75	10128	.771
35	.0084	.21	.33	.56	.65	12149	.644
36	.0076	.19	.28	.48	.57	14840	.526
37	.0068	.17	.26	.43	.51	18536	.421
38	.0060	.15	.19	.31	.40	23808	.328
39	.0052	.13	.16	.26	.31	31696	.246
40	.0048	.12	.15	.24	.28	37184	.210
41	.0044	.11	.14	.21	.26	44268	.176
42	.0040	.10	.13	.18	.23	53564	.146
43	.0036	.09	.11	.17	.20	66136	.118
44	.0032	.08	.10	.14	.17	83664	.093
45	.0028	.07	.08	.13	.15	108648	.072
46	.0024	.06	.07	.10	.12	148764	.053
47	.0020	.05	.05	.08	.10	214284	.036
48	.0016	.040	.04	.060	.075	334000	.023
49	.0012	.030	.03	.045	.055	595000	.013
50	.0010	.025	.02	.030	.040	855000	.009

Nearest Equivalent Wire Gauges.

S.W.G.	Nearest Equivalent B & S	S.W.G.	Nearest Equivalent B & S	S.W.G.	Nearest Equivalent B. & S.
7/0	4/0	13	11	31	29
6/0	4/0	14	12	32	29
5/0	3/0	15	13	33	30
4/0	3/0			34	31
3/0	2/0	16	14	35	32
2/0	0	17	15		
0	0	18	17	36	32
		19	18	37	33
1	1	20	19	38	34
2	1			39	36
3	2	21	20	40	36
4	3	22	21		
5	4	23	22	41	37
		24	23	42	38
6	5	25	24	43	39
7	5			44	40
8	6	26	25	45	40
9	7	27	26		
10	8	28	27	46	40
		29	27	47	40
11	9	30	28	48	40
12	10			50	40

Metric Equivalents

IT is not unusual to find, when going through some electrical or radio formulae, that certain of the quantities are expressed in the metric scale, such as the thickness of a plate in centimetres, or the diameter of a wire in millimetres.

As metric measuring instruments are distinctly rare in Australia, a conversion factor, which may be used to convert the metric quantities into English measurements, becomes necessary. Conversion factors for the more usual quantities will be found in the following table:—

Metric		English
1 metre	=	39.37079 inches
1 centimetre	=	0.393 inches
1 millimetre	=	0.0393 inches

In addition to the metric measures of length there are also metric measures of inductance and capacity. This, inductance and capacity are expressed in centimetres, instead of fractions of a henry, or farad, as the case may be. Equivalents are given below:—

Metric			English
Inductance :	1 centimetre	=	0.001 microhenry
Capacity :	1 centimetre	=	1.1124 micro-microfarads
	or 900 centimetres	=	1 microfarad (approx.)

Radio Colour Codes

IN addition to the familiar resistor colour code, sponsored by the Radio Manufacturers' Association of U.S.A. and adopted as standard in Australia, other wiring codes have been formulated and even though very few of the American components mentioned reach Australia, it is not outside the bounds of possibility that the wiring codes for them will be adopted as standard for apparatus manufactured in this country.

In any case, the data provides a useful reference list for use by Australian engineers who encounter American apparatus at any time, and as such is well worth perusal.

Speaker Output Transformers

Green	outside lead of primary winding.
Brown	inside lead of primary winding.
Red	primary centre tap if one is used.
White	outside lead of secondary winding.
Maroon	inside lead of secondary winding.

Speaker Field Coils

Yellow	outside lead of winding.
Black	inside lead of winding.
Grey	centre tap if one is used.

If two separate fields are employed.

Yellow	outside lead of winding No. 1.
Black	inside lead of winding No. 1.
Grey	outside lead of winding No. 2.
Blue	inside lead of winding No. 2.

Voice Coils

White	outside lead of winding.
Maroon	inside lead of winding.

These colour codings correspond with codes of speaker transformer secondary winding.

Power Transformers

Black	Primary leads.
Black	common of tapped primary.
Black & Yellow	50/50 stripes—tap of primary.
Black & Red	50/50 stripes—finish of primary.
Red	plate leads of high voltage secondary.
Red & Yellow	50/50 stripes—high voltage centre tap.
Yellow	rectifier filament leads.
Yellow & Blue	50/50 stripes—rectifier centre tap.
Green	filament winding No. 1.
Green & Yellow	50/50 stripes—No. 1 filament centre tap.
Brown	filament winding No. 2.
Brown & Yellow	50/50 stripes—No. 2 filament centre tap.
Slate	filament winding No. 3.
Slate & Yellow	50/50 stripes—No. 3 filament centre tap.

Intermediate Frequency Coils

Blue	plate lead.
Red	B + lead.
Green	grid (or diode) lead.
Black	grid return.

With full-wave transformer

Green	diode lead.
Green-Black	diode lead.
Black	centre tap (diode return).

Standard Colour Coding for Resistors

In the RMA (American) standard coding, ten colours are assigned to the figures as shown in the following table:

Figure	Colour	Figure	Colour
0	Black	5	Green
1	Brown	6	Blue
2	Red	7	Violet
3	Orange	8	Grey
4	Yellow	9	White

The body (A) of the resistor is coloured to represent the first figure of the resistance value. One end (B) of the resistor is coloured to represent the second figure A band, or dot (C) of colour, representing the number of ciphers following the first two figures, is located within the body colour.

Examples:—	A		B		C	
10 ohms	Brown	(1)	Black	(0)	Black	(No Ciphers)
200 ohms	Red	(2)	Black	(0)	Brown	(One "
3,400 ohms	Orange	(3)	Yellow	(4)	Red	(Two "
40,000 ohms	Yellow	(4)	Black	(0)	Orange	(Three "
44,000 ohms	Yellow	(4)	Yellow	(4)	Orange	(Three "

Condenser Data

Dielectric Strengths

Material	Volts per mm.
Bakelite	6, to 30,000
Glass	8,000
Paraffin	12,000
Micanite	40,000
Ebonite	30,000
Porcelain	10,000
Empire Cloth	10,000
Presspahn	5,000
Fibre	3, to 16,000

Two sharp points in air 10 inches apart will flash over at about 100,000 volts.

Dielectric Constants

Material.	K	Material.	K
Bakelite	5.1 – 5.8	Resin	1.8 – 2.6
Ebonite	2.7 – 2.9	Shellac	3 – 3.7
Glass, crown	5 – 7	Silica, fused	3.5 – 3.6
" hard	7 – 9	Sulphur	3.6 – 4.3
" flint	7 – 10	Vaseline	2.2
" mirror	6 – 7	Oil, castor	4.6 – 4.8
Ice (–2° C)	93.9	" Olive	3.1 – 3.2
Indiarubber	2.1 – 2.3	" Paraffin	4.6 – 4.8
Marble	8.3	Vaseline	1.9
Mica	5.7 – 7		
Paper, dry	2 – 2.5	Wood	2–5
Paraffin wax	2 – 2.3	Water	81
Pitch	1.8	" =36 m.	3.32
Porcelain	4.4 – 6.8	" =12 m.	2.79
Quartz	4.5	Air 0° C.	1.000586
Slate	10 – 30	" 20° C.	1.000576

Gases all have a value of "k" near to one while a rise in temperature causes a fall in "k." The dielectric constant is also known as the specific inductive capacity of S.I.C.

Resistance Calculation for Radio Receiver Design

RESISTORS of various kinds play a very important part in radio receiver design and the use of resistors of the correct rating throughout the construction of a receiver does much to minimise service troubles.

The resistors used in a radio receiver may be classed under six general headings, each of which overlap to some extent. These are as follows:—

(1) Voltage dropping resistors.
(2) Decoupling resistors.
(3) By-passing or shunting resistors.
(4) Bias resistors.
(5) Plate load resistors.
(6) Grid resistors or leaks.

Voltage Dropping Resistors

Voltage dropping resistors can be of two kinds; those in series with a valve or component which draws current and those which form part of a tapped voltage divider shunted across a source of voltage.

The calculation of the former is merely a matter of the application of Ohm's Law for resistance (R — E/1) and, as the voltage is to be dropped and the current which is to be drawn through the resistance is known, the resistance and wattage dissipation may easily be calculated. The chart shown on this page (Figure 1) will assist greatly in this direction as it will be seen that four columns are provided, each of which is calibrated with one of the four factors which enter into the operation of a resistor in a D.C. circuit. These calibrations are so arranged that if any two quantities are known the remaining two may be read off directly from the chart by the simple expedient of placing a rule between the two known points and noting the points of intersection on the remaining columns.

In the case of a voltage dropping resistor which forms part of a voltage divider system the calculation is a little more complicated, as here we have not only the current drawn by a particular portion of the circuit to consider but also that of other portions of the circuit which are fed from the same divider and also the steady bleed current drawn by the divider system itself.

Actually, the problem is by no means as involved as it sounds and a little thought and the application of Ohm's Law (or the resistance calculation chart) will do the job very nicely. Details of the procedure involved have already been given in the Ohm's Law section under the heading "Fundamental Electrical Formulae," and need not be elaborated upon further at this point. It is quite obvious that the chart may be used in this case also for the determination of the resistance values and ratings required. The main point that must be borne in mind when designing a voltage divider is that the current flowing in any section is equal to the total of (1) The current drawn from the tap it feeds, (2) The current drawn from all lower voltage tappings on the same divider and (3) the "bleed" current required. The question of "bleed" current is quite important, as this bleed, besides placing a steady load on the power supply system (which reduces the peak voltage value while the set is warming up) also serves to reduce the value of resistance necessary in the entire divider system and so improves the voltage regulation from any of the tappings. An example will serve to make this last point clearer.

We will assume that the tubes in a radio receiver require a screen voltage of 100, and that the total drain of the screens is 15 mA. If the maximum voltage of the power supply is 250 volts, a resistor having a value of 10,000 ohms

(Continued on page 182)

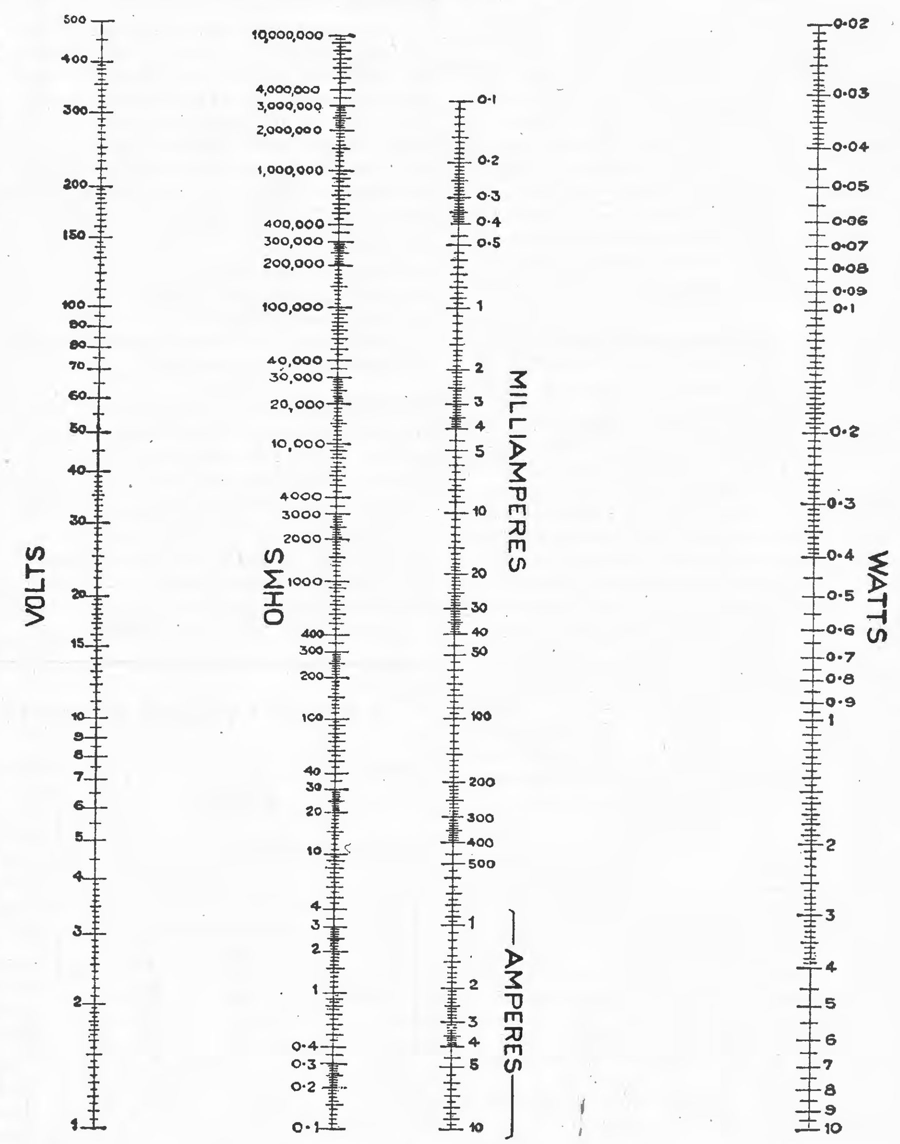


Fig. 1.—Chart for Calculating Resistors, etc.

RESISTOR CALCULATIONS—(Continued)—

will be required to give the necessary drop of 150 volts. This is quite in order, but, unfortunately, the screen drain of modern receivers varies considerably on account of the A.V.C. action and, on a strong signal, the 15 mA. total drain may quite easily be reduced to 5 mA. Under these circumstances the drop in the 10,000 ohm resistor will only be 50 volts, with the result that 200 volts will be applied to the screens instead of the rated 100 volts. If, however, a voltage divider system is used which places a drain of 10 mA. on the 100 volt screen tapping the position changes considerably. Under these circumstances the drain in the main dropping resistor will total 25 mA. and, as a result, only 6,000 ohms will be required to provide the necessary 150 volt drop.

A 10,000 ohm resistor between the 100 volt screen lead and the negative return will be required in order to supply the 10 mA bleed. Should the screen current drop to 5mA. it will reduce the total current (assuming the bleed stays at 10 mA.) to 15 mA. This alone is sufficient to give a 90 volt drop through the 6,000 ohm main feed resistor with the result that the applied screen voltage is only 160 volts. However, this increase in screen voltage will also increase the bleed through the 10,000 ohm resistor (which is shunted across the screen tapping) so that actually the total current drawn will be somewhat more than 15 mA. and the voltage applied to the screens will be kept much nearer to the 100 volt mark. The actual voltage supplied can be calculated, but, for the purpose of this discussion, it can be assumed that a mean is struck between the 160 volt and 100 volt levels.

From this it can be seen that instead of a screen voltage regulation of nearly 100%, the use of a bleed reduces the regulation percentage to somewhat near 30. In actual practice these figures will be reduced slightly, due to the fact that the screens will draw more current at the increased voltage than they do at the rated voltage, but the example serves admirably for the purpose of illustration. Still better voltage regulation may be achieved by the use of a larger bleed current than that specified.

Decoupling Resistors

Decoupling resistors may also be of two kinds; those which carry current and those which merely act as filters. The first type also act as filters, but, as they carry current, they must be regarded as voltage-dropping resistors when it comes to deciding the values to be used in a circuit. Examples of decoupling resistors which also act as voltage dropping resistors are those used to decouple the screens of two or more tubes which are all fed from one voltage divider tapping and those which are used to decouple the plate circuits of two or more tubes which are all fed from one main supply.

Occasionally, the functions of voltage dropping and decoupling (or filtering) are intentionally combined and in this case the resistor is chosen for its voltage dropping qualities alone; additional decoupling (or filtering) being provided by larger values of by-pass condensers, if required.

If the decoupling (or filtering) is the main function of the resistor and voltage loss is to be avoided as much as possible the resistor is made as small as possible and used in conjunction with a condenser which has a relatively low impedance at the frequency which is to be "stopped." Efficient decoupling will usually be provided when the condenser has an impedance of about one-tenth of that of the resistor. Actually, in practice, the procedure adopted is to choose a standardised size of condenser for the job and to proportion the resistor to it, as it is far easier to obtain a resistance of odd value than a condenser.

The problem is much simpler when the resistor only acts as a filter and carries no appreciable amount of current. Typical examples are bias and A.V.C. decoupling resistors. In both of these cases the resistor acts as a filter in both directions, that is, it is used to prevent R.F. or A.F., as the case may be, getting back into the power supply or the grid circuits of other valves and it is also used to smooth out any irregularities in the bias or A.V.C. supply. This necessitates the use of a somewhat higher ratio of capacitative impedance and resistance than would normally be necessary and it is not unusual to find ratios of several hundred-thousand to one being used. However, as very little or no current is flowing through the resistor, the higher ratio does no harm and ensures that complete decoupling or filtering is effected. An exception to this is found in the case of a bias decoupling resistor used on an output tube, as in this case there is a definite limit to the amount of resistance which can be inserted in the grid circuit of the tube.

In this particular instance the procedure is usually to employ the maximum size of resistor possible (bearing the characteristics of the tube in mind and remembering that the grid leak proper is also in the grid circuit), and to use the largest capacity condenser that is economically possible. Normal practice usually places the respective values at 100,000 to 250,000 ohms and 0.5 mfd. As the reactance of a 0.5 mfd. condenser is about 6,500 ohms at 50 cycles it will be seen that the impedance ratio is very favourable for effective decoupling and also, with the usual value of grid leak employed, very favourable for effective A.C. filtration. (Reference to earlier notes in the "Fundamental Electrical Formulae" section will service to clarify this point).

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GREEK SYMBOLS USED IN RADIO FORMULAE

Letter. Small.	Letter. Capital.	Name.	English Equivalent.
α	Α	Alpha	a
β	Β	Beta	b
γ	Γ	Gamma	g
δ	Δ	Delta	d
ε	Ε	Epsilon	ĕ (as in " met ")
ζ	Ζ	Zeta	z
η	Η	Eta	ēē (as in " meet ")
θ	Θ	Theta	th
ι	Ι	Iota	i
κ	Κ	Kappa	k
λ	Λ	Lambda	l
μ	Μ	Mu	m
ν	Ν	Nu	n
ξ	Ξ	Ksi	x
ο	Ο	Omicron	ŏ (as in " olive ")
π	Π	Pi	p
ρ	Ρ	Rho	r
σ	Σ	Sigma	s
τ	Τ	Tau	t
υ	Υ	Upsilon	u
φ	Φ	Phi	ph
χ	Χ	Chi	ch (as in " school ")
ψ	Ψ	Psi	ps
ω	Ω	Ōmega	o (as in " broke ")

RESISTOR CALCULATIONS FOR RADIO DESIGN—(Continued)—

By-Pass or Shunt Resistors

Resistors are often used in radio receivers as "lossers," that is, they are shunted across some portion of the circuit where it is necessary to either dissipate some power or to reduce the resonant impedance of a tuned circuit. A bleed resistance is one example of a "losser" resistor, as in this case it is necessary to dissipate some power in order to improve the regulation of the supply system. One function of a bleed resistor has already been explained and it is fairly obvious that by having a fairly heavy "standing" load the percentage effect of any variations is reduced considerably.

Another well-known type of "losser" resistor is that used as a partial short-circuit across the aerial for local-distance switching. The operation of this merely boils down to a simple application of Ohm's Law for parallel resistances. The resistance is so proportioned that a large proportion of aerial input signal is by-passed to earth instead of going through the (relatively) high-impedance aerial coupling coil.

Another resistance by-passing function is in conjunction with tuned circuits. This application is rarely used nowadays, but was quite common at one time. The resistor acts as a pure "losser" and, in effect, flattens the resonant peak of the tuned circuit so that the voltage developed is restricted. The system was usually employed for stabilisation.

Resistances are sometimes used in high quality A.F. amplifiers for the purpose of "loading" the secondary of a coupling transformer. The function here is a two-fold one, the first phase of which is to flatten out any peaks in the transformer design which tend to emphasise any particular frequency and the second to match the secondary to the primary input impedance and so to improve the low-frequency response. Unless the resistance is intended as a pure "losser" (to flatten out peaks in the response) the correct value of the resistance is determined by the plate resistance of the preceding value and the ratio of the transformer. The idea often proves very useful in the case of A.F. amplifiers lacking in bass response and is well worth keeping in mind. The correct loading resistance to use for this purpose should have a value equal to the plate resistance of the preceding valve multiplied by the square of the transformer ratio. Thus, for low-frequency "boosting" in an amplifier stage using a 2-1 transformer and a driver valve with a plate resistance of 10,000 ohms the secondary of the transformer should be shunted with a resistance of 40,000 ohms. 10,000 × (2 squared)). This procedure will result in a big drop in overall level, but is well worth while if bass response is at all lacking.

Bias Resistors

Bias resistors are, in some ways, the least involved of all resistor applications in a radio receiver and their choice is a very cut-and-dried matter, especially with the aid of the chart given at the beginning of this article.

The bias required for any tube may be ascertained from its characteristics, as also may be its total cathode current. Knowing these two factors, the remainder of the problem is a simple matter for Ohm's Law or the calculation chart if a self-bias resistor is required. The total cathode current figure is most important, especially with pentodes or other multi-electrode tubes. Some people are apt to forget that the screen current of a tube passes through a resistor used for self-bias as well as the plate current. If the total cathode current figure is not shown on the valve characteristic sheet available it is only necessary to add up the currents taken by all electrodes (except the heater of course) and use the figure so obtained as the current for the resistor calculation. The chart will show the resistance and wattage rating necessary.

For "bleed," or "semi-fixed," bias applications where the bias resistor for the output tube is connected in the main "B" return lead it is necessary to ascertain the total drain of the receiver before proceeding with any calculations. This may be done by reference to the valve characteristic charts for all the tubes used in the receiver. In the case of R.F. and other tubes controlled by A.V.C. or other means which causes the plate current of the tubes in question to vary it is advisable to reckon about two-thirds of the maximum current drain as the average for calculation purposes. This may be regarded as hair-splitting by some, but the fact remains that it is quite possible for the output tube to be underbiassed by as much as 15 per cent. when the receiver is operating on a strong local if this factor is not taken into account. Having obtained the total drain of all tubes in the receiver, it will then be necessary to add bleed current from dividers, etc., to this figure. The calculation is then carried out using this total current drain figure and the required bias as the two known factors. The "wattage" column on the chart should prove very useful for these calculations as there is a very definite tendency to underrate, or rather, overrun, "bleed" bias resistors in many receivers.

Load or Coupling Resistors

Much of the performance obtained from modern receivers depends on the load resistors used in conjunction with the tubes in the audio channel for coupling purposes.

These load resistors may be subdivided into three types (a) those used for the load of a diode rectifier; (b) those used for shunt feeding of A.F. transformer primaries; and (c) those used as load or coupling resistors in resistance-capacity coupled amplifiers.

The first type carry practically no current and as the current carried is the rectified output of the diode, the choice of value to be used depends on the diode characteristics and the voltage it is necessary to develop. Standard practice and manufacturer's tube ratings place the value of diode load resistors at somewhere between 250,000 ohms and one megohm.

For an A.V.C. voltage rectifier diode, the higher value is usually to be preferred as it will ensure adequate voltage being developed for control purposes. For the demodulator diode, the resistance value to be used is controlled by the same factors, but is to some extent modified by the coupling condenser and grid leak used on the following audio stage. This particular phase of the problem will be dealt with fairly extensively in the section dealing with grid leaks and will not be elaborated on here.

Resistors used for shunt-feeding the primaries of A.F. transformers and resistors used as the plate load in an R-C. coupled amplifier really come under the same classification—both are plate loads and both are in series with the "B" supply to the tube—so that they may be dealt with together.

The choice of a resistor for use in either of these two positions must necessarily be a compromise as the fact that they are in series with the "B" supply to the tube, thus causing loss of voltage, is in direct opposition to the requirements for maximum gain from a tube operating as a resistance capacity coupled amplifier.

An expression which gives the theoretical stage gain which may be expected from a tube operating as an R-C. coupled amplifier is given by the following:—

$$\text{Stage gain} = \frac{\text{A.F.} \times \text{RL}}{\text{RL} + \text{RP.}}$$

where A.F. is the amplification factor of the valve; RL is the plate load resistor and RP is the plate resistance of the valve. This expression multiplied by 0.75 will give a very close approximation to the effective stage gain which can be expected.

It will be seen from the above that the full amplification factor of the valve in use can never be fully realised; also that the higher the value of plate load resistor used, the nearer will the gain of the stage approach that of the tube alone.

The reason for this is shown in figs. 2 (a) and 2 (b). From fig. 2 (a) it will be seen that RL and RP are in series across the voltage E.I., which can be regarded as the input voltage to the valve multiplied by its amplification factor. E.2 is the available voltage output from the stage and it is quite obvious that the ratio E2/E1 is entirely dependent upon the ratio of RL to RP. The graph in fig. 2 (b) shows E2 as a percentage of E1 (in other words, the stage gain as a percentage of the amplification factor of the valve) for various values of the ratio RL/RP.

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RESISTOR CALCULATIONS—
(CONTINUED)

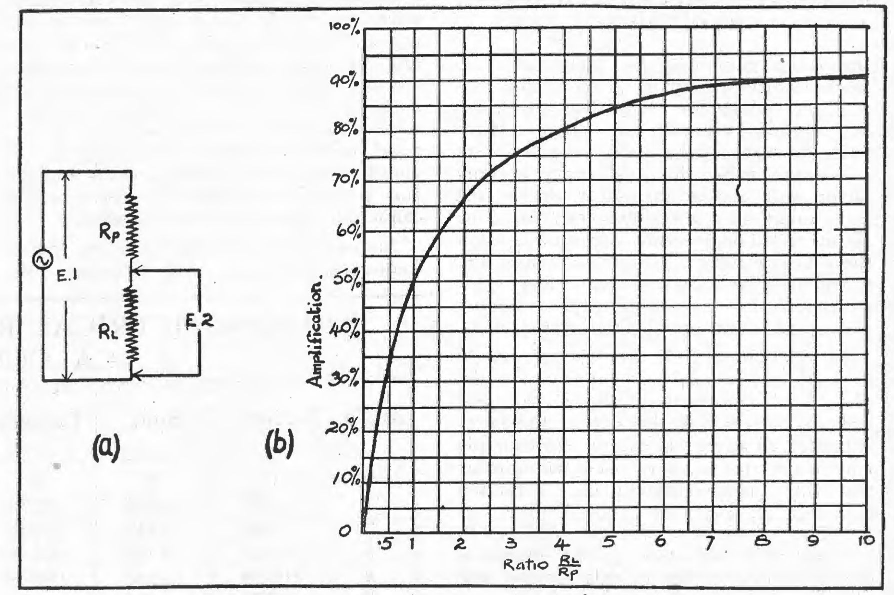

Fig. 2—Load Resistance/Amplification Graph for Resistance Coupled Amplifiers.

Strictly speaking, the amplification of the stage will increase with the ratio RL/RP until a figure very close to that of the tube gain is reached. Actually, in practice, as will be seen from the graph in fig. 2 (b), the increase is so gradual for ratios greater than about 7 to 1 that no useful purpose is served by their use. The shunting effect of the grid leak and coupling condenser of the following tube must also be taken into account when high plate load values are attempted and this introduces a further limiting factor which will be dealt with later.

At the same time the voltage dropping function of the plate load resistor must also be taken into account, not so much because of the plate voltage reduction directly, but because of the fact that reduced plate voltage means reduced grid voltage acceptance. It is obviously futile to design an amplifying stage with high gain if the grid of the tube is incapable of handling the signal supplied by previous stages.

In connection with this it must also be remembered that "contact potential" enters into the picture when the operation of indirectly heated tubes at low grid voltages is attempted and as this potential (where the grid commences to draw current) is often as much as a volt on the negative side of zero bias it follows that the plate voltage applied to the tube should never be so low that the contact potential is very close to the operating grid bias otherwise the tube will be incapable of handling any signal at all. To explain:—a type 75 tube requires two volts negative grid bias at 250 volts on the plate. As this tube is indirectly heated, the operating signal range is limited to the one volt difference between operating bias (two volts) and contact potential (one volt).

Reduction of the plate voltage applied to the 75 to 100 volts will mean that only one volt of bias may be applied if plate current cut-off is to be avoided. But contact potential is approximately one volt, so that, actually, no signal can be handled by the tube under these conditions unless a fair amount of distortion can be tolerated. For really satisfactory operation of this tube, unless the signal voltages to be handled are extremely small, the plate load resistor should be so proportioned that it is possible to apply at least 1.25 volts negative bias to the tube. This will enable a signal of about 0.25 volts to be handled without distortion. A plate load resistor of about 250,000 ohms together with a self-bias resistor of 3,000 ohms and a plate supply voltage of 250 will satisfy these conditions, and also enable the useful amplification factor of forty to be attained even if a grid leak of the same value as the plate resistor is uesd for the following tube.

This example has been somewhat in the nature of a digression, but will serve to illustrate very effectively that the voltage dropping function of the plate load resistor must always be taken into account.

The limitations detailed above, together with one which will be dealt with fully in the "grid resistor" section, limits the useful value of plate load resistor which may be employed to somewhere between two and five times the plate resistance of the tube in question. Somewhere near the lower value is usually employed for indirectly heated tubes, where contact potential is on the negative side of zero bias, unless unlimited plate voltage is available. Directly heated tubes do not start to draw grid current (as a general rule) until zero bias is reached, so that a proportionately higher value of plate load resistor may be employed without seriously restricting the signal handling capacity of the stage.

Grid Resistors or Leaks

The grid leak in a resistance-coupled amplifier stage, such as is used in the audio channels of the majority of modern receivers, has a much greater effect on overall performance than is generally realised.

The choice of the correct grid-leak value is, in most cases, largely a matter of compromise, but a full understanding of the factors involved will assist greatly in this direction and provide some assurance that the compromise effected is favourable.

Besides having a marked effect on the overall gain of an amplifying stage, the grid resistor also affects the fidelity of the amplifier and, lastly, can affect the life to the tube it is used in conjunction with to a marked degree.

This latter factor is the chief reason for a compromise having to be effected and will be dealt with first. Due to the possibility of grid current flowing, especially in power tubes, with strong signals, there is a definite limit to the amount of resistance which can be used in the grid circuit of an amplifier tube. This grid current flow causes loss of bias, the amount of loss being dependent on the value of resistance in circuit, consequently, tube manufacturers usually specify a maximum value of grid resistor for various tubes; this value being also dependent on the manner in which the tube is biassed. Self-biassed tubes may use a higher value of resistor than those which are supplied with fixed bias.

Output pentodes, such as the 42, are limited to a grid resistance value of about one megohm for self-bias operation and to about 100,000 ohms for fixed bias. Tubes operating with semi-fixed bias (such as bleed arrangements where most of the current is supplied by the power tube itself) may use a grid resistor of about 250,000 ohms.

Output triodes, such as the 2A3, are still further limited and the maximum value of grid-resistor for self-bias operation is specified as being 500,000 ohms. Fixed bias conditions call for a resistance of only 10,000 ohms, so that transformer coupling is the only system which is normally practicable.

Intermediate stage tubes, such as small triodes and high-grain pentodes, are not so critical, and it is usually found possible to use grid resistors up to two or three megohms in value without any serious effects.

Bearing this limiting factor in mind, then, we can proceed with the consideration of the other factors controlling the choice of a grid leak.

The first thing that must be remembered is that the stage coupling condenser and the grid-leak are in series between the preceding tube plate and ground and are therefore shunted across its plate load resistor, so that the leak must have as high a value as possible (subject to the limiting factor mentioned previously) if it is desired to keep the stage amplification as high as possible. The effect of a low resistance leak on

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RESISTOR CALCULATIONS—
(CONTINUED)

the stage gain may be quite large, as reference to the details given in the preceding section (on plate load resistors) and Ohm's Law will soon show. However, in circuits where the coupling is to an output tube, the grid input limiting factor will almost invariably decide the leak value and very little can be done about it. For intermediate audio stages there is not such a definite limitation and it will usually be found that a leak value of four to five times that of the preceding plate load resistor will prove satisfactory.

In this connection some thought could be paid with regard to proportioning the plate load resistor to "match" the grid leak in cases where the size of the latter is limited to any great extent. An example may make this clearer. We will assume that the output tube in use is limited to a grid resistance of 250,000 ohms. A coupling condenser of 0.02 mfd. is to be used and reference to the reactance charts printed earlier in this Annual will show that this condenser has a reactance of about 80,000 ohms at 100 cycles. Therefore the leak and condenser in series have a shunting effect of 330,000 ohms which is presented to the plate load resistor of the preceding tube. If this tube is of the high-mu-triode or pentode type, it is quite possible that a plate load resistor of 250,000 ohms will be used in order to get the highest stage amplification possible. The effective value, however (with a 330,000 ohm shunt) will be somewhere near 140,000 ohms.

Under these circumstances, then, it is questionable whether the use of the high plate load resistor value is justifiable. Reduction to 200,000 ohms will result in the effective plate load being reduced to 125,000 ohms, but will also result in a higher effective plate voltage being applied to the tube. This in turn means that more bias can be applied to the tube, with consequent greater signal-handling capacity. These two factors will easily offset the slight drop in gain caused by the 10 per cent. or so reduction in plate load. Some attention paid to amplifier design along these lines will often result in quite surprising improvements in performance being effected.

There is a fairly widespread impression existing that the coupling condenser plays a very important part in determining the fidelity of an A.F. resistance-capacity coupled amplifier. This impression is correct as far as it goes, but it does not give a complete picture. Actually, it is the ratio of the coupling condenser impedance to the grid leak resistance (or impedance) that is the controlling factor.

Improper understanding of this has led to the common assumption that the bigger the coupling condenser used, the better the fidelity. Actually, the voltage transfer between two tubes in a resistance-capacity coupled amplifier will be 95% of the optimum at any given frequency when the impedance (in ohms) of the coupling condenser is a third of the resistance of the grid leak. It is not usually desirable to go past the 95% efficiency mark as any increase of the condenser size past this point will tend to introduce troubles in the form of grid blocking and will also tend to aggravate any loss of bias troubles caused by high-tension voltage leaking through the condenser. This leakage is always present, even though it is not noticeable with a good mica condenser, and there is obviously no sense in increasing the leakage and possibility of bias loss by using a condenser bigger than is necessary.

Assuming 50 cycles as being the lowest frequency required, the following leak and condenser combinations will be found 95% efficient. At higher frequencies, of course, the condenser impedance is reduced, and the ratio will be even more favourable. Other combinations may readily be determined by reference to a reactance chart.

1.00 megohm leak—0.01 mfd. condenser
0.75 „ „ —0.15 „ „
0. 5 „ „ —0.02 „ „
0.25 „ „ —0.04 „ „
0. 1 „ „ —0. 1 „ „

(Continued on page 187)

TRIGONOMETRICAL RATIOS USED IN RADIO CALCULATIONS

Angle.	Radians.	Sine.	Tangent.	Co-tangent.	Cosine.		
0°	0	0	0	∞	1	1·5708	90°
1	·0175	·0175	·0175	57·2900	·9998	1·5533	89
2	·0349	·0349	·0349	28·6363	·9994	1·5359	88
3	·0524	·0523	·0524	19·0811	·9986	1·5184	87
4	·0698	·0698	·0699	14·3007	·9976	1·5010	86
5	·0873	·0872	·0875	11·4301	·9962	1·4835	85
6	·1047	·1045	·1051	9·5144	·9945	1·4661	84
7	·1222	·1219	·1228	8·1443	·9925	1·4486	83
8	·1396	·1392	·1405	7·1154	·9903	1·4312	82
9	·1571	·1564	·1584	6·3138	·9877	1·4137	81
10	·1745	·1736	·1763	5·6713	·9848	1·3963	80
11	·1920	·1908	·1944	5·1446	·9816	1·3788	79
12	·2094	·2079	·2126	4·7046	·9781	1·3614	78
13	·2269	·2250	·2309	4·3315	·9744	1·3439	77
14	·2443	·2419	·2493	4·0108	·9703	1·3265	76
15	·2618	·2588	·2679	3·7321	·9659	1·3090	75
16	·2793	·2756	·2867	3·4874	·9613	1·2915	74
17	·2967	·2924	·3057	3·2709	·9563	1·2741	73
18	·3142	·3090	·3249	3·0777	·9511	1·2566	72
19	·3316	·3256	·3443	2·9042	·9455	1·2392	71
20	·3491	·3420	·3640	2·7475	·9397	1·2217	70
21	·3665	·3584	·3839	2·6051	·9336	1·2043	69
22	·3840	·3746	·4040	2·4751	·9272	1·1868	68
23	·4014	·3907	·4245	2·3559	·9205	1·1694	67
24	·4189	·4067	·4452	2·2460	·9135	1·1519	66
25	·4363	·4226	·4663	2·1445	·9063	1·1345	65
26	·4538	·4384	·4877	2·0503	·8988	1·1170	64
27	·4712	·4540	·5095	1·9626	·8910	1·0996	63
28	·4887	·4695	·5317	1·8807	·8829	1·0821	62
29	·5061	·4848	·5543	1·8040	·8746	1·0647	61
30	·5236	·5000	·5774	1·7321	·8660	1·0472	60
31	·5411	·5150	·6009	1·6643	·8572	1·0297	59
32	·5585	·5299	·6249	1·6003	·8480	1·0123	58
33	·5760	·5446	·6494	1·5399	·8387	·9948	57
34	·5934	·5592	·6745	1·4826	·8290	·9774	56
35	·6109	·5736	·7002	1·4281	·8192	·9599	55
36	·6283	·5878	·7265	1·3764	·8090	·9425	54
37	·6458	·6018	·7536	1·3270	·7986	·9250	53
38	·6632	·6157	·7813	1·2799	·7880	·9076	52
39	·6807	·6293	·8098	1·2349	·7771	·8901	51
40	·6981	·6428	·8391	1·1918	·7660	·8727	50
41	·7156	·6561	·8693	1·1504	·7547	·8552	49
42	·7330	·6691	·9004	1·1106	·7431	·8378	48
43	·7505	·6820	·9325	1·0724	·7314	·8203	47
44	·7679	·6947	·9657	1·0355	·7193	·8029	46
45	·7854	·7071	1·0000	1·0000	·7071	·7854	45
		Cosine.	Co-tangent.	Tangent.	Sine.	Radians.	Angle.

RESISTOR CALCULATIONS—
(CONTINUED)

All of these combinations of leak and condenser values will give approximately 95% transfer efficiency at 50 cycles. If 100 cycles is deemed to be sufficiently low for the reproduction balance required, the condenser values may be halved. The optimum value of load resistor for use with these combinations will be one-quarter of the leak value in each case (see previous notes).

RADIO FREQUENCY RESISTANCE

While on the subject of resistance calculation for radio receiver design it is appropriate that some mention be made of the increase in resistance of conductors which is apparent when they are carrying radio-frequency currents.

This increase in resistance must not be confused with the impedance of a conductor wound into a coil in such a manner that inductance is created. The fact that both vary with frequency is almost the only factor which is common to the two phenomena.

R. F. resistance, or A.C. resistance as it is sometimes termed, is exhibited by any conductor carrying radio-frequency current and is one of the major problems which must be contended with in the design of coils for tuning purposes. It is still evident in straight conductors, however, and must be considered where long spans of wire, such as aerials, are used.

The increase in resistance of a straight conductor under R.F. conditions is entirely due to "skin effect." This in turn is rather an involved function of the diameter of the conductor and the frequency and is created by the non-uniform current distribution in a conductor carrying R.F. It is possible to calculate the skin effect for various conductors, but such a procedure is outside the scope of these notes and no useful purpose would be served by its description.

When a conductor is wound into the form of a coil another factor enters into the problem which also tends to increase the resistance of the conductor. This is known as the "proximity factor" and is due to the magnetic field set up by the turns in the coil interfering with the current flow in adjacent turns. This effect is also a function of frequency.

These two factors lump together and form a multiplying factor which, when applied to the D.C. resistance of a coil, gives the R.F. resistance value. A point to remember is that both of these factors increase with the wire diameter. However, the D.C. resistance of the conductor **decreases** with the increase of diameter, so that there will be, for any given frequency, an optimum diameter where the R.F. resistance will be at a minimum. In other words, for operation at any frequency, a wire diameter can be found where an increase **or** decrease will result in an increase of R.F. resistance. This is a most important point and should be borne in mind when any coil design is being attempted.

The effect of the non-uniform current distribution is to cause the current flowing to crowd to the surface of the conductor. From this it can be seen how the term "skin effect" came to be used.

Several methods have been devised for the reduction of skin effect and they will be dealt with in turn. They are all based on the principle that skin effect can be reduced by increasing the surface of a conductor with relation to its volume.

(1) **The use of flat copper strip.** Skin effect is still present, but is reduced considerably by the fact that the centre of the conductor is a line rather than a point. Consequently, more even current distribution is obtained and with it a closer approach to D.C. conditions.

(2) **The use of tubular conductors.** The skin effect of a tubular conductor is lower than that of a solid conductor as there is practically no internal field at all; even current distribution is therefore effected. Another way of explaining the reduction of skin effect is by saying that as a tubular conductor is nearly all "skin" the current paths for R.F. and D.C. are the same, or nearly so; consequently the ratio of R.F. resistance to D.C. resistance is very low.

Strip and tubular conductors are usually used for high power transmitting inductances where space requirements are usually subservient to efficiency.

(3) **The use of stranded wire conductors.** It can be shown that the magnitude of the skin effect is proportional to the diameter of a conductor. From this it can be seen that the ratio of R.F. to D.C. resistance may be reduced by decreasing the size of the conductor. However, this procedure also increases the D.C. resistance so that the net result may be an actual increase in effective resistance. The increase of D.C. resistance may be overcome by paralleling a number of small conductors. This is done in Litzendraht wire, where the parallel conductors are stranded together to form one cable. It is most important, however, that each strand be thoroughly insulated from the next and that the stranding be so effected that each strand passes regularly from the centre to the outside of the cable (and vice versa) at regular intervals. This latter precaution is necessary to ensure that all strands are affected like by the magnetic flux (see earlier note on proximity factor). To obtain the best reduction of resistance ratio in Litz conductor it is obviously essential that all strands be continuous.

Reading the Frequency/Wavelength Conversion Chart

THE chart on the following page shows the equivalent frequencies, in kilocycles per second, of the band of wavelengths between 10 and 100 metres. As will be seen, wavelengths are to be found in the column marked "M" and the equivalent frequency is shown in the adjacent right hand column marked "KC."

As the relationship of wavelength and frequency always remains constant, conversion for any wavelength or frequency outside the range of the chart may be effected by the use of a **multiplying** factor on one column and a **divisor** of the same value on the other. A factor of 10 will prove to be the most useful as the procedure is then simplified to a matter of shifting the decimal point.

Example: The equivalent frequency of 1,000 metres is required. 1,000 metres is ten times 100 (the highest wavelength on the chart). The equivalent frequency is therefore (2,998 kc/sec. **divided** by 10) 299.8 kc/sec.

The reverse operation is quite as simple, and to illustrate this we will find the equivalent wavelength of 60 megacycles (60,000 kc/sec.). The nearest submultiple of this figure on the chart is 5,996 kc/sec., the frequency equivalent for 50 metres. 60,000 kc./sec. is very nearly ten times 5,996 kc/sec. so that it will be necessary to **divide** the wavelength equivalent of 5,996 kc/sec. by ten. This will give 5 metres (approximately) as the wavelength equivalent to 60 megacycles.

FREQUENCY/WAVELENGTH CONVERSION CHART

M.	KC.	M.	KC.	M.	KC.	M.	KC.	M.	KC.	M.	KC.	M.	KC.	M.	KC.	M.	KC.
10.1	29,690	20.1	14,920	30.1	9,961	40.1	7,477	50.1	5,984	60.1	4,989	70.1	4,277	80.1	3,743	90.1	3,328
10.2	29,390	20.2	14,840	30.2	9,928	40.2	7,458	50.2	5,973	60.2	4,980	70.2	4,271	80.2	3,738	90.2	3,324
10.3	29,110	20.3	14,770	30.3	9,895	40.3	7,440	50.3	5,961	60.3	4,972	70.3	4,265	80.3	3,734	90.3	3,320
10.4	28,830	20.4	14,700	30.4	9,862	40.4	7,421	50.4	5,949	60.4	4,964	70.4	4,259	80.4	3,729	90.4	3,317
10.5	28,550	20.5	14,630	30.5	9,830	40.5	7,403	50.5	5,937	60.5	4,956	70.5	4,253	80.5	3,724	90.5	3,313
10.6	28,280	20.6	14,550	30.6	9,798	40.6	7,385	50.6	5,925	60.6	4,948	70.6	4,247	80.6	3,720	90.6	3,309
10.7	28,020	20.7	14,480	30.7	9,766	40.7	7,367	50.7	5,913	60.7	4,939	70.7	4,241	80.7	3,715	90.7	3,306
10.8	27,760	20.8	14,410	30.8	9,734	40.8	7,349	50.8	5,902	60.8	4,931	70.8	4,235	80.8	3,711	90.8	3,302
10.9	27,510	20.9	14,350	30.9	9,703	40.9	7,331	50.9	5,890	60.9	4,923	70.9	4,229	80.9	3,706	90.9	3,298
11.0	27,260	21.0	14,280	31.0	9,672	41.0	7,313	51.0	5,879	61.0	4,915	71.0	4,223	81.0	3,701	91.0	3,295
11.1	27,010	21.1	14,210	31.1	9,641	41.1	7,295	51.1	5,867	61.1	4,907	71.1	4,217	81.1	3,697	91.1	3,291
11.2	26,770	21.2	14,140	31.2	9,610	41.2	7,277	51.2	5,856	61.2	4,899	71.2	4,211	81.2	3,692	91.2	3,288
11.3	26,530	21.3	14,080	31.3	9,579	41.3	7,260	51.3	5,844	61.3	4,891	71.3	4,205	81.3	3,688	91.3	3,284
11.4	26,300	21.4	14,010	31.4	9,548	41.4	7,242	51.4	5,833	61.4	4,883	71.4	4,199	81.4	3,683	91.4	3,280
11.5	26,070	21.5	13,950	31.5	9,518	41.5	7,225	51.5	5,822	61.5	4,875	71.5	4,193	81.5	3,679	91.5	3,277
11.6	25,850	21.6	13,880	31.6	9,488	41.6	7,207	51.6	5,810	61.6	4,867	71.6	4,187	81.6	3,674	91.6	3,273
11.7	25,630	21.7	13,810	31.7	9,458	41.7	7,190	51.7	5,799	61.7	4,859	71.7	4,182	81.7	3,670	91.7	3,270
11.8	25,410	21.8	13,750	31.8	9,428	41.8	7,173	51.8	5,788	61.8	4,851	71.8	4,176	81.8	3,665	91.8	3,266
11.9	25,200	21.9	13,690	31.9	9,399	41.9	7,156	51.9	5,777	61.9	4,844	71.9	4,170	81.9	3,661	91.9	3,262
12.0	24,990	22.0	13,630	32.0	9,369	42.0	7,139	52.0	5,766	62.0	4,836	72.0	4,164	82.0	3,656	92.0	3,259
12.1	24,780	22.1	13,570	32.1	9,340	42.1	7,122	52.1	5,755	62.1	4,828	72.1	4,158	82.1	3,652	92.1	3,255
12.2	24,580	22.2	13,510	32.2	9,311	42.2	7,105	52.2	5,744	62.2	4,820	72.2	4,153	82.2	3,647	92.2	3,252
12.3	24,380	22.3	13,440	32.3	9,282	42.3	7,088	52.3	5,733	62.3	4,813	72.3	4,147	82.3	3,643	92.3	3,248
12.4	24,180	22.4	13,380	32.4	9,254	42.4	7,071	52.4	5,722	62.4	4,805	72.4	4,141	82.4	3,639	92.4	3,245
12.5	23,990	22.5	13,330	32.5	9,225	42.5	7,055	52.5	5,711	62.5	4,797	72.5	4,135	82.5	3,634	92.5	3,241
12.6	23,800	22.6	13,270	32.6	9,197	42.6	7,038	52.6	5,700	62.6	4,789	72.6	4,130	82.6	3,630	92.6	3,238
12.7	23,610	22.7	13,210	32.7	9,169	42.7	7,022	52.7	5,689	62.7	4,782	72.7	4,124	82.7	3,625	92.7	3,234
12.8	23,420	22.8	13,150	32.8	9,141	42.8	7,005	52.8	5,678	62.8	4,774	72.8	4,118	82.8	3,621	92.8	3,231
12.9	23,240	22.9	13,090	32.9	9,113	42.9	6,989	52.9	5,668	62.9	4,767	72.9	4,113	82.9	3,617	92.9	3,227
13.0	23,060	23.0	13,040	33.0	9,086	43.0	6,973	53.0	5,657	63.0	4,759	73.0	4,107	83.0	3,612	93.0	3,224
13.1	22,890	23.1	12,980	33.1	9,058	43.1	6,956	53.1	5,646	63.1	4,752	73.1	4,102	83.1	3,608	93.1	3,220
13.2	22,710	23.2	12,920	33.2	9,031	43.2	6,940	53.2	5,636	63.2	4,744	73.2	4,096	83.2	3,604	93.2	3,217
13.3	22,540	23.3	12,870	33.3	9,004	43.3	6,924	53.3	5,625	63.3	4,736	73.3	4,090	83.3	3,599	93.3	3,214
13.4	22,370	23.4	12,810	33.4	8,977	43.4	6,908	53.4	5,615	63.4	4,729	73.4	4,085	83.4	3,595	93.4	3,210
13.5	22,210	23.5	12,760	33.5	8,950	43.5	6,892	53.5	5,604	63.5	4,722	73.5	4,079	83.5	3,591	93.5	3,207
13.6	22,040	23.6	12,700	33.6	8,923	43.6	6,877	53.6	5,594	63.6	4,714	73.6	4,074	83.6	3,586	93.6	3,203
13.7	21,880	23.7	12,650	33.7	8,897	43.7	6,861	53.7	5,583	63.7	4,707	73.7	4,068	83.7	3,582	93.7	3,200
13.8	21,730	23.8	12,600	33.8	8,870	43.8	6,845	53.8	5,573	63.8	4,699	73.8	4,063	83.8	3,578	93.8	3,196
13.9	21,570	23.9	12,540	33.9	8,844	43.9	6,830	53.9	5,563	63.9	4,692	73.9	4,057	83.9	3,574	93.9	3,193
14.0	21,420	24.0	12,490	34.0	8,818	44.0	6,814	54.0	5,552	64.0	4,685	74.0	4,052	84.0	3,569	94.0	3,190
14.1	21,260	24.1	12,440	34.1	8,792	44.1	6,799	54.1	5,542	64.1	4,677	74.1	4,046	84.1	3,565	94.1	3,186
14.2	21,110	24.2	12,390	34.2	8,767	44.2	6,783	54.2	5,532	64.2	4,670	74.2	4,041	84.2	3,561	94.2	3,183
14.3	20,970	24.3	12,340	34.3	8,741	44.3	6,768	54.3	5,522	64.3	4,663	74.3	4,035	84.3	3,557	94.3	3,179
14.4	20,820	24.4	12,290	34.4	8,716	44.4	6,753	54.4	5,511	64.4	4,656	74.4	4,030	84.4	3,552	94.4	3,176
14.5	20,680	24.5	12,240	34.5	8,690	44.5	6,738	54.5	5,501	64.5	4,648	74.5	4,024	84.5	3,548	94.5	3,173
14.6	20,540	24.6	12,190	34.6	8,665	44.6	6,722	54.6	5,491	64.6	4,641	74.6	4,019	84.6	3,544	94.6	3,169
14.7	20,400	24.7	12,140	34.7	8,640	44.7	6,707	54.7	5,481	64.7	4,634	74.7	4,014	84.7	3,540	94.7	3,166
14.8	20,260	24.8	12,090	34.8	8,616	44.8	6,692	54.8	5,471	64.8	4,627	74.8	4,008	84.8	3,536	94.8	3,163
14.9	20,120	24.9	12,040	34.9	8,591	44.9	6,678	54.9	5,461	64.9	4,620	74.9	4,003	84.9	3,531	94.9	3,159
15.0	19,990	25.0	11,990	35.0	8,566	45.0	6,663	55.0	5,451	65.0	4,613	75.0	3,998	85.0	3,527	95.0	3,156
15.1	19,860	25.1	11,950	35.1	8,542	45.1	6,648	55.1	5,441	65.1	4,606	75.1	3,992	85.1	3,523	95.1	3,153
15.2	19,720	25.2	11,900	35.2	8,518	45.2	6,633	55.2	5,432	65.2	4,598	75.2	3,987	85.2	3,519	95.2	3,149
15.3	19,600	25.3	11,850	35.3	8,494	45.3	6,619	55.3	5,422	65.3	4,591	75.3	3,982	85.3	3,515	95.3	3,146
15.4	19,470	25.4	11,800	35.4	8,470	45.4	6,604	55.4	5,412	65.4	4,584	75.4	3,976	85.4	3,511	95.4	3,143
15.5	19,340	25.5	11,760	35.5	8,446	45.5	6,589	55.5	5,402	65.5	4,577	75.5	3,971	85.5	3,507	95.5	3,139
15.6	19,220	25.6	11,710	35.6	8,422	45.6	6,575	55.6	5,392	65.6	4,570	75.6	3,966	85.6	3,503	95.6	3,136
15.7	19,100	25.7	11,670	35.7	8,398	45.7	6,561	55.7	5,383	65.7	4,563	75.7	3,961	85.7	3,498	95.7	3,133
15.8	18,980	25.8	11,620	35.8	8,375	45.8	6,546	55.8	5,373	65.8	4,557	75.8	3,955	85.8	3,494	95.8	3,130
15.9	18,860	25.9	11,580	35.9	8,352	45.9	6,532	55.9	5,364	65.9	4,550	75.9	3,950	85.9	3,490	95.9	3,126
16.0	18,740	26.0	11,530	36.0	8,328	46.0	6,518	56.0	5,354	66.0	4,543	76.0	3,945	86.0	3,486	96.0	3,123
16.1	18,620	26.1	11,490	36.1	8,305	46.1	6,504	56.1	5,344	66.1	4,536	76.1	3,940	86.1	3,482	96.1	3,120
16.2	18,510	26.2	11,440	36.2	8,282	46.2	6,490	56.2	5,335	66.2	4,529	76.2	3,935	86.2	3,478	96.2	3,117
16.3	18,390	26.3	11,400	36.3	8,260	46.3	6,476	56.3	5,325	66.3	4,522	76.3	3,929	86.3	3,474	96.3	3,113
16.4	18,280	26.4	11,360	36.4	8,237	46.4	6,462	56.4	5,316	66.4	4,515	76.4	3,924	86.4	3,470	96.4	3,110
16.5	18,170	26.5	11,310	36.5	8,214	46.5	6,448	56.5	5,307	66.5	4,509	76.5	3,919	86.5	3,466	96.5	3,107
16.6	18,060	26.6	11,270	36.6	8,192	46.6	6,434	56.6	5,297	66.6	4,502	76.6	3,914	86.6	3,462	96.6	3,104
16.7	17,950	26.7	11,230	36.7	8,170	46.7	6,420	56.7	5,288	66.7	4,495	76.7	3,909	86.7	3,458	96.7	3,101
16.8	17,850	26.8	11,190	36.8	8,147	46.8	6,406	56.8	5,279	66.8	4,488	76.8	3,904	86.8	3,454	96.8	3,097
16.9	17,740	26.9	11,150	36.9	8,125	46.9	6,393	56.9	5,269	66.9	4,482	76.9	3,899	86.9	3,450	96.9	3,094
17.0	17,640	27.0	11,100	37.0	8,103	47.0	6,379	57.0	5,260	67.0	4,475	77.0	3,894	87.0	3,446	97.0	3,091
17.1	17,530	27.1	11,060	37.1	8,081	47.1	6,366	57.1	5,251	67.1	4,468	77.1	3,889	87.1	3,442	97.1	3,088
17.2	17,430	27.2	11,020	37.2	8,060	47.2	6,352	57.2	5,242	67.2	4,462	77.2	3,884	87.2	3,438	97.2	3,085
17.3	17,330	27.3	10,980	37.3	8,038	47.3	6,339	57.3	5,232	67.3	4,455	77.3	3,879	87.3	3,434	97.3	3,081
17.4	17,230	27.4	10,940	37.4	8,017	47.4	6,325	57.4	5,223	67.4	4,448	77.4	3,874	87.4	3,430	97.4	3,078
17.5	17,130	27.5	10,900	37.5	7,995	47.5	6,312	57.5	5,214	67.5	4,442	77.5	3,869	87.5	3,427	97.5	3,075
17.6	17,040	27.6	10,860	37.6	7,974	47.6	6,299	57.6	5,205	67.6	4,435	77.6	3,864	87.6	3,423	97.6	3,072
17.7	16,940	27.7	10,820	37.7	7,953	47.7	6,286	57.7	5,196	67.7	4,429	77.7	3,859	87.7	3,419	97.7	3,069
17.8	16,840	27.8	10,780	37.8	7,932	47.8	6,272	57.8	5,187	67.8	4,422	77.8	3,854	87.8	3,415	97.8	3,066
17.9	16,750	27.9	10,750	37.9	7,911	47.9	6,259	57.9	5,178	67.9	4,416	77.9	3,849	87.9	3,411	97.9	3,063
18.0	16,660	28.0	10,710	38.0	7,890	48.0	6,246	58.0	5,169	68.0	4,409	78.0	3,844	88.0	3,407	98.0	3,059
18.1	16,560	28.1	10,670	38.1	7,869	48.1	6,233	58.1	5,160	68.1	4,403	78.1	3,839	88.1	3,403	98.1	3,056
18.2	16,470	28.2	10,630	38.2	7,849	48.2	6,220	58.2	5,152	68.2	4,396	78.2	3,834	88.2	3,399	98.2	3,053
18.3	16,380	28.3	10,590	38.3	7,828	48.3	6,207	58.3	5,143	68.3	4,390	78.3	3,829	88.3	3,395	98.3	3,050
18.4	16,290	28.4	10,560	38.4	7,808	48.4	6,195	58.4	5,134	68.4	4,383	78.4	3,824	88.4	3,392	98.4	3,047
18.5	16,210	28.5	10,520	38.5	7,788	48.5	6,182	58.5	5,125	68.5	4,377	78.5	3,819	88.5	3,388	98.5	3,044
18.6	16,120	28.6	10,480	38.6	7,767	48.6	6,169	58.6	5,116	68.6	4,371	78.6	3,814	88.6	3,384	98.6	3,041
18.7	16,030	28.7	10,450	38.7	7,747	48.7	6,156	58.7	5,108	68.7	4,364	78.7	3,810	88.7	3,380	98.7	3,038
18.8	15,950	28.8	10,410	38.8	7,727	48.8	6,144	58.8	5,099	68.8	4,358	78.8	3,805	88.8	3,376	98.8	3,035
18.9	15,860	28.9	10,370	38.9	7,707	48.9	6,131	58.9	5,090	68.9	4,352	78.9	3,800	88.9	3,373	98.9	3,032
19.0	15,780	29.0	10,340	39.0	7,688	49.0	6,119	59.0	5,082	69.0	4,345	79.0	3,795	89.0	3,369	99.0	3,028
19.1	15,700	29.1	10,300	39.1	7,668	49.1	6,106	59.1	5,073	69.1	4,339	79.1	3,790	89.1	3,365	99.1	3,025
19.2	15,620	29.2	10,270	39.2	7,648	49.2	6,094	59.2	5,065	69.2	4,333	79.2	3,786	89.2	3,361	99.2	3,022
19.3	15,530	29.3	10,230	39.3	7,629	49.3	6,082	59.3	5,056	69.3	4,326	79.3	3,781	89.3	3,357	99.3	3,019
19.4	15,450	29.4	10,200	39.4	7,610	49.4	6,069	59.4	5,047	69.4	4,320	79.4	3,776	89.4	3,354	99.4	3,016
19.5	15,380	29.5	10,160	39.5	7,590	49.5	6,057	59.5	5,039	69.5	4,314	79.5	3,771	89.5	3,350	99.5	3,013
19.6	15,300	29.6	10,130	39.6	7,571	49.6	6,045	59.6	5,031	69.6	4,308	79.6	3,767	89.6	3,346	99.6	3,010
19.7	15,220	29.7	10,090	39.7	7,552	49.7	6,033	59.7	5,022	69.7	4,302	79.7	3,762	89.7	3,342	99.7	3,007
19.8	15,140	29.8	10,060	39.8	7,533	49.8	6,020	59.8	5,014	69.8	4,295	79.8	3,757	89.8	3,339	99.8	3,004
19.9	15,070	29.9	10,030	39.9	7,514	49.9	6,008	59.9	5,005	69.9	4,289	79.9	3,752	89.9	3,335	99.9	3,001
20.0	14,990	30.0	9,994	40.0	7,496	50.0	5,996	60.0	4,997	70.0	4,283	80.0	3,748	90.0	3,331	100.0	2,998

THE DECIBEL SYSTEM

The decibel (or "transmission unit") has been adopted as the practical unit by which the loudness of sounds may be compared. The computation of the unit is based on the Briggsian (base 10) logarithmic tables, and it has many other applications than that of loudness comparison. The chart shown below and the accompanying explanation will give a useful insight into the working and application of the system.

Energy. "Up"	Voltage "Up"	Number of Decibels	Energy. "Down"	Voltage "Down"
1.26	1.12	1	0.794	0.891
1.59	1.26	2	.631	.794
2.00	1.41	3	.501	.708
2.51	1.59	4	.398	.631
3.16	1.79	5	.316	.562
3.98	2.00	6	0.251	0.501
5.01	2.24	7	.1999	.447
6.31	2.51	8	.158	.398
7.94	2.82	9	.126	.355
10.00	3.16	10	.100	.316
12.59	3.55	11	.079	0.282
15.85	3.98	12	.063	.261
19.96	4.47	13	.050	.224
25.12	5.01	14	.040	.200
31.62	5.62	15	.032	.178
39.81	6.31	16	.025	0.158
50.12	7.08	17	.020	.141
63.10	7.94	18	.016	.126
79.43	8.91	19	.013	.112
100.00	10.00	20	.010	.100
125.9	11.22	21	.0079	.089
158.5	12.59	22	.0063	.079
199.6	14.13	23	.0050	.071
251.2	15.85	24	.0040	.063
316.2	17.78	25	.0032	.056
398.1	19.96	26	.0020	.050
501.2	22.39	27	.0025	.047
631.0	25.12	28	.0016	.040
794.3	28.18	29	.0013	.035
1,000.0	31.62	30	.0010	.032
1,259	35.48	31	.0008	.028
1,585	39.81	32	.0006	.025
1,996	44.67	33	.0005	.022
2,512	50.12	34	.0004	.020
3,162	56.23	35	.00032	.018
3,981	63.10	36	.00020	.016
5,012	70.80	37	.00025	.014
6,310	79.43	38	.00016	.013
7,943	89.13	39	.00013	.011
10,000	100.00	40	.00010	.010
12,590	112.2	41	.00008	.0089
15,850	125.9	42	.00006	.0079
19,960	141.3	43	.00005	.0071
25,120	158.5	44	.00004	.0063
31,620	177.8	45	.000032	.0056
39,810	199.6	46	.000025	.0050
50,120	223.9	47	.000020	.0045
63,100	251.2	48	.000016	.0040
79,430	282.0	49	.000013	.0036
100,000	316.0	50	.000010	.0032
1,000,000	1,000	60	.000001	.001
10,000,000	3,162	70	.0000001	.0003
100,000,000	10,000	80	.00000001	.0001
1,000,000,000	31,620	90	.000000001	.00001
10,000,000,000	100,000	100	.0000000001	.00003

The fundamental formula, in terms of power, is—

$$\text{Number of db} = 10 \log \frac{\text{Watts output}}{\text{Watts input}}$$

Substituting for power in terms of current and resistance we have

$$\text{Number of db} = 10 \log \frac{(\text{Output current})^2 \times \text{Impedance}}{(\text{Input current})^2 \times \text{Impedance}}$$

$$= 10 \log. \frac{(I_1)^2}{(I_2)^2}$$

Now the log of the square of a number is equal to twice the log of that number, hence

$$\text{Number of db} = 20 \log \frac{I_1}{I_2}$$

This is true only if the output and input impedances (in which the respective currents I_1 and I_2 are flowing) are equal.

In some cases it may be more convenient to measure the voltages across the output and input circuits. In such cases—

$$\text{Number of db} = \frac{(\text{Output voltage})^2 \div \text{Impedance.}}{(\text{Input voltage})^2 \div \text{Impedance.}}$$

$$= 10 \log \frac{(V_1)^2}{(V_2)^2} = 20 \log \frac{V_1}{V^2}$$

The accompanying table will enable the number of decibels corresponding to various energy and voltage ratios to be ascertained.

Care should be taken not to confuse "Gain in db" with "Level in db." Each is commonly expressed in decibels although, strictly speaking, a level should be referred to as "db above zero level." Thus while the output level of a given amplifier is, say, 30 db, its gain may be only 20 db.

The threshold of audibility is much too low a level to be used as a reference intensity for relatively loud sounds such as those coming from a loud speaker, therefore "zero level" of 0 db = 6 milliwatts has been adopted from telephone transmission practice.

An idea of the intensity of sound at "zero level" may be had if it is remembered that speech from a telephone receiver held tightly against the ear is about zero level when it is just too loud to be comfortable. This represents a level roughly 50 db above the threshold of audibility.

The great advantage of the decibel system is that overall figures may be obtained by adding the decibels gain or loss of the various stages. For example, consider the overall gain of an amplifier whose first stage has a voltage amplification factor of 15, followed by a 10 db attenuator, another stage whose amplification fac-

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DECIBELS—(Continued)—

tor is 15, and a final stage whose factor is 5. Referring to the table, we have the following approximate figures:

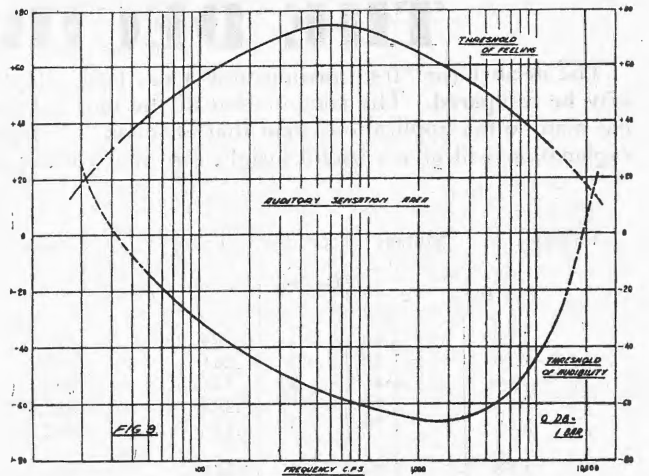
Overall gain= 23 — 10 + 23 + 14 = 50 db.

This is a much simpler and less unwieldy procedure than the older method of multiplying the gain factors together.

It will be observed that 10 times power indicates a level of 10 db, 100 times indicates 20 db, 1,000 times indicates 30 db, etc. A handy rule for finding the level when the ratio of the powers involved is a power of 10, is to remember that the number of decibels is ten times the index figure. In the examples above, $10 = 10^1$, $100 = 10^2$, and $1{,}000 = 10^3$, hence the levels are (10 x 1), 10 x 2), and (10 x 3) decibels respectively. This should be of assistance to those unfamiliar with the use of logarithms.

SENSITIVITY OF THE EAR

While the human ear is an extremely sensitive acoustic device it is also an extremely erratic one. No two ears are exactly the same when judged by "sensitivity" or frequency response curves. Each one is full of small peaks at differing frequencies. In addition the sensitivity of the ear will vary from day to day and considerably over a period of years. In general as age creeps on the ear becomes less sensitive to the higher frequencies in comparison to the lower.

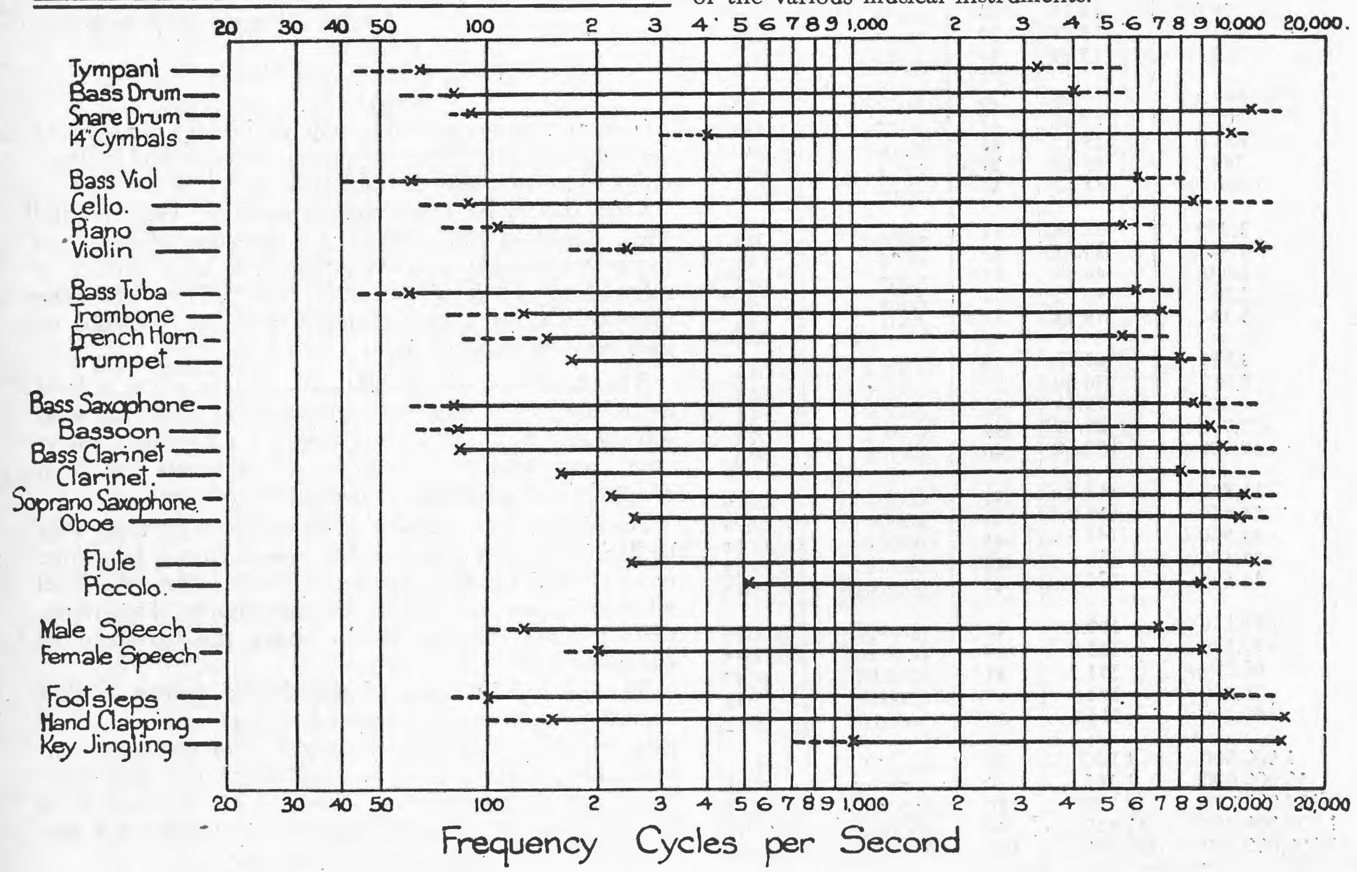


Experiment has shown that the ear is most sensitive to notes of a pitch between 1,500 and 4,000. An average sensitivity curve shows that the energy ratio of just audible sounds of pitch 100 and 2,000 respectively is around 1,000.

The average energy ratio of just audible sounds of 2,000 and 8,000 cycles is about 3. Some people even find it hard to hear sounds of a frequency above 5,000.

FREQUENCY SPECTRA

The diagram shown below will be of interest to all acoustic engineers as it shows the full range of frequencies which must be reproduced for complete recognition of the various musical instruments.



A Dictionary of Radio Definitions

Abac. An alignment chart by which formulae can be enumerated and results read off by the simple expedient of placing a ruler between appropriate columns and noting the points of intersection with other columns.

Acoustic Labyrinth. An absorbent conduit attached to the rear of a loud speaker to prevent sound pressure waves radiated by the back of the cone from interfering with the sound pressure waves radiated from the front. Actually, any properly proportioned chamber lined with sound absorbent material will do this, but in order to reduce space requirements, the acoustic labyrinth is arranged so that the conduits are folded upon themselves.

Active Current. The "in-phase" component of an alternating current flowing in a circuit. The product of this and the voltage gives the true power.

Admittance. Denoted by the letter Y, is the reciprocal of the impedance of an alternating current circuit.

Antenna Resistance. Given by the power supplied to the entire antenna circuit divided by the square of the antenna current (measured at the point where the power is supplied to the antenna).

Amplification Factor. A change in grid-cathode or input voltage of a tube will produce a corresponding change in plate-cathode or output voltage. The amplification factor is defined as the ratio between these voltages.

Amplifier, Class "A". A class "A" amplifier is one in which the bias and exciting grid voltages are such that plate current through the valve flows at all times. The ideal class "A" amplifier is one in which the alternating component of the plate current is an exact reproduction of the form of the alternating grid voltage, and the plate current flows 360 electrical degrees. The characteristics of a class "A" amplifier are low efficiency and output.

Amplifier, Class "B". A class "B" amplifier is one in which the grid bias is approximately equal to the cut-off value so that the plate current is virtually zero when no exciting grid voltage is applied, and so that the plate current in each tube flows during approximately one-half to each cycle when an exciting grid voltage is present. The ideal class "B" amplifier is one in which the alternating component of plate current is an exact replica of the alternating grid voltage of a half-cycle when the grid is positive with respect to bias voltage, and the plate current flows 180 electrical degrees. The characteristics of a class "B" amplifier are a medium efficiency and output.

Amplifier, Class "C". A class "C" amplifier is one in which the grid bias is appreciably beyond the cut-off so that the plate current in each valve is zero when no exciting grid voltage is present, and so that the plate current flows in each valve for appreciably less than one-half of each cycle when an exciting grid voltage is present. Class "C" amplifiers find application where high plate circuit efficiency is the paramount requirement and where departures from linearity between input and output are permissible. The characteristics of a class "C" amplifier are high plate circuit efficiency and high power output.

Angular Frequency. If the frequency of an A.C. wave is "f" c.p.s., the rotating vector by which it can be represented makes "f" revolutions per second, and, therefore, rotates through an angle of $2\pi f$ radians per second. This is known as the angular frequency and is usually denoted by a small Greek omega, "ω", or a small Greek rho "ρ."

Apparent Inductance. The effective inductance of a coil. This is the inductance of the winding plus the extra inductance which is brought about by self-capacity in the winding.

Atmospherics. Strays produced by atmospheric conditions. The term static has come to be used quite generally as a synonym for atmospherics.

Attenuation. The reduction in magnitude of a wave with increasing distance from its source or from a specified point of reference.

Autodyne Reception. A system of heterodyne reception through the use of a device which is both an oscillator and a detector.

Automatic Volume Control. A system whereby the output of a receiver is held virtually constant over wide variations of signal input.

B/H Curve. A graph showing the relation between the magnetising force (H) and the resultant magnetic flux density (B) produced (usually in iron). The ratio B/H is known as the permeability of a material.

Beating. A phenomenon in which two or more periodic quantities of different frequencies react to produce a result having pulsations of amplitude. The resultant complete cycle of pulsations is known as a "beat."

Bias. A term used to denote the potential difference, usually negative, existing between cathode and control grid of a tube.

Biotron. A combination of two tubes connected so as to produce a particularly steep characteristic curve.

Bridge. A balanced measuring device in which two parallel paths, one of which contains an unknown quantity (of resistance, inductance or capacity), are provided for the flow of current. Balance of the two paths indicates that the unknown section of one path is equal in value to a known section in the other path. The bridge method of measurement was first introduced by Wheatstone as a resistance measuring device, but has since been adapted for the measurement and comparison of inductance or capacity.

Cathode Rays. Streams of electrons emitted by the cathode or negative electrode of a thermionic valve. See also under "Oscillograph."

DICTIONARY OF RADIO DEFINITIONS.—

(Continued from page 191)

Centimetre Units (of inductance and capacity). The C.G.S. (metric) units of inductance and capacity. One microhenry is equivalent to 1,000 centimetres of inductance, and one centimetre of capacity is equal to 1.1 micro-microfarads.

Coercive Force. The magnetising force which must be applied in the reverse direction to a magnetised body in order to remove its magnetism.

Codan. Initials of "Carrier operated device, anti-noise." A muting system arranged to suppress noise during breaks in carrier. Specially developed for communications services.

Conversion Transconductance. The ratio of the intermediate frequency current in the primary of the I.F. transformer to the applied radio frequency voltage producing it. Used to determine performance of a frequency changer valve.

Coupling Co-efficient. The ratio of the mutual or common impedance component of two circuits to the square roots of the product of the total impedance components of the same kind in the two circuits. The impedance components may be inductive, capacitative, or resistive.

Cross Modulation. Due to modulation of the carrier of a desired signal by an undesired signal.

Decibel. The decibel is the practical transmission unit in which gains or levels are expressed. The gain of an amplifier in decibels is numerically equal to ten times the common or "base 10" logarithm of the ratio of the output power to the input power.

Decrement of a train of waves is the ratio of one peak value to that immediately succeeding it in the same direction.

Detection. Any process of operation on a modulated signal wave to obtain the signal imparted to it in the modulation process.

De-modulation. A term applied to the process of modulation carried out in such a manner as to recover the original signal. In radio reception the term "detection" is commonly used for this process.

Dielectric. Insulating material used between the plates of a condenser, and having a specific inductive capacity usually greater than unity.

Differential Resistance. The ratio of a change of applied voltage to the resultant change of current in any electrical device where the two are not related as in Ohm's Law. This applies in particular to the plate resistance of a valve.

Diode. A type of thermionic valve containing two electrodes and which passes current wholly or predominantly in one direction.

Direction Finder. A radio receiving device which permits determination of the line of travel of radio waves as received.

Distortion. A change in wave form occurring in a transducer or transmission medium. The principal sources are (a) non-linear relations between input and output at a given frequency; (b) non-uniform transmission at different frequencies, and (c) phase shift not proportional to frequency.

Doublet Antenna. One consisting of two elevated conductors substantially in the same straight line and of approximately equal lengths with the power delivered at the centre.

Dynatron. A valve operated with a low plate voltage and a high grid or screen voltage so that the plate impedance is virtually negative due to secondary emission. Oscillation will occur if the plate circuit is tuned, no feed back to the grid circuit being necessary.

Eddy Currents are those induced in a solid conductor due to a varying magnetic field, as, for example, in the core of a power transformer.

Electron. This is the fundamental particle of electricity, negative in sign.

Facsimile Transmission. The electrical transmission of a graphic record having a limited number of shade values.

Fidelity. The degree to which a system, or any portion of a system, accurately reproduces at its output the form of the signal which is impressed upon its input.

Field Intensity. The effective (root-mean-square) value of the electric or magnetic field intensity at a point due to the passage of radio waves of a specified frequency. It is usually expressed in terms of electric field intensity in microvolts or millivolts per metre. When the direction in which the field intensity is measured is not stated, it is assumed to be measured in the direction of maximum field intensity.

Filter, Band-Pass. A combination of inductances and condensers designed to pass a pre-determined band of frequencies with a sharp cut-off at each end of the band.

Filter, High-Pass. A filter circuit arranged to permit only frequencies above a certain value to pass.

Filter, Low-Pass. A filter circuit arranged to permit only frequencies below a certain value to pass.

Flux Density. The number of lines of magnetic force per unit area of cross section of a magnetic circuit. Usually expressed as "lines per square (inch or centimetre)." Symbol is "B."

Forced Oscillations. Those maintained in a tuned circuit by an outside source of energy, always at the frequency of the supply.

Free Oscillations. Those which occur in a tuned circuit at the natural or resonant frequency of the circuit.

Fundamental Frequency. The lowest component frequency of a periodic wave or quantity.

Gauss or "Maxwell." The unit of field strength or magnetic flux density used for comparative purposes or for calibration. Is a flux density of one line per square centimetre. Thus a flux density of 10,000 lines per sq. cm. would be expressed as 10,000 Gauss.

DICTIONARY OF RADIO DEFINITIONS.—

(Continued from page 192)

Gilbert. The unit of magnetomotive force.

Grid Rectification. The use of a valve for de-modulating high frequency transmission by utilising the one-way conductivity of the grid filament circuit. During the impact of a train of waves, the resultant flow of current through the grid leak depresses the mean voltage of the grid, and so reduces the value of the plate current at an audible frequency corresponding to modulated components in the original wave.

Harmonic. A component of a periodic wave or quantity having a frequency which is a multiple of the fundamental frequency. For example, a component whose frequency is twice the fundamental frequency is called the second harmonic.

Heterodyne Reception. The process of receiving radio waves by combining in a detector a received voltage with a locally generated alternating voltage. The frequency of the locally generated voltage is usually different from that of the received voltage. This system is sometimes known as beat reception.

Heaviside Layer. A stratum or layer of ionised particles in the upper regions of the atmosphere. This layer serves to reflect and/or refract electro-magnetic sky waves which would otherwise escape into space.

Homing Device. A direction-finder system for aircraft use, comprising a fixed loop and a trailing aerial. Manipulation of a switch indicates whether the aircraft is on or off the course, determined by a radio beacon.

Hysteresis. The tendency of magnetisation to lag behind the magnetising force, as, for example, in the case of an iron-cored transformer. This produces the transformer iron loss which is directly proportional to the area of the hysteresis loop for the particular sample of iron in use.

Image Ratio. A term used in the assessment of superheterodyne receiver selectivity. Is the ratio of the signal strength increase required to produce the same output, when the receiver is detuned twice the I.F. from resonance with the signal, as when the receiver is tuned to resonance.

Impedance. The opposition offered by a circuit to the passage of alternating current due to the combined effects of inductance, resistance, and capacity.

Inductance. The property of a circuit by virtue of which it opposes any alteration in the value of the current, and hence offers opposition to alternating current.

Inverse Voltage, Peak. The highest voltage that a rectifier valve can safely stand in the direction opposite to that in which it is designed to pass current.

Ionisation. The process of splitting up molecules into their component ions carrying positive or negative charges. The ions so produced thus act as carriers of electricity through the liquid or gas.

Kilocycles Per Second. A unit of frequency equal to 1000 cycles per second. The frequency corresponding to any wave-length may be found by dividing the wave-length in metres into the constant 300,000. Conversely to obtain the wave-length in metres, divide the constant 300,000 by the frequency in kilocycles per second.

Linear Detection. That form of detection in which the output voltage under consideration is substantially proportional to the carrier voltage throughout the useful range of the detecting device.

Litzendraht (Litz). A stranded conductor in which each strand is insulated from every other strand. Radio frequency resistance is reduced by this means.

Magnetron. A diode valve having a straight filament surrounded by a cylindrical anode, a powerful magnetic field being applied coaxially with the filament. Used as a generator of ultra-high frequencies.

Magnetising Force. The magnetic field strength in lines per sq. cm. at a point where no iron or other magnetic material is present. Symbol is "H," so that flux density (B) in magnetic material will be μ H lines per sq. cm. (where "μ" is the permeability of the material).

Megacycle Per Second. A unit of frequency equal to one million cycles per second.

Mho. The unit of admittance (A.C.) and also of conductance (D.C.).

Modulation. The process whereby the frequency or amplitude of a wave is varied in accordance with a signal wave.

Modulation Capability. The maximum percentage of modulation that is possible without objectionable distortion.

Mutual Conductance. The ratio of a small change in plate current to the small change in the control grid voltage producing it, under the condition that all other voltages remain unchanged. The unit may be expressed in milliamperes per volt, or micromhos.

Octode. A dual purpose valve containing 6 grids in addition to a heater, cathode and anode. Usually employed as a frequency changer in superheterodyne circuits; similar to the pentagrid.

Oscillator. A non-rotating device for producing alternating current, the output frequency of which is determined by the characteristics of the device.

Oscillograph. An instrument for showing visually, or recording photographically, the wave form of alternating or other periodically changing currents and voltages. In the electro-magnetic type, a large mirror is attached to a small coil suspended in a magnetic field. In the cathode ray type, a stream of electrons is controlled by electro-static and/or electro-magnetic fields. (See measuring instrument section for full definitions of all terms used in cathode-ray oscillograph operation).

DICTIONARY OF RADIO DEFINITIONS.—

(Continued from page 193)

Pentagrid. A dual purpose valve containing 5 grids in addition to a heater, cathode and anode. Usually employed as a frequency changer in superheterodyne circuits, where electronic modulation provides the coupling between the oscillator and amplifier portions of the valve.

Pentode. A 5 electrode valve incorporating between screen and plate a suppressor grid which is usually connected to the cathode. By this means the effect of secondary emission in the vicinity of the plate is avoided.

Percentage of Modulation. This is 100 times the ratio of half the difference between the maximum and minimum amplitudes of a modulated wave to the average amplitude.

Permeability. The ratio of the magnetic flux produced in any substance to the applied magnetising force, which is itself equal to the magnetic flux in air. The measure of magnetic conductivity.

Picture Transmission. The electrical transmission of a picture having a gradation of shade values.

Power Detection. That in which the power output of the detecting device is used to supply a substantial amount of power, directly to a device such as a loudspeaker or recorder.

Power Factor. The ratio of the true power (watts) in an alternating current circuit to apparent power (volt-amperes). It is always less than unity, since the voltage and current are not in phase.

Preselector. A selective tuned circuit preceding the radio frequency amplifier in a receiver, in order to avoid cross modulation troubles and lack of selectivity. Sometimes referred to as a band-pass filter.

Proximity Effect. One of the factors which tend to increase the R.F. resistance of a conductor wound into a coil. Is set up by the interference of the magnetic fields of adjacent turns.

Quartz Crystal Oscillator. One utilising the piezo-electric effect of a quartz crystal plate. The mechanical oscillations of the quartz plate are maintained by means of a thermionic valve, a high degree of frequency stability being obtained.

Radiation Efficiency. The ratio of the power radiated to the total power supplied to the antenna.

Radiation Resistance. This is obtained by dividing the power radiated from an antenna by the square of the antenna current, measured at the point where the power is supplied to the antenna.

Radio Beacon. A transmitting station in a fixed geographic location which emits a distinctive or characteristic signal for enabling mobile stations to determine bearings or courses.

Radio Compass. A direction-finder used for navigational purposes.

Reflex Circuit. One in which the signal is amplified both before and after detection, in the same amplifier valve or valves.

Regeneration. Sometimes called reaction or feedback. A process by which a part of the power in the output circuit of an amplifying device reacts upon the input circuit in such a manner as to reinforce the initial power, thereby increasing the amplification.

Regulation. A measure of the change in voltage at the output of an electrical device under varying conditions of load.

Renode. A thermionic valve which has no grid in the accepted sense of the term. Control is provided by focussing the electrons emitted by the cathode into a beam and using various electrodes for the purpose of focussing or acceleration. Greater sensitivity and linearity of response is obtained and also greater efficiency. The new "beam power" valves, such as the 6L6, operate on a similar principle to this. First introduced by A. S. Jensen, a Danish engineer.

Screen Grid Valve. (See also Tetrode.) A four electrode valve in which an extra grid carrying a high positive potential is interposed between the plate and the control grid, electro-statically screening these elements and preventing capacity feed back. At the same time the flow of electrons is not impeded.

Secondary Emission. Electrons liberated from the plate of a valve by the violent impact of the normal electron stream from the cathode.

Sideband. A band of frequencies on either side of the carrier frequency produced by the process of modulation.

Skin Effect. The tendency for high frequency currents to travel along the outside of a conductor. The radio frequency resistance of a solid wire is thus somewhat higher than its D.C. resistance.

Space Charge. A cloud of electrons which hovers between the cathode and the plate. This charge tends to repel electrons leaving the cathode, with a resultant increase in internal impedance of the valve.

Specific Inductive Capacity, or Dielectric Constant. The ratio between the capacities of two condensers, one with the material under consideration as the dielectric, the other with an air dielectric. Abbreviated, S.I.C.

Static. See atmospherics.

Strays. Electro-magnetic disturbances in radio reception, other than those produced by radio transmitting systems.

Superheterodyne Reception. The method of reception in which the received voltage is combined with the voltage from a local oscillator and converted into voltage of an intermediate frequency which is amplified and then detected to reproduce the original signal wave. Sometimes called "double detection" or "supersonic" reception.

Super Re-generation. A circuit in which a reactive detector is maintained, by means of a local quenching valve, at the threshold of oscillation, where it operates with increased efficiency.

DICTIONARY OF RADIO DEFINITIONS.—

(Continued from page 194)

Television. The electrical transmission of a succession of images and their reception in such a way as to give a substantially continuous and simultaneous reproduction of the object or scene before the eye of a distant observer.

Tetrode. A type of thermionic valve containing a plate, cathode and two additional electrodes ordinarily in the nature of grids.

Transconductance. The ratio of the change in the circuit of an electrode to the change in the voltage on another electrode, under the condition that all other voltages remain unchanged.

Triode. A type of thermionic valve containing an anode, cathode, and a third electrode, in which the current flowing between the anode and cathode may be controlled by the voltage between the third electrode and the cathode.

Variable-mu Valve. A thermionic valve which has a long sloping characteristic, thus enabling a continuous change of amplification factor to be effected by a change of grid bias.

Vector. A quantity which is represented by both the magnitude and direction of a straight line. Vector methods are largely used in alternating current work.

Vodas. The initials of "voice operated device, anti-singing." A device developed by Australian and New Zealand engineers for use on the Trans-Tasman telephone service for reduction of feed-back effects encountered during operation.

Wattage, Dissipation, Anode. The difference between input and output wattages in the plate circuit of a valve, the maximum permissible figure usually being stated by the manufacturer.

Wave Form. The shape of a curve representing an alternating current.

Wave-length. The distance between two successive peaks in any periodic wave-train.

Measuring Instruments

Types in Use and their Operation

AS the moving coil or D'Arsonval type of direct current meter forms the basis of the majority of measuring instruments in use to-day, this type of movement and its functioning will be described. A description of the various other types of movements used in indicating meters, both A.C. and D.C. will follow together with details of their application.

Various types of "composite" instruments which use these various meter movements as indicating devices will also be described and their operation outlined, followed by that latest and most versatile tool of the radio engineer—the cathode-ray oscillograph.

The D'Arsonval Movement

IF a coil carrying direct current is placed in a magnetic field it will tend to orient itself axially along that field. The degree to which it does so is controlled by both the inertia of the coil (freedom of movement) and the magnetic field set up in the coil itself by the current flowing.

This is the principle underlying the operation of all moving coil instruments of the D'Arsonval type, and is the principle upon which the majority of D.C. meters operate.

Reference to fig. 1 (a) will show how this principle is applied to the construction of a meter. The poles "N" and "S" are extensions of the permanent magnet and are arranged so that they come into close proximity with the coil shown between them.

The coil is pivoted at its centre so that the ends of the coils may describe an arc of a circle around the pivoting point. Application of a D.C. voltage to the leads from the coil will

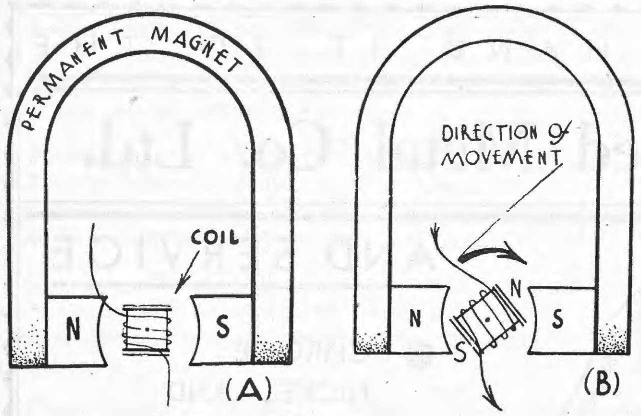


Fig. 1.

cause current to flow and a magnetic field to be set up which has definite polarity. Fundamental magnetic principles tell us that "unlike poles attract" so that the now magnetised coil will move as indicated, by the arrow in fig 1 (b), that is, it will endeavour to orient itself longitudinally between the magnet poles "N" and "S." The extent to which it succeeds is governed by the two factors mentioned above, assuming, of course, that the magnet field strength and number of turns on the coil are constant.

It is fairly obvious that, if an indicating pointer be attached to the coil, the degree of movement could be accurately noted by placing a finely divided scale along the path travelled by the pointer. As the coil inertia will also be a constant, in addition to the factors mentioned before, it follows that the degree of movement noted above may be taken as in indication of the current flowing (or the applied voltage).

In actual practice, a soft iron core is placed inside the coil which serves to concentrate the magnetic field set up by the permanent magnet into the path between the pole pieces. Also, two light spiral springs are fitted to the coil assembly, one at each pivot point, which serve to bring the coil back to its normal position, after the applied voltage is removed. These springs tend to restrict the freedom of movement of the coil (i.e., increase its inertia), and, consequently, the response of the "movement" to any given current flow depends on the strength of these springs. From this we can see that the "sensitivity" (degree of response to a given current flow) of any meter can be controlled in two ways, the first of which is by means of the return springs and the second, by the number of turns wound on the coil. Thus, a meter intended for the measurement of very small currents will have very light return springs and as many turns as possible on the coil.

The springs also serve as the connecting leads to the coil, and are insulated from one another and from the frame of the meter.

The coil is usually wound on a lightweight metal (aluminium in many cases) former, and the energy dissipation in this former, set up by eddy currents induced while the former is moving, makes the movement somewhat more "sluggish" than it would be if controlled by the return springs and magnetic field alone. Without this "sluggishness" the movement would oscillate to and fro for an appreciable period before coming to rest at any point. This is undesirable, as much time would be lost in obtaining readings. A movement which has the springs and eddy current losses correctly proportioned and so comes to rest quickly is said to be "dead-beat."

Any particular meter movement may have its range of current measurement extended by the simple expedient of by-passing the coil by means of a resistance. Such a bypass is known as a "shunt" and reference to previous discussions on Ohm's Law will show how shunts may be proportioned, once the meter coil resistance is known, so that any multiple of the original current range of meter may be measured.

Similarly, by adding resistance in series, the instrument may be calibrated as a voltmeter, since the current forced through the resistance and meter is a function of the voltage across such a system. Series resistances used for this purpose are known as "multipliers."

The Dynamometer Movement

The dynamometer type of movement comprises a moving coil in series with a fixed field coil. The passage of current produces opposing fields in the two coils, with a resultant movement of the pointer across the scale. This type of instrument can be used for D.C. or A.C. measurements. In the latter case the R.M.S. or effective value is indicated. Generally such instruments are not as sensitive as the permanent magnet or D'Arsonval type, requiring larger currents for corresponding deflections. Dynamometer instruments are affected by the presence of external magnetic fields, from which they should be kept away when in use. In practice, however, these meters can be made immune to such fields if an astatic type of coil construction is adopted.

Moving Iron Meters

Moving iron instruments are used extensively for A.C. measurements, and consist of a light iron vane which is drawn into a solenoid field coil through which the current passes. The pointer is attached to the moving vane. The scale of a moving iron instrument is crowded at the zero end and gradually opens out until maximum deflection is reached. For measuring heavy

(Continued on page 197)

MEASURING INSTRUMENTS—(Continued)—

currents a field coil of relatively few turns, but of heavy wire, is used and shunts are rarely necessary. Voltmeters are constructed in the usual manner by the addition of series resistances.

Electrostatic Voltmeters

These are the only commonly used instruments which do not make use of magnetic phenomena as the basic principle of their operation.

Electro-static voltmeters are actuated by the field set up between a set of fixed plates and a moving vane to which the pointer is attached. As the instruments are capacitative (of the order of 10 to 50 mmfd. at full scale deflection, according to the range of the meter) no D.C. current, and only a small A.C. current, is drawn when used on either type of circuit. Normally the scale cannot be calibrated below approximately 20% of full scale deflection.

This type of instrument is very useful for measuring voltages which would be upset by the load placed on the circuit if any other type of meter were used. Consequently, their major application is found in the measurement of extremely high voltages. Multiplication of the meter scale may be effected by means of a transformer of known voltage ratio or by means of accurately calibrated series condensers.

Composite Meters

In addition to the fundamental "movements" outlined above there are quite a few instrument types which make use of one or another of these various "movements" in association with various other items of subsidiary apparatus. The combination may then be used for measuring voltages and/or currents which are either above or below the original scale range of the meter or it may be used for the measurement of audio or radio frequency current or voltage.

Thermocouple Meters

This type is one of the simpler composite types and the principle of operation makes use of the fact that if the junction of two metals, such as copper and constantan, is heated, a voltage is developed across the outer ends of the junction wires. The junction metals are chosen according to their thermo-electric power, which indicates the voltage developed between the metals per degree rise in temperature. This voltage is measured on an ordinary moving coil movement, suitably calibrated either for current or voltage as the case may be. The heater wire is usually a high resistance alloy. Certain types of meters have the complete thermo-couple mounted in evacuated glass bulbs to avoid cooling effects due to draughts, etc. These meters are eminently suitable for high frequency work, and may also be used for D.C. purposes. They must be used with extreme care owing to the comparatively low overload factor.

Rectifier Meters

Rectifier type meters may be used for all low and audio-frequency measurements and consist of a conventional moving coil unit which registers the D.C. current produced by a small copper-oxide rectifier built in to the instrument. These instruments are useful over a wide frequency range, although not nearly to the same extent as the thermo-couple type. The scale may be calibrated for voltage or current in the usual way.

A point that must be borne in mind, however, is that, for purposes of either voltage or current scale multiplication the meter and rectifier must be regarded as one unit. This means that the input to the rectifier is to be regarded as the input to the meter and, consequently, series multipliers for high voltage indications must be connected in series with one of the leads to the rectifier. Shunting, for the purpose of current range increase, must also be effected on the input side of the rectifier, the actual procedure in this case being to measure the voltage drop, set up by the current to be measured, across a known resistor. For very heavy currents, where the insertion of any appreciable amount of extra resistance in the circuit under consideration is undesirable, a "current transformer" is used, this being a step-up transformer with a primary of only a few turns of heavy copper wire. The ratio of the transformer is made sufficiently high to bring the very small voltage drop across the primary to readily measurable proportions. This system is also used with moving-iron type meters when very heavy currents are to be measured.

This type of meter uses a bridge rectifier circuit with a low resistance D.C. movement connected directly across its terminals, as shown in fig. 2. It is important that the resistance connected across the D.C. terminals of the bridge should be low, as the apparent resistance of the set-up to A.C. current is directly dependent on this resistance in the D.C. side. If this becomes high (e.g., an open circuit) a large A.C. voltage drop will be caused across the bridge, perhaps sufficient to destroy it and certainly enough to upset its calibration.

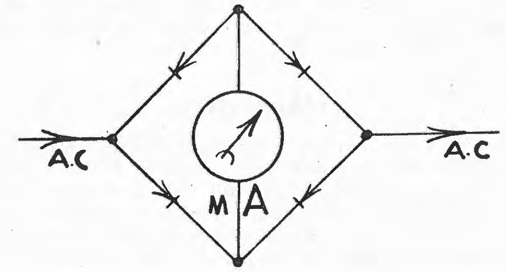


Fig. 2.

For this reason it is desirable, when using a meter separate from the rectifier unit, to provide a switch to automatically short-circuit the D.C. side of the bridge when the meter is removed. A double circuit jack conveniently does this. Alternatively, the A.C. side of the rectifier may be opened as a safeguard.

Westinghouse metal rectifiers are available in ranges of 1, 5 and 10 mA. (D.C. output), for meters whose voltage drop (D.C.) does not exceed 500mV. To make full use of the accuracy obtainable by the combination of such a bridge with a high-class moving coil instrument, facilities should be available for accurate calibration on A.C. It is possible, however, to provide an approximate calibration from D.C. methods, or even by relying on the existing D.C. calibration of the meter, and using a multiplying factor.

The effective or r.m.s value of an A.C. wave is 0.707 of the peak value. However, the average value is 0.636 of the peak value. The ratio between these two values is 1.11, known as the "form factor" of the A.C. wave. Since a D.C. moving coil meter is an instrument with a linear movement law, its indication is proportional to the average value of the current passing through it. For this reason the D.C. scale reading has to be multiplied by a factor of 1.11 to obtain the A.C. current passing.

It is to be noted that due to losses in the rectifier, the calibration is not exactly linear, but, as the error only effects the first 1/1000 of the scale, it can be neglected. The only case in which it is important is in low reading (less than 10 v.) voltmeters. In voltmeters of higher ranges than this the scale can be assumed to be quite linear but that the zero and 0.5 volt readings are identical.

This means, in effect, that all milliammeters, ammeters and high reading voltmeters can be calibrated by a single reading against some accurate standard, or against D.C. instruments with two readings on reversed polarity. In the case of low reading voltmeters, however, it will be necessary to draw a complete calibration curve, particularly over the first half of the scale. Six or seven points along the scale will suffice for a good calibration.

In any calibration with A.C. the wave-form of the applied voltage should be as nearly as possible sinusoidal. If this is not so, the form factor will differ from 1.11 and the meter will read inaccurately on other wave-forms than that on which calibration was effected.

Temperature co-efficients for rectifier-type milliammeters vary from 0.005 to 0.015% per degree Centigrade, the error being such as to make the instrument read low at increased temperatures. The unit should be calibrated at a temperature near its ultimate or normal ambient temperature. Voltmeter temperature errors, except in low reading voltmeters, are negligible

(Continued on page 198)

MEASURING INSTRUMENTS—(Continued)—

above the first fifth of the scale reading. Even in low reading units the error is negligible near full scale readings. At small scale deflections the error is positive, a 300 volt set-up reading (say) 0.04% high per degree Cent., at a scale reading of 25 volts. At a reading of 200 volts the temperature co-efficient may be zero.

Frequency errors are small and due solely to the self-capacity of the rectifier providing a shunt across the A.C. terminals and causing the meter to read low at high frequencies. At 5,000 cycles we may expect an error of 1%. Finally, the whole arrangement provides a cheap and robust method of obtaining a sensitive movement for A.C. operation.

Ohmmeters

An ohmmeter is really a moving-coil milliammeter in series with a resistance and some source of E.M.F. The resistance is arranged so that full scale deflection is obtained on the meter when the circuit is completed without any external resistance in series. The series resistor is usually made wholly or partly variable in order to compensate for variations in supply voltage. Obviously, the range of resistances which can be measured by this method depends on the total internal resistance in circuit, the current rating of the meter and the applied voltage. A typical combination is shown in fig. 3, where means are provided for varying the current rating of the meter (by means of a shunt) and the total internal resistance of the combination. It will be seen that two combinations are available as follows:—

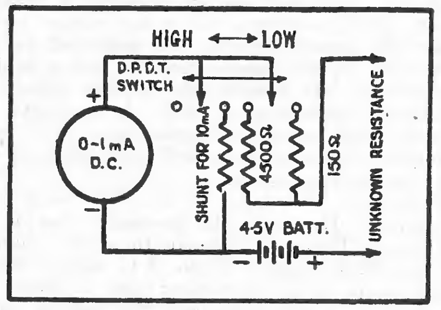


Fig. 3.

High, 1mA meter with 4,500 ohms in series; **Low,** 10mA meter with 450 ohms in series. The applied voltage is 4.5 volts in each case. Calibration may be effected by two means, the first of which is the connection of a number of known resistances across the "unknown" terminals and the second by means of the application of Ohm's Law. The calculation is merely a matter of noting the current flowing (by the meter scale) when the unknown resistance is in circuit. The voltage is known, so that the **total** resistance in circuit may be found by the application of the standard R = E/I equation. Having determined the total resistance it is then necessary to deduct the internal series resistance from this figure. The final value may be calibrated on the scale. If the calibration procedure is carried out carefully, and the shunt is arranged so that the meter has a ten to one scale ratio on the low and high positions, it will be found that the readings will be exact multiples on the two scales. In other words 100 ohms on the "low" scale will fall on the same point as 1,000 ohms on the "high" scale. The useful working range for a meter of this description will be between 100 and 100,000 ohms on the "high" range and nearly zero to 10,000 ohms on the "low" range.

Shunts and Multipliers

Before proceeding further with a discussion of the various type of composite instruments in use it will be as well to say a few words about the shunts and multipliers necessary when a moving coil meter is used to indicate current or voltage values above the actual scale range of the movement.

Let us consider a D.C. milliammeter (0-1) which gives full scale deflection when one milliampere flows through the meter. The resistances of such meters in commercial use range from 20 to 50 ohms. In the extreme case, considering a meter of 50 ohms resistance, the voltage drop across the meter at full scale current would be, according to Ohm's Law, (50 × .001) = 0.05 volts.

Referring to Figure 4, we see that the meter can be used as a voltmeter if a resistance (or "multiplier") is connected in series with it.

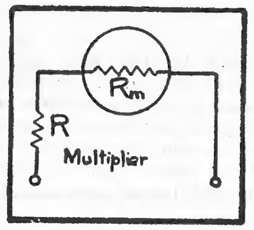


Fig. 4.

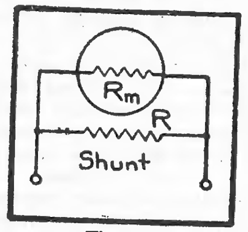


Fig. 5.

The value of this resistance must be such that practically the whole of the voltage drop will occur across it. If a voltage drop of more than 1/20 volt is impressed across the meter it will go off scale and probably be damaged. Furthermore, this small drop of 1/20 volt can be quite neglected in comparison with the total voltage. Thus the resistance must be of such value that if 1 milliampere of current (which is full scale deflection of the meter) flows through it the voltage across the resistance will be equal to the full scale voltage indication which is required. If the maximum scale deflection required is 10 volts, it can be seen, by Ohm's Law, that the value of the series resistance must be 10,000 ohms.

If a 0-10 milliammeter was used in place of the 0-1 instrument the multiplier would, of course, be only 1/10 of the value in the previous example. This would also apply to the scale multiples. However, the 10 mA meter will consume appreciable current in itself and may in some cases introduce a considerable error, particularly where the resistance of the multiplier is not considerably higher than the system to which it is connected, as the regulation of the voltage supply system may be seriously affected when it is called upon to supply an additional 10 milliamperes to operate the voltmeter.

This emphasises the importance of a high resistance voltmeter: in the first example, the resistance was 1,000 ohms per volt, while in the second instance it was only 100 ohms per volt. For a reasonable degree of accuracy in radio work a voltmeter having a resistance of 1,000 ohms per volt will be quite suitable.

To use the 0-1 milliammeter for indicating higher currents, it is necessary to provide a shunt as in Fig. 5. In this case it is essential to know accurately the resistance of the meter. Assume that it has a resistance of 27 ohms and that we want to have scale readings of 10, 50, 100 and 500 milliamperes.

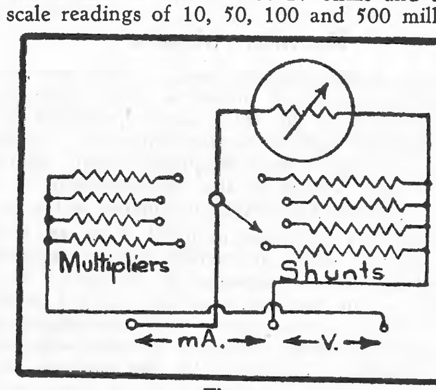


Fig. 6.

Referring to Fig. 5 it is evident that to use the meter for 0-10 mA. measurements the meter would carry 1/10 of the total current and the shunt 9/10, therefore, the shunt resistance would be 3 ohms: correspondingly, the shunt resistance for use as an 0-50 milliammeter would be (1/49 × 27) =

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MEASURING INSTRUMENTS—(Continued)—

0.551 ohms. For the 100 and 500 mA. scales the shunt resistance should be 0.2727 ohms and 0.0541 ohms respectively.

The general formula is:—

$$Rs = \frac{Rm \times Im}{I - Im}$$

where Rs = resistance of shunt in ohms.
Rm = resistance of meter in ohms.
Im = full scale current for meter (unshunted).
I = total current for full scale deflection (shunted).

By having a multiple switch, as shown in Figure 6, one meter can be used as a voltmeter or milliammeter at any desired range. The accompanying chart shows the resistance of a shunt or multiplier as the case may be.

It should be noted that each of the multipliers must be of large enough capacity to carry 1 mA. without unduly heating and thus changing in value.

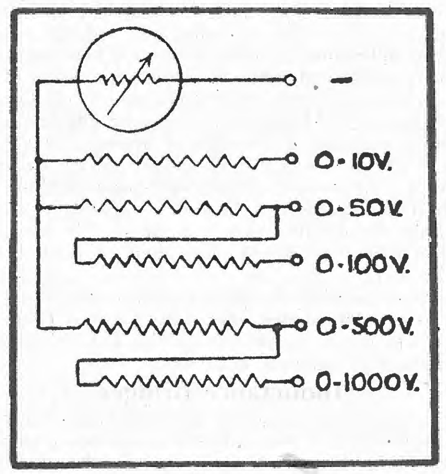

Fig. 7.

The circuit is also shown, in Figure 7, of a multi-range voltmeter in which the multipliers are not separate units but are made up by addition.

Shunt and Multiplier Values

27 Ohm (0-1) Milliammeter

Scale	Use as:	Resistance in Ohms of Multiplier or Shunt		Multiply Old Scale by
0–10	Voltmeter	10,000	M	10
0–50	”	50,000	M	50
0–100	”	100,000	M	100
0–250	”	250,000	M	250
0–500	”	500,000	M	500
0–1000	”	1,000,000	M	1,000
0–10	Milliammeter	3	S	10
0–50	”	0.551	S	50
0–100	”	0.2727	S	100
0–500	”	0.0541	S	500
35 Ohm (0–1.5) Milliammeter				
0–15	Voltmeter	10,000	M	10
0–150	”	100,000	M	100
0–750	”	500,000	M	500
0–15	Milliammeter	3.89	S	10
0–75	”	0.714	S	50
0–150	”	0.354	S	100
0–750	”	0.0701	S	500

BRIDGES

The Wheatstone Bridge, in any of its many forms, constitutes one of the most valuable aids to electrical measurement practice yet devised.

In earlier sections we have shown how inductance, capacity and resistance may all be checked by means of simple series measuring devices. These devices are all dependent on the accuracy of calibration of the meter used and also on the accuracy of the method of calibration used. Also, in the case of A.C. operated systems (for inductance and capacity) the wave-form of the supply voltage plays an important part and unless this is constant, inaccuracies will be introduced from this source also.

The Wheatstone Bridge method of measurement overcomes all of these difficulties as all checking and measuring is carried out by reference to a standard of some kind, the accuracy of which is very nearly the only limitation to the accuracy of the combination. Consequently, the bridge method of measurement is almost universal in laboratory practice and a brief description of the major methods of measurement by this means will not be out of place.

Resistance Bridges

A fundamental circuit diagram of a Wheatstone Bridge intended for resistance measurement is shown in Fig. 8. As will be seen the arrangement consists of a source of E.M.F. (E), an indicating instrument (G) and a network of resistors (R1, R2, R3, R4). The arrangement of these resistors is in series-parallel, R1 and R2 being in series and shunted by R3 and R4; the entire arrangement being shunted across the source of E.M.F. The indicating instrument is connected between the junction of R1, R2 (X) and the junction of R3, R4 (Y). This instrument is usually of the centre-zero type so that the needle is free to travel in either direction.

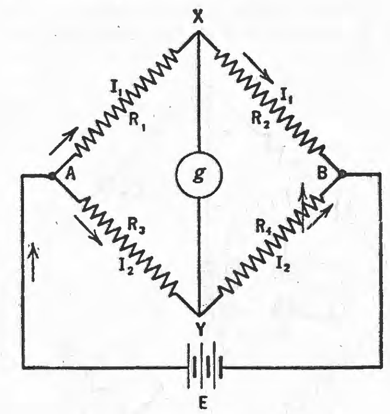

Fig. 8.

The sensitivity of the bridge is to a very large extent limited by the sensitivity of this meter, although the applied voltage plays quite an important part. In commercial bridges of the semi-portable type, the meter is usually a galvano-meter with a swing of about 25 microamperes each side of zero. The resistance of the movement is not very important.

The applied E.M.F. is connected to the points A and B on the bridge and it can be seen that the current flowing will be split between two paths as indicated by the arrows and the current designations. Furthermore, it can also be seen that unless the **ratios** R1/R2 and R3/R4 are the same X and Y will be at different potentials and current will flow through G, the direction of current flow being dependent on the relative potentials of X and Y.

It follows then, that if the arms of the bridge are adjusted until the ratios R1/R2 and R3/R4 are equal no current will flow through G, as X and Y will be at the same potential.

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MEASURING INSTRUMENTS—(Continued)—

This applies whether the **total** resistances of the paths R1, R2, and R3, R4 are the same, or widely dissimilar. The **ratios** of the component arms are the important points.

From this it can be seen that if R1 equals R2, R3 must equal R4 if balance is to be established (i.e., G is to remain at zero). This is the principle of operation of the bridge. R1 and R2 are made fixed quantities for the measurement of any given resistance value. R3 is the unknown resistance and R4 is made variable over the range required and a calibration provided which shows the value of R4 at any required point. This calibration will also show the value of R3 if R1 and R2 are equal. In actual practice R1 is also made variable in multiples of R2 so that various ratios may be obtained. This procedure enables any value of R3 to be determined as, obviously, if the ratio R1/R2 is (say) three, R3 must be equal to 3R4 if balance is to be obtained.

The necessity for a centre-zero meter is self-evident as the zero point is actually the reference point, and some indication of whether R4 is high or low is necessary. (If R4 is too high, X will be positive with relation to Y and vice versa. Assuming that A is the positive end of the bridge).

An alternative method of bridge measurement is sometimes used where R4 is fixed and the ratio R1/R2 is made continuously variable. The value of R3 in this case is determined by the same method as that used above when R1 was used as a multiplier. (R3 = (R1/R2) R4).

The advantage of the bridge method from an accuracy viewpoint is immediately evident. No calibrations on the meter are required as it is only used for balance indication; the voltage or nature of the supply is immaterial as long as it is such that it will operate the meter; therefore, once the ratio R1/R2 is accurately known the only limitations are those of the accuracy of the calibration provided for R4 and the "fineness" of the zero setting available.

Capacity Bridges

The same principle may be applied to the measurement of capacity and a typical capacity bridge circuit is shown in fig. 9. In this case, however, other characteristics of the condenser under test may be determined at the same time and the bridge proves doubly useful.

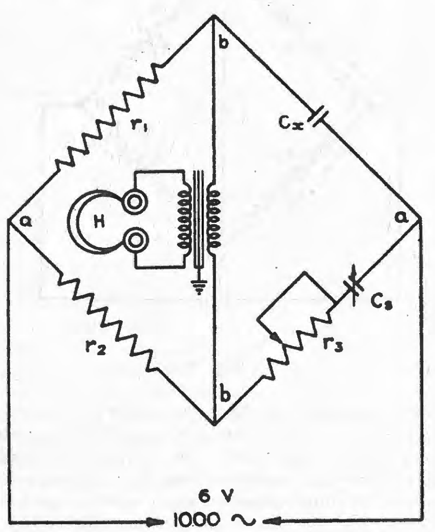

Fig. 9.

As will be seen an A.C. source of supply is used for this bridge and the circuit is re-arranged slightly. R1 and R2, instead of being in series and forming one branch path, are placed one in each path, the object being to balance the bridge symmetrically to ground in order to overcome stray capacity effects. For the same reason, the headphones (used as an indicating device) are fed from the secondary of an electrostatically shielded transformer. The principle of operation remains the same, however, and the object is still to balance that two paths between "a" and "a" so that no potential is developed across the points "b" and "b."

It has been mentioned before that a condenser, besides its capacity, has a certain amount of series resistance. This resistance tends to increase the losses caused by the insertion of a condenser in an A.C. circuit and an accurate determination of the amount of resistance present in any condenser is valuable as an indication of the "goodness" of any condenser. For this reason, a variable resistor (R3) is included in the "standard" arm of the capacity bridge in series with the standard condenser (Cs) which is also variable. The range of this resistor will be dependent entirely on the average quality of the condensers to be tested in the Cx position. Cs must be of the best possible quality, with a series resistance value as near zero as possible.

R1 and R2 are merely inserted for the purpose of completing the bridge. Two condensers could be used, but it is far easier to obtain two resistors which **exactly** match (as R1 and R2 must in this circuit) than two condensers. Cs and R3 must both be juggled in order to balance this bridge, and balance is indicated by cessation of sound in the headphones, thus indicating that no voltage is being developed across "b" and "b." The setting of Cs (when balance is reached) will give the capacity of the condenser under test and the setting of R3 will give the **difference** in series resistance between Cx and Cs. R3 is usually calibrated with the series resistance of Cs as its minimum setting. Series resistance values of Cx can then be read off directly. Multiplication may be effected by shunting Cs with other standard condensers of known value. These are preferably made to be multiples of the maximum capacity of Cs so that a continuous capacity calibration without any gaps is available (for example; if Cs has a capacity of 500 mmfd., the first shunt should also have a value of 550 mmfd. Values between 500 and 1000 mmfd. may then be read directly from the scale of Cs).

The operation of this bridge is identical to that of the resistance type as the **impedance** offered by Cx and Cs to the 1000 cycle A.C. acts in the same way as the D.C. resistance of R3 and R4 in the first example dealt with.

Inductance Bridges

The circuit and operation of an inductance bridge is identical with that of fig. 9, the only difference being that inductors are substituted for Cx and Cs. The use of R3 is not essential, but is useful as it enables some idea of the relative **resistance** of the inductor under test to be obtained. In both of these instances it is important to note that the value of R3 must be as low as possible (no larger than the highest value of series resistance likely to be encountered) as it is quite possible to obtain very erroneous balance settings due to this resistance taking the place of some of the impedance which should be represented by Cs (or Ls, as the case may be). This condition is not likely to arise but should be borne in mind as a possibility.

Apart from the accuracy of measurement made possible with the bridge type of circuit on account of the fact that all measurements are made by direct reference to a standard, the independence of the bridge from the voltage or nature of the actuating E.M.F. is also a very important point. The reason for this is immediately apparent on inspection of the circuits as it will be seen that the standard and the component under test are both operating under identical conditions. Large variations of the applied E.M.F. will not affect the accuracy of the bridge, unless, of course, the voltage drops to such a point that it is no longer possible to obtain a reading on the indicating instrument.

Variation of wave-form, in the case of an A.C. operated bridge, is immaterial, simply because the standard and "unknown" are both being checked under the conditions applying at the time. The only factor, in connection with the supply voltage, which is important is that the frequence of the supply be somewhere close to that at which the component will be operating, and, moreover, be close to that at which the standard was calibrated. This is important on account of the varying frequency characteristics displayed by condensers and inductances and it is quite possible that if the standard is calibrated at (say) 1000 cycles it will display entirely different characteristics at 10,000 cycles. The same applies to the component under test so that it is advisable that the calibration, test and operating frequencies be as close as possible to one another, if any degree of reliance is to be placed on the test results obtained from the bridge. This applies to **any** testing equipment at all and should always be borne in mind.

Vacuum-Tube Voltmeters

A VACUUM-TUBE voltmeter is really a thermionic rectifier with a meter in its output circuit to indicate the changes in its plate current set up by signal voltages applied to its grid.

The advantages of a vacuum-tube voltmeter are that it imposes very little load on the circuit under measurement; it may be used over a very wide range of frequencies without appreciable discrimination, and by proper attention to its characteristics may be used to measure peak, trough or r.m.s. values of an A.C. wave.

Its disadvantages are that constant calibration checks against a standard are necessary to counteract the effects of ageing tubes and variation of power supply.

However, both of these disadvantages may be minimised by careful choice of a circuit arrangement, and, in any case, the instrument forms a cheap and easily built substitute for the only comparable instrument (from a frequency discrimination point of view) the thermo-couple meter. The almost negligible load imposed by the vacuum-tube voltmeter is a great point in its favour, and, even if it possessed no other advantage, this factor alone would warrant some attention being paid to the instrument and some of its many forms.

There are almost as many types of V.T.V.M. circuits as there are radio receiver circuits and a volume could be filled with a discussion of its many forms. Several representative types are shown in figure 10, and a brief description of each follows.

"R.M.S." Type V.T.V. Meter

Fig. 10 (a) is what might almost be termed a basic V.T.V.M. circuit, although there are simpler forms. The circuit illustrated is that of a meter intended for the determination of the r.m.s. voltage of an A.C. wave. "V.T." indicates the tube used, which may be of almost any type. A medium-mu-triode with a fairly steep slope is preferable from a sensitivity angle, but a low-mu tube is preferable if high voltages are to be measured. A, B and C are the filament, plate and bias supply voltages respectively; while S, and R2 are for filament control.

As will be seen, the meter "M" is in series with the plate supply to the tube, it being placed on the negative side of the "B" battery to simplify the "bucking" necessary in order to neutralise the effect of standing plate current. R3 is provided as a bucking voltage control and is used to vary the amount of counter E.M.F. applied to the meter. The resistance of this control will be such that it has no appreciable shunting effect on the meter, which will usually be an 0-500 microamp. or 0-1 mA. movement with a resistance of 20-100 ohms. It can quite easily be seen from this that even if full scale "bucking" of the 0-1 mA. meter is required and an "A" supply of only two volts is used this resistance must have a value of very close to 2,000 ohms.

C2 is provided as an R.F. or A.C. by-pass, and should have a low reactance to the frequency of the voltage being measured. Usual values will be about 0.01 mfd. for R.F. and I.F. and 1 or 2 mfd. for audio and low-frequency A.C.

C1 and R1 are not absolutely essential and may be omitted from the circuit if all measurements are to be taken across a continuous circuit. The function of R1 is to see that a continuous direct current path is provided between the bias supply (C) and the grid of the tube. C1 serves to isolate any D.C. component of an A.C. voltage being measured (such as the voltage developed across the primary of an audio transformer). It is, of course, not used when D.C. voltages, such as A.V.C. voltage, are being measured.

When carrying out measurements across a continuous circuit, C1 and R1 may be omitted, as mentioned before, and, under these conditions the input resistance of the V.T.V.M. is at its highest, being that of the tube used. The capacitative shunt effect under these conditions is also very low (that of the tube input) and accurate measurements may be carried out at all frequencies up to 5 or 6 megacycles without appreciable effect on the circuit under measurement.

If it is necessary to measure an R.F. or A.F. voltage where D.C. is also present (as at the plate of an R.F. or A.F. valve) the isolating network will be necessary. Under these conditions "C" must present a negligible impedance to the frequency under discussion, and to avoid unduly loading the circuit under measurement "R" must be made as high as possible. Reference to earlier sections dealing with the proportioning of the grid leak and condenser of an A.F. amplifier will indicate suitable values to be employed for R1 and C1, although, in the interest of accuracy it is advisable to make the resistance reactance ratio of R1 and C1 somewhat higher than the 3 to 1 ratio recommended for amplifier coupling. Suitable values for R.R. work will be 2-3 megohms and 0.002 mfd. while, for A.F., a leak of the same value and a condenser of 0.02—0.05 mfd. will do the job nicely.

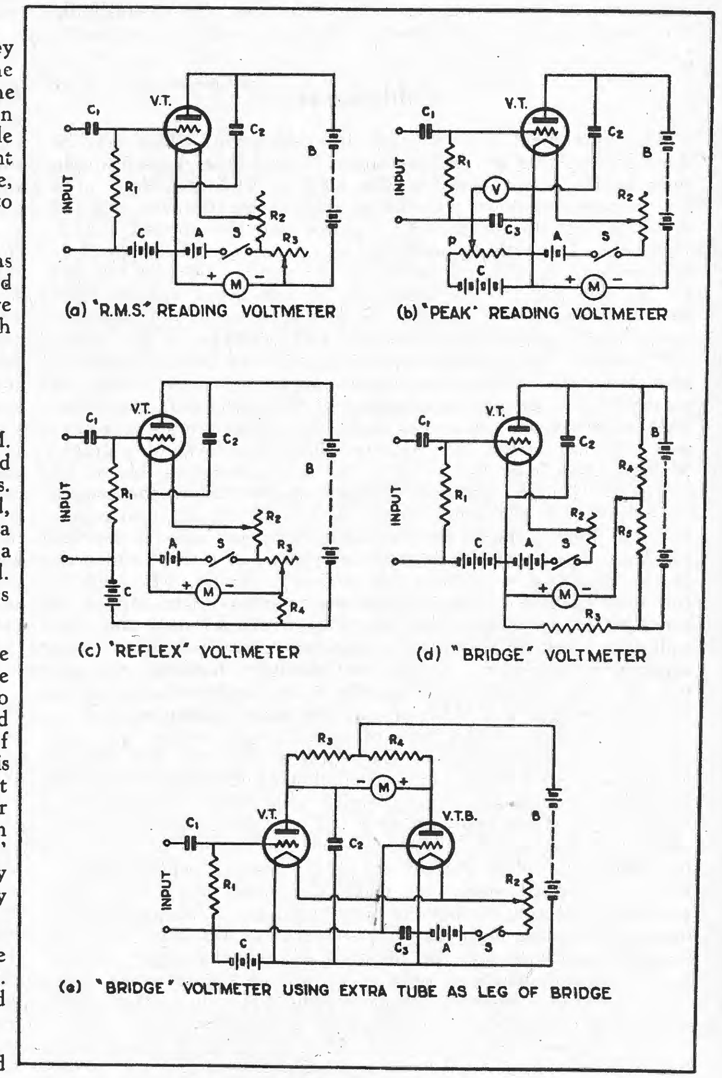

Fig. 10

(Continued on page 202)

VACUUM-TUBE VOLTMETERS—(Continued)—

The procedure for operation of the V.T.V.M. illustrated in fig. 10 (a) is as follows:—

With R1 in position or the grid connected direct to the bias supply, adjust the bias until the meter M indicates that cut-off is nearly reached. The bucking voltage supplied by R3 and the "A" battery should be disconnected from the meter while this is being done. In case "cut-off" is rather difficult to find exactly, adjust the bias until the meter indicates that a plate current is flowing equal to about one-tenth of that which would flow under ordinary class "A" conditions. Theoretically, a plate circuit rectifier of this type should be operated at "cut-off" bias, but, due to the curvature of the tube characterisic, this procedure will result in undue crowding of the calibration at the zero end. For this reason it is better to allow some plate current to flow. However, this "standing" plate current will spoil the zero setting of the meter and it is necessary for it to be "bucked" out if full scale operation of the meter is required. R3 comes into operation here and, after connection, this control is carefully adjusted until the meter reads exactly zero.

Calibration

The instrument is now ready for calibration. This may be done by applying an A.C. voltage (50 cycles) of known amplitude to the input leads of the meter. The secondary of a low voltage step-down transformer with a potentiometer shunted across it will do for the A.C. source and the applied E.M.F. may be read directly by means of an ordinary rectifier type A.C. volt meter. It will, of course, be necessary to adjust C1 and C2 to suit the low-frequency A.C. The input voltage from the transformer may now be varied by means of the potentiometer and corresponding voltages and readings of the meter "M" noted. The adjustments of C and R3 are not to be altered after the initial adjustment, except for an occasional check, by means of R3, on the zero setting of the meter. If the meter (M) is fitted wih an 0-100 scale the voltage input readings and scale indications may be arranged in the form of a graph. Multiplication may be arranged by either shunting M, or by means of a high resistance voltage divider across the source of supply with the input to the V.T.V.M. tapped into a section of known ratio to the whole. Great care is needed for the adoption of either of these systems of multiplication as, in the first case, it is obviously useless to shunt "M" until its full scale reading is greater than the zero-bias plate current of the tube in use. Secondly, the voltage divider used for multiplication must be absolutely non-inductive and free from shunt capacity in any form. Carried out carefully, however, the system is quite effective and enables quite high voltages to be measured with a V.T.V.M. of only low scale reading in itself.

The operation of this type of meter hinges on the fact that the positive half-cycles of the applied R.F. or A.C. signal neutralise portion of the bias, thus allowing the plate current of the tube to increase. The effective scale range of any r.m.s. type V.T.V.M. is approximately 0.7 of the applied bias voltage. In other words, if 10 volts bias is applied to the tube to reduce the plate current to nearly zero, it will require 7 volts of applied signal to make the meter read full scale (assuming, of course, that the meter used has a full-scale deflection equal to the zero bias plate current of the tube in use). Greater sensitivity may be obtained by using a meter with a scale deflection which is only a fraction of the zero-bias plate current. Under these circumstances the full-scale voltage reading will be reduced somewhere near proportionately.

A calibration carried out on A.C., as detailed above, will hold for all frequencies from the calibration frequency up to two or three megacycles with very little error. A constant check on the zero setting "B" supply voltages is essential, however, as any variation of either of these will obviously alter the adjustment of the entire instrument.

"Peak" Type V.T.V. Meter

An alternative type of V.T.V.M. is illustrated in figure 10 (b). This circuit is for a "peak" reading voltmeter of the "slide-back" type. Most of the remarks passed with relation to the r.m.s. type of fig. 10 (a) still hold here, but it will be noted that there are two essential points of difference. The first of these is that no provision is made for bucking voltage on the meter and the second that provision is made for variation of the bias supply. A meter (V) is also provided to enable accurate determination of the bias voltage to be obtained. The condenser C3 is merely an R.F. by-pass for the volt meter.

The preliminary adjustment of this instrument is similar to that of the previous job, in that the bias is regulated until plate current cut-off is nearly reached. The meter setting is left as it is and the bias voltmeter reading carefully noted. Application of a signal to the input terminals will result in the meter "M" swinging over further on the scale, and the bias potentiometer "P" is now adjusted until the reading on "M" returns to its original setting. The voltage indication on "V" is again noted, and the difference between the new bias reading and the original is equal to the peak voltage of the applied signal. In practice "V" is usually arranged so that it only reads on the increase of bias necessary to neutralise the effect of the applied signal. By this means, direct voltage calibrations are obtained and no calculation is necessary.

"Reflex" Type V.T.V. Meter

Another type of V.T.V.M. is shown in fig. 10 (c). This is known as a "reflex" voltmeter, and in the form shown is suitable for reading r.m.s. volts on any A.C. wave. Basically, the circuit is identical with fig. 10 (a) the only difference being the inclusion of a resistance (R4) in series with the return leads of the "B" and "C" supplies. The operation of this resistor is somewhat similar to that of a self-bias resistor and its function is the same, that is, to regulate the bias applied to the tube. When the bias is adjusted to nearly cut-off point, very little current flows through R4 and very little voltage is dropped across it. Consequently the bias applied to the tube is very nearly that of the bias battery alone. With the application of a signal to the valve the plate current rises, and with it, the voltage drop across R4. As a result, more bias is applied to the tube and some of the effect of the signal is neutralised. The net plate current increase is therefore smaller than it would be if R4 were not present, so that a smaller meter indication is obtained for a given applied voltage. The range of the instrument is thus extended considerably and very effective multiplication of the meter scale is obtained. The amount of multiplication is obviously controlled by the value of R4, as the larger this is, the larger the voltage drop for a given current increase. A common arrangement is to shunt R4 by a switch. The circuit then becomes that of 10 (a) when the switch is closed and sensitivity is at a maximum. Usual values for R4 are between 10,000 and 200,000 ohms.

"Bridge" V.T.V.M. Circuits

All of the circuits so far detailed are dependent upon the constancy of the power supply for the permanency of their calibration. Figure 10 (d) shows one method which may be used for partly overcoming this difficulty. Careful analysis of the circuit will show that the plate resistance of the tube, R3, R4 and R5 are arranged in the form of a bridge, with the meter M in the usual indicating position. R3 is given a value equal to the plate resistance of the tube with the bias voltage close to cut-off point. R4 and R5 are given practically any value as long as they are equal, and too much load is not placed on the "B" supply. Under these conditions, balance of the bridge (M indicating zero current) may be reached by a slight adjustment to the bias. Application of a signal to the grid of the tube will cause its plate resistance to change; the bridge will be thrown out of balance and "M" will show a reading. Calibration may be carried out in the same manner as outlined previously for the V.T.V.M. of fig. 10 (a). The advantage of this system is that small variations of the "B" supply voltage have no effect on the setting of M and do not affect the calibration. This, as will be remembered, is a common characteristic of all bridge type measuring devices, and proves very useful in the operation of circuits such as this. The full-scale rating of the meter is a matter for experiment, but it will usually be found that a rating of about one-fifth of the zero bias plate current of the tube will be necessary.

A further advantage of the bridge V.T.V.M. circuit is that no bucking potential for the meter is required. This is evident from the details given above, as true balance of the bridge is only reached when no current is passing through the meter.

(Continued on page 203)

VACUUM TUBE VOLTMETERS—(Continued)—

Another bridge type V.T.V.M. circuit is shown in fig. 10 (e). Quite a number of changes are evident here, the most outstanding being that one resistance leg of the bridge is replaced by another tube (V.T.B.). Common A, B and C supplies are used for this balance tube and the rectifier tube so that, to all intents and purposes, the meter calibration is independent of variations of any of these (within reasonable limits, of course). C3 is a by-pass condenser across the common bias supply and R3, R4, make up the two remaining arms of the bridge. The value of these two resistors may be anything from half the plate resistance of the tubes (with bias near cut-off) to about twice the plate resistance. In practice, balance is obtained by connecting R3 and R4 to the two ends of a small potentiometer (having only a small fraction of the resistance of the two resistance arms) and connecting the "B" supply to the slider. This is necessary, in order to compensate for slight differences in the two tubes. Alternatively, separate bias batteries may be used for the two tubes and balance obtained by a slight variation of the bias applied to V.T.B. As R3 and R4 are equal, balance will be obtained as soon as the two tubes are matched. Variations in plate, filament or bias supply will affect both tubes equally, so that balance is always obtained, unless a signal is applied to the grid of V.T. Under these circumstances the operation of the circuit is the same as that of 10 (d). This type of circuit is particularly suitable for use on A.C. when small fluctuations of line voltage are constantly taking place.

Both of these bridge circuits, as depicted, are suitable for r.m.s. readings. "Peak" voltage readings may be obtained on 10 (d) by adding a potentiometer and voltmeter as in 10 (b). If this is done it is preferable to use a centre-zero type meter for "M" as it is then much easier to note the true balance point and to return to it.

Separate bias supply will be essential in 10 (e) if peak readings are required; the bias on V.T.B. being naturally left at the value required for balance, slide-back operations being carried out on V.T. only.

This brief description covers only a few types of vacuum-tube voltmeters, but should be sufficient to give an insight into the principles of these versatile instruments.

The Cathode-Ray Oscillograph

The cathode-ray oscillograph is an extremely versatile instrument which can be adapted to a wide variety of applications. A few of the more important are the study of wave shapes and transients, measurement of modulation and peak voltages, adjustment of radio receivers, comparison of frequencies, and the indication of balance in bridge circuits. These notes are not intended as a complete treatment of the subject, but will serve as a guide to the general handling and functioning of cathode-ray equipment.

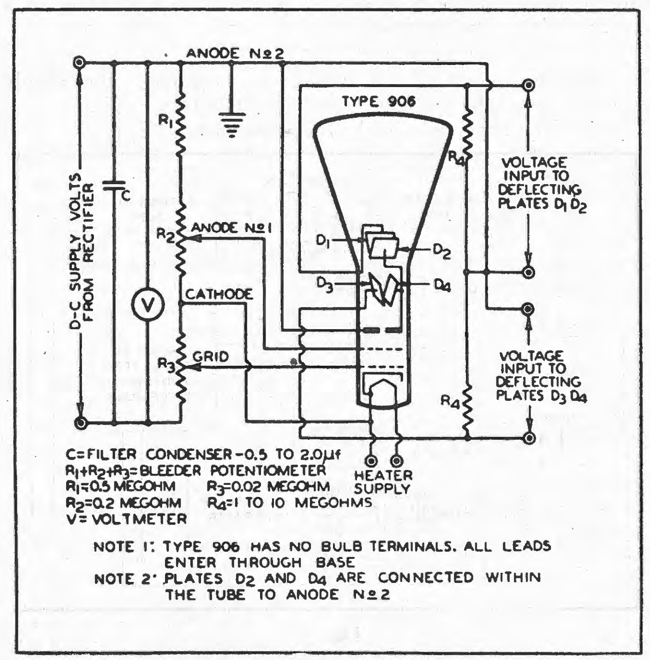

Fig. 11.

An oscillograph circuit (employing the Radiotron 906) is shown in fig. 11. The electrode voltages are obtained from a bleeder circuit connected across the high-voltage supply. A bleeder current of one or two milliamperes is usually satisfactory; considerably larger values may require the use of more filtering than that provided by a single condenser shunted across the d-c supply. With small bleeder currents, a single condenser filter is usually adequate. A variable d-c voltage for the control electrode and for anode No. 1 can be obtained from potentiometers in the bleeder circuit. Some cathode-ray tube types have an additional accelerating electrode; the d-c voltage for this electrode can be taken from another fixed tap on the voltage divider.

Focusing of the fluorescent spot produced by the beam is controlled by adjustment of the ratio of the voltages on anodes No. 2 and No. 1. The focusing is ordinarily accomplished by adjustment of the No. 1 anode voltage.

Regulation of spot size and intensity can be accomplished by the variation of No. 2 anode current and/or voltage. The current to anode No. 2 may be increased by reducing the bias voltage applied to the control electrode (grid No. 1). An increase in the No. 2 anode current increases the size and intensity of the spot. An increase in the voltage applied to anode No. 2 increases the speed of the electrons, which increases spot intensity and decreases spot size. When any of these adjustments are made, consideration should be given to the limiting voltage and power ratings shown in the tabulated data which is available for each tube type.

In applications involving extremely accurate measurements, the No. 2 anode current should be reduced to the minimum value consistent with the desired brilliance of pattern. Where great brilliance is an important consideration, the No. 2 anode voltage may be increased to the maximum rated value. This procedure, however, is not always desirable since the greater electron speed causes reduced deflection sensitivity.

It is important to note that a beam producing a high-intensity spot will burn the fluorescent screen if the spot is allowed to remain stationary. Such operation may even cause excessive heating of the glass with resultant puncture. To prevent this possibility, it is recommended that the beam be kept in motion; it is desirable to apply voltage or current to the deflecting system before the electron stream is permitted to flow. Ordinarily, the brilliancy of the spot is kept low by means of the control-grid voltage, except for periods of use when higher brilliancy is required. The spot may also be prevented from burning the screen by removal of the voltage from anode No. 2.

Deflection of the electron beam may be accomplished by electro-static or electromagnetic means, or by a combination of both. In practice, one deflecting field is controlled by the phenomena under observation; the other may then be used to provide a suitable time sweep. The latter field serves to spread the tracing across the viewing screen.

(Continued on page 204)

CATHODE-RAY OSCILLOGRAPH—(Continued)—

Time-sweep circuits are of various types. The choice of circuit depends upon the type of phenomena under observation as well as upon the type of cathode-ray tube used. For recurrent phenomena, a periodic sweep with a repetition frequency adjustable to a simple multiple relation with the frequency of the phenomena is generally employed. For transient phenomena, a single sweep of the electron beam across the screen is ordinarily desirable; the starting of this sweep is essentially coincident with the starting of the transient and can and may be controlled manually, or automatically by electrical circuits depending upon the application.

A means of synchronising the time-sweep frequency with the frequency of recurrent phenomena is necessary if a stationary pattern is desired. A mechanically-controlled sweep can be used when it is desired to synchronise the sweep with the movement of some mechanical device, such as a rotating condenser.

A sweep which is linear with respect to time (displacement proportional to time) is generally most useful. For some applications, it may be desirable or more convenient to use a non-linear sweep; this may be sinusoidal, logarithmic, or of some other relation with respect to time. The sweep can control the electron beam either electromagnetically or electrostatically, depending upon the type of cathode-ray tube used. One convenient method of obtaining a non-linear time sweep which is suitable for some applications employs an a-c voltage of the desired peak value, obtained from the power line preferably by means of a separate transformer winding so as to isolate the control voltage.

A different method of timing involves the use of a recording film moving at a constant speed, or a system of mirrors rotating at a uniform velocity. Cathode-ray tubes such as the 907 and 908, which have a short-persistence (No. 5 phosphor) screen, are especially designed for use with these latter timing systems. Blurring of the trace does not occur because of the extremely short after-glow or phosphorescence of the No. 5 screen.

A photographic record of many types of phenomena can be made if desired. Such records may be helpful in the study of phenomena and are sometimes necessary for wave-analysis work.

Sweep-Circuit Oscillators

As pointed out previously, it is usually necessary to employ some form of sweep or time base circuit in conjunction with the cathode-ray tube in order to obtain a plot of the magnitude of any A.C. wave with respect to time.

Such a plot or pattern may be conveniently made for recurrent waves by means of a "saw-tooth" oscillator circuit using a type 885 gas-discharge tube in conjunction with a cathode-ray tube.

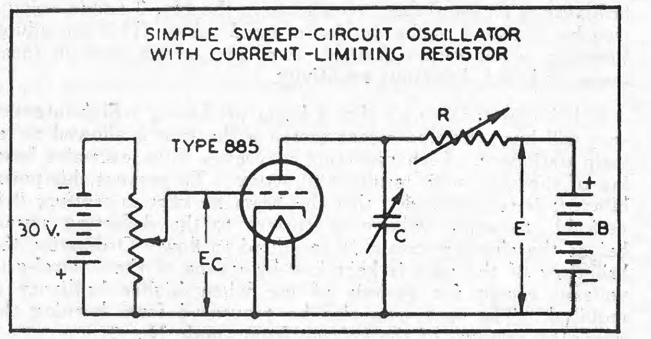

Fig. 12

This is done, as previously mentioned briefly, by means of two fields which deflect the electron beam in the cathode-ray tube. One field is varied according to the magnitude of the wave at any instant; the other field, placed at right angles to the first, is controlled by a varying voltage representing time. The deflection representing time must start at some pre-determined point on the fluorescent screen of the cathode-ray tube, travel across the screen at a uniform rate, and return to begin a new cycle. Since the return period of the beam is not of special interest, is usually non-uniform, and superimposes a second and interfering wave-form on the screen, it should be made as small a proportion of the total sweep-cycle as possible. A return sweep having a relatively short duration makes an almost invisible trace on the viewing screen of a cathode-ray tube. It is an additional convenience to have the sweep-cycle synchronised with the wave-form under observation. These requirements are adequately realised by the use of the 885 in a relaxation-oscillator circuit to provide the time-sweep voltage.

A simple sweep-circuit oscillator is shown in fig. 12. Condenser (C) is charged by battery (B) through resistance (R). The grid-bias voltage (Ec) prevents current flow through the tube until the voltage across the condenser and plate circuit reaches the breakdown value. At this point, the condenser discharges through the tube and loses its potential. As soon as the condenser voltage drops below the ionization potential of the tube, the negative grid attracts any positive ions to itself and drives any electrons to the other tube elements, thus de-ionizing the space between cathode and plate. During the de-ionization period, the discharge current ceases to flow, the grid resumes control, and the condenser starts to recharge for a new cycle.

Cathode-Ray Curve-Tracing Apparatus for Aligning Tuned Circuits

Curve-tracing devices for showing the resonance curves of the intermediate- or radio-frequency stages of broadcast receivers have been developed and a few words concerning their application should be of interest. The curve tracer is particularly useful where the r-f (or i-f) coupling is such that a double-peaked or a flat-topped resonance curve is obtained, since the actual shape of the curve is difficult to determine unless a plot of the curve can be examined. Such a plot is, of course, constantly before the aligner when "visual" equipment is used, so that the effect of coupling or tuning adjustments can be observed during the adjustment process. Some of the advantages of a cathode-ray curve tracer are:

1. The trace is brilliant.
2. Overload does not damage the apparatus, but merely causes the beam to deflect off the screen.
3. The apparatus can be made portable.

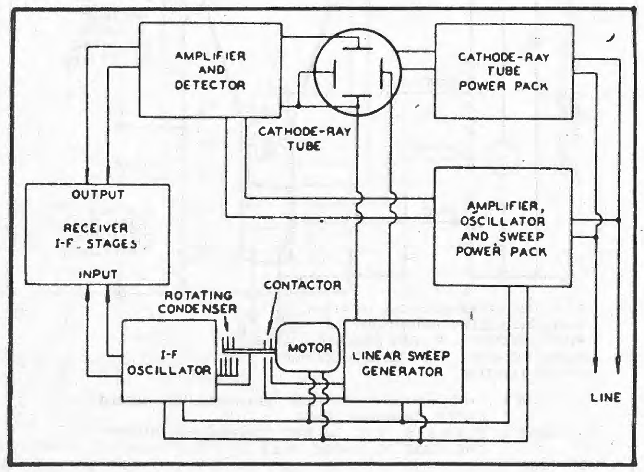

Fig. 13

A resonance curve is a plot of the voltage output of a tuned stage for a given frequency band. To obtain this curve, it is necessary to have a voltage source, and to have a source of variable frequency covering a range which extends above and below the resonant frequency. The frequency variation (to sweep across the frequency range of the tuned circuit) can be accomplished manually by hand manipulation of a condenser, or it can be speeded up by means of a motor. The fluctuating output voltage of the stage is then amplified, rectified, and

(Continued on page 205.)

CATHODE-RAY OSCILLOGRAPH—(Continued)—

again amplified, and finally applied to one set of deflecting plates of a cathode-ray tube. The other set of deflecting plates is supplied with the sweep-frequency voltage. A block schematic of the apparatus used is shown in fig. 13.

Cathode-Ray Tube Terminology

This material is abstracted and adapted from a paper entitled "Cathode-Ray Tube Terminology," by T. B. Perkins (Research and Development Laboratory, R.C.A. Radiotron Division, R.C.A. Manufacturing Company, Inc.). The complete paper appeared in the "Proceedings of the Institute of Radio Engineers," (U.S.A.).

Apparent Line Width: The apparent line width (visible or recorded width of moving spot) can be different from the apparent spot size of the stationary spot because screen luminescence is dependent upon the duration of excitation.

Apparent Spot Size, Apparent Spot Diameter: When the spot size is measured visually or from a photographic record, the resultant spot size is not necessarily the true spot size; therefore, the terms "apparent spot size" and "apparent spot diameter" should be used in such cases.

Beam Current: The current in the electron beam at the screen, usually measured in microamperes.

Beam Voltage: The instantaneous voltage of the electron beam at any point; usually referred to as the voltage of the beam at the point of deflection, where the beam voltage is substantially the same as the second anode voltage.

Candlepower-Distribution Characteristic: The relation which, when plotted, is invariably represented by a polar curve illustrating the luminous intensity of a cathode-ray tube in a plane of the tube axis and with the screen at the origin. This characteristic shows how the candlepower of a luminescent screen varies when the screen is viewed at different angles.

Deflection Sensitivity, Electrostatic: The ratio of the distance which the electron beam moves across the screen to the change in potential difference between the deflection plates; this is usually expressed in millimetres per volt. The sensitivity varies inversely with the beam voltage at the point of deflection.

Deflection Sensitivity, Magnetic: The ratio of the distance which the electron beam moves across the screen to the change in the flux density producing the motion. The sensitivity may be expressed in millimetres per gauss, but due to the difficulty in the determination of flux density, it is often more practical to express the sensitivity in millimetres per ampere-turn, or simply in millimetres per ampere. It varies inversely as the square root of the beam voltage at the point of deflection.

Defocus: A term used to describe a spot which is not optimum with respect to shape and size.

Efficiency, Gun-Current: The ratio of the beam current to the current which leaves the cathode. This ratio, multiplied by 100, gives the gun-current efficiency in per cent.

Efficiency, Screen Actinic: The measure of the ability of a viewing screen to convert the electrical energy of the electron beam to radiation which affects a certain photographic surface. This term should be expressed in microwatts per watt, but is often expressed for ease of measurement in terms of actinic power per watt relative to a screen of well-known characteristics.

Efficiency, Screen Luminous: The measure of the ability of a viewing screen to produce visible radiation from the electrical energy of the electron beam. The efficiency should be measured in lumens per watt. For convenience of measurement, however, it is usually expressed in candlepower per watt, because candlepower is a measure of the luminous flux per unit solid angle in a given direction and can be converted to lumens where the candlepower-distribution characteristic of the screen is known. It is usual practice to measure candlepower in the direction normal to the screen.

Efficiency, Screen Radiant: The measure of the ability of a viewing screen to produce luminescence from the electrical energy of the electron beam. The efficiency should be expressed in microwatts per watt, but due to the difficulty of making absolute measurements is more often expressed in radiant energy per watt relative to some screen of well-known characteristics.

Fluorescence: The luminescence emitted by a phosphor during excitation. As applied to a cathode-ray tube, this term refers to the radiation emitted by the viewing screen during the period of beam excitation.

Line Width: The true width of the moving spot measured at right angles to its direction of motion.

Luminescence: The term describing all forms of visible and near-visible radiation which depart widely from the black-body radiation law. It can be diveded according to the means of excitation into many classes, such as: candoluminescence—the luminescence of incandescent solids; photoluminescence—the luminescence created by exposure to radiation; chemiluminescence—the luminescence created by chemical reactions; electroluminscence—the luminescence given off by ionized gas; bioluminescence—the luminescence emitted by living organisms; triboluminescence—the luminescence created by the disruption of crystals; crystalloluminescence—the luminescence excited by emissions from radioactive materials; galvanoluminescence—the luminescence phenomena observed at electrodes during some electrolyses; cathodoluminescence—the luminescence produced by the impact of electrons, etc. In cathode-ray tubes, cathodoluminescence is principally involved; therefore, the luminescence of the screen is that radiation which is produced by the impact of the electron beam.

Luminescent Spot: The spot formed on the screen of a cathode-ray tube at the impact point of the focused electron beam.

Pattern Distortion: When the electron beam is moved by changing fields, a pattern is formed on the screen; the wave-form of the spot movement will be identical with the resultant waveforms of the electrical phenomena producing these fields unless there is pattern distortion present. This distortion takes many forms, such as: amplitude, frequency, phase, brightness, persistence, spot size, etc.

Persistence Characteristic: The relation showing the brilliance of light emitted by a cathode-ray tube screen as a function of time after excitation. This characteristic is generally shown in a curve where relative brilliance as the ordinate is plotted on a logarithmic scale against time on a linear scale. "Relative brilliance" is used to denote luminous intensity per unit area evaluated in arbitrary units.

Phosphor: The solid material in the screen which produces luminescence when excited by the electron beam.

Phosphorescence: The luminescence emitted after excitation. As applied to a cathode-ray tube, this term refers to the radiation which persists after the electron-beam excitation has ceased.

Spectral Characteristic: The relation between the radiant energy per element of wavelength and each wavelength of the spectrum. It is generally shown in a curve plotted with relative radiant energy against wavelength in angstroms, microns, or millimicrons. "Relative radiant energy" is expressed in arbitrary units of radiant energy.

Spectral Characteristic, Actinic: The relation between the energy per element of wavelength which affects a certain photographic surface, and each wavelength of the spectrum. This is generally shown in a curve plotted with relative actinic energy against wavelength in angstroms, microns, or millimicrons. "Relative actinic energy" is obtained by multiplying the relative radiant energy values (taken from the screen's spectral characteristic) for each wavelength by the relative sensitivity of a given photographic surface at that wavelength.

Spectral Characteristic, Visual: The relation between the luminous energy per element of wavelength and each wavelength of the spectrum. It is generally shown in a curve plotted with relative luminous energy against wavelength in angstroms, microns, or millimicrons. "Relative luminous energy" is obtained by multiplying the relative radiant energy values (taken from the screen's spectral characteristic) for each wavelength by the relative response of the eye at that wavelength.

Spot Diameter: The term used to express the true size of a round spot.

Spot Distortion: A term used to describe the condition of a spot which is not optimum with regard to shape.

Spot Size: The true dimension or dimensions of the spot. Spot size may be measured under various conditions, and is commonly designated by such names as "spot diameter" or "line width." When the spot is stationary its size can be measured in any direction, but is usually determined by its dimensions along the longest and shortest axes.

Radio Laboratory Equipment

NO radio factory is complete without precision measuring equipment, and a description of the various instruments employed in a modern radio laboratory, together with their applications, forms the basis of the following article.

A signal generator of some kind forms the nucleus of any radio laboratory and the first article not only presents a discussion of the principles involved in the construction of such an instrument, but gives practical constructional details and particulars whereby the calibration of the instrument can be carried out.

The article is fully sectionalised, and the radio engineer will find much information in the description of the various units which can be applied to other purposes than that covered by the entire article.

The second article not only covers the use of the standard signal generator in making sensitivity and selectivity tests on a radio receiver, but goes on to describe the application of other instruments such as the beat-frequency oscillator and the vacuum-tube voltmeter, in the testing of various stages of a radio receiver, as well as the determination of fidelity characteristics.

A SIGNAL generator, as its name implies, is an instrument by which a radio-frequency signal, modulated or pure, may be developed. This, as will readily be seen, opens up a very wide field, and, as a result, the term "signal generator" may apply to any form of radio-frequency oscillator.

The most precise instruments of this nature are known as "standard signal generators," and, for the present, we will confine ourselves to a discussion of this class of equipment, and, at the same time, present sufficient constructional details to enable the moderately well-equipped engineer to proceed with the construction of an instrument, which, even if not "standard" in its accuracy will certainly be of far more value than the average "modulated" oscillator.

The design requirements of a standard signal generator are very rigid, for the purpose of this instrument is to provide the means for obtaining quantitative data on the performance of radio-frequency amplifiers and complete receivers.

In order to carry out any accurate experimental work of this nature, it is essential that the generator be capable of developing a steady signal at any predetermined level within wide limits, and, furthermore, retaining this setting over long periods of time. In addition, it is essential that the frequency calibration be absolutely accurate so that a signal may be developed at any required point in the entire range of the communication spectra. Lastly, provision must be made for modulating this signal with any desired audio frequency note, at any percentage of modulation depth used in broadcast transmission, in order to enable satisfactory duplication of receiver working conditions to be obtained.

These are what might be termed "fundamental requirements." In addition, all these settings, and combinations of settings, must be easily reproducible and no appreciable signal should be obtainable from the instrument other than that fed to the apparatus under test through the output leads of the generator.

This latter entails shielding of a very high degree of efficiency, especially when frequencies of the order of 15-20 megacycles are being used.

Constructional Requirements

From the above it will be seen that a standard signal generator consists of four major elements, viz.—

(1) A radio-frequency oscillator capable of delivering a reasonably constant amount of energy at any frequency used in radio communication.

(2) An audio-frequency oscillator with provision for modulating the output of (1) to any desired degree.

(3) A meter whereby an accurate indication of the output of (1) may be obtained.

(4) Some means of subdividing the equalised output of (1) in order to obtain signal amplitudes below the lowest readable indication of (3).

All of these four elements must be separately shielded and constructed in such a way that no uncontrollable coupling exists between them.

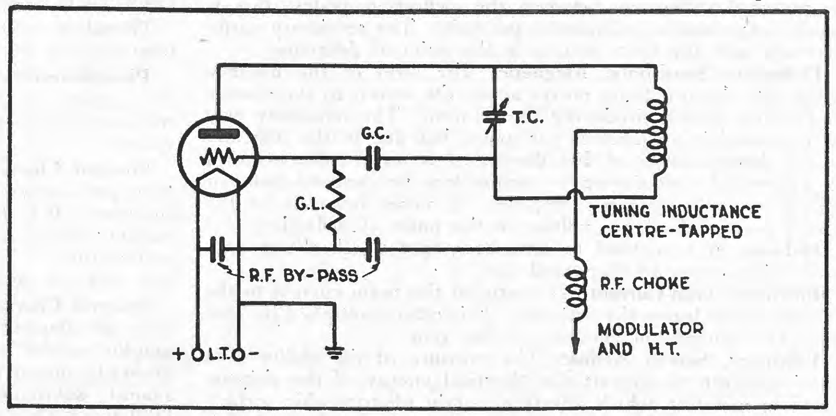

Fig. 1—Modified Colpitts Oscillator circuit for signal generator use.

Radio Frequency Oscillators

The first consideration, that of building a stable R.F. oscillator which will operate over an extremely wide range of frequencies, is comparatively easy to realise, as normal receiver practice teaches the engineer much in this direction. However, there are several points which must be borne in mind in the design of this portion of the equipment, as they have a definite bearing on the ultimate performance and versatility of the completed instrument. Prominent among these is the output range desired. Normal receivers nowadays have absolute sensitivities ranging as high as fractions of a microvolt, but must, at the same time, be capable of accepting signals from powerful locals with amplitudes as high as 500 millivolts. Obviously, then, if we wish to be able to duplicate actual reception conditions, our standard signal generator must be capable of delivering a signal level at least as high as the maximum signal obtainable from a broadcast station under ordinary reception conditions.

Special tests have to be catered for, too, such as A.V.C. tests and single stage gain measurements, so that the completed

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generator should be capable of supplying a modulated signal of one volt at the output terminals. Provision must be made for losses in the measuring and subdivision networks, so that if we arrange the R.F. oscillator to deliver a constant output of one and one-half to two volts on all wave-bands, all contingencies will be taken care of. The question of power output from the oscillator is not of great importance, as unless the subdivision network is very badly designed, no more than ten milliwatts will be required under any circumstances. This is readily obtainable by the use of a triode, such as a type 30, with a high-tension supply of about 90 volts.

Various methods are employed to ensure frequency stability at the oscillator, and most designers prefer some variation of the Colpitts circuit, although a Hartley circuit, with its bias derived from a grid condenser and leak combination, is capable of attaining a very high order of frequency stability. Schematics of two suitable circuits are given in figs. 1 and 2. These circuits will apply whether the radio-frequency output is taken from a coupling coil located near the centre of the tuned coil, or portion of an R.F. pentode is used as an oscillator, and electron coupling is employed.

Variation in the filament and plate voltages to the oscillator, with consequent variation in the tube characteristics can be responsible for quite a considerable amount of frequency drift, and this is one of the main arguments in favour of operating standard signal generators from batteries. This is a moot point, however, and there is much to be said for both sides of the question. All that concerns us at the moment is that if any degree of frequency stability is to be obtained from the oscillator, all supply voltages must be kept absolutely constant. Careful attention to all constants employed is necessary if it is desired to keep the harmonic content of the output within reasonable limits. One way of making sure of this is to keep the bias voltage developed across the grid leak somewhere close to the value set by the tube manufacturers for optimum operation of the tube used as a Class "A" amplifier at the plate voltage employed. The bias voltage developed may be readily determined by means of a vacuum tube voltmeter, or, if one is not available, by a microammeter connected in series with the grid leak.

Frequency Coverage

Having made sure that the oscillator circuit used fulfils the above requirements satisfactorily, the next point to consider is that of frequency coverage. This introduces a new set of problems, as the frequencies used in modern radio practice range from about 25 megacycles to 100 kilocycles. Assuming that a 3-1 frequency ratio is possible with the tuning condenser to be used, it will be seen that five steps will be required to cover the entire range. Providing that a really reliable switch is available, and that adequate

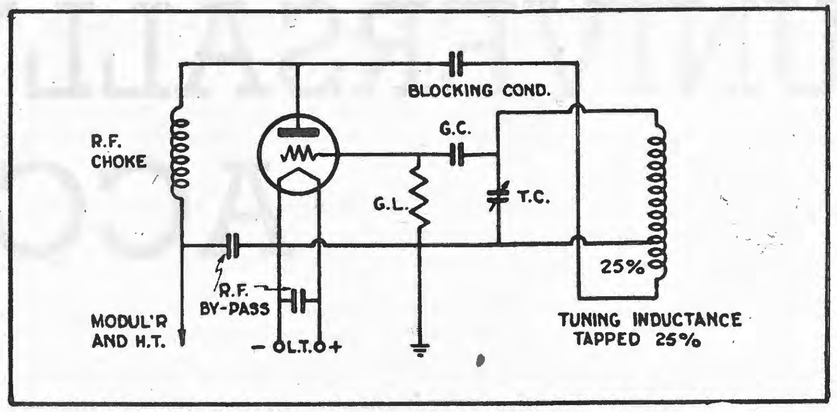

Fig. 2—Modified Hartley Oscillator circuit for signal generator use.

provision is made for individual shielding of each coil, it is quite practicable to build these five coil assemblies into the completed instrument. Plug-in coil units are used in many cases, and opinion is divided as to the relative merits and demerits of each system, with the balance somewhat in favour of plug-in coils.

For work where extreme accuracy is not required, the 3-1 frequency ratio will serve quite well, and, if switching is used, much space will be saved.

However, for accurate research work, there are several drawbacks to the use of a 3-1 ratio, and the better class of instruments use a ratio in the neighbourhood of 2-1.

This is readily explained by a little mental arithmetic, which will soon show the extremely crowded calibration of the dial, especially at high frequencies. The use of a large dial will overcome this to some extent, but even with an eight inch diameter dial (on a standard 180 degree condenser) split into two hundred divisions, each division will be equal to approximately 80 kc/sec. on the highest frequency range. Reducing the frequency ratio to 2-1, and using the same dial cuts this figure down to 60 kc/sec., which is quite a decided improvement. Another method of obtaining great accuracy, with a 3-1 ratio tuning system, is to place a small variable trimmer in parallel with the main tuning condenser. If the capacity of this trimmer is so arranged that its full sweep is equal to one degree variation of the main condenser, the trimmer dial can be calibrated in tenths of a degree and so enable fine tuning adjustments to be made. Great care is required in frequency calibration if this method is employed, as it is obviously essential that the main dial be set exactly at a division mark before any reliable reading can be taken on the trimmer dial.

Reduction of the frequency ratio may be accomplished in several ways. The obvious method is to reduce the capacity of the tuning condenser to a value where the desired range is obtained. This is not always practicable, however, and it becomes necessary to fall back on more or less indirect methods of doing the job. The first of these is to use a centre-tapped Colpitts circuit, as shown in fig. 1, and herein is to be found another reason for the popularity of the Colpitts for this work. Another method is to tap the tuning condenser across portion of the inductance, and yet another is to use a fixed capacity of about twice the maximum tuner capacity in series with the stator plates of the tuning condenser. These two latter methods are familiar to all who have done any work with receivers employing "band-spread" on short waves.

The advantages of having a fairly "open" tuning dial are too obvious to require enumeration here, but chief among them are ease of calibration and the simplification of obtaining selectivity curves.

Another, and less obvious, advantage in the use of a restricted frequency ratio for each band, is the greater ease in maintaining the oscillator output constant throughout the band. This is not absolutely essential, as it is usual to incorporate some means of regulating the oscillator output before measurement. However, most people can only use their two hands when conducting tests on apparatus, and, if it is at all possible to keep the oscillator output constant throughout the band in use, there is one knob less to worry about. Whereas it is a comparatively simple procedure to stabilise an oscillator over a frequency ratio of 2-1, it is quite a lot more than fifty per cent. extra trouble to do the same thing over a band fifty per cent. wider.

The only other point to consider with relation to the radio-frequency oscillator is that of power supply when the completed instrument is driven from A.C. Apart from questions of regulation and consequent frequency drift, very particular attention must be paid to filtration, both of the R.F. and A.C. ripple types. It must be borne in mind that, as the receiver under test is running off the same lines, there is a definite coupling link between the generator and the set. As long as this link only carries A.C. no trouble will be experienced, but great precautions must be taken to preclude any possibility of any R.F. leakage from the generator through this channel. It is also absolutely essential that only pure

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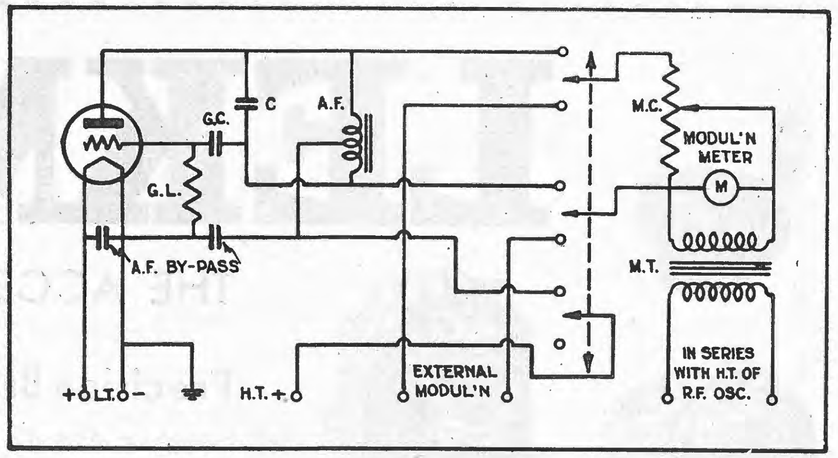

Fig. 3—Complete Modulation System for signal generator use.

D.C. is supplied to the oscillator plate, as any trace of ripple will appear as modulation in the final output, with a resultant inaccuracy of calibration, particularly at the lower signal levels.

Having covered the various points in the design and construction of the R.F. oscillator section, we can now go on and deal with the provision for modulating the radio frequency signal with any desired percentage of audio-frequency.

Audio Frequency Oscillators

The standard specifications for obtaining the sensitivity of a radio receiver call for the development of an audio frequency output of 50 milliwatts in a non-inductive resistor connected at the output terminals of the receiver, this resistor to have a value equal to the rated load of the power tube for optimum performance.

Obviously, from this, a plain R.F. oscillator is of no use for measurements of this kind, and so provision must be made for modulating the radio frequency signal with an audio-frequency component. In order to still further standardise matters, the specifications set down that this modulation shall be 30% of the R.M.S. R.F. signal amplitude and that its frequency be 400 cycles.

This is accomplished by incorporating an audio frequency oscillator, tuned to 400 cycles, into the generator and coupling it to the R.F. oscillator in such a way as to accomplish the desired modulation of the R.F. signal. It is usual to make the A.F. oscillator sufficiently powerful to enable almost complete modulation of the R.F. signal to be effected, as it is often necessary to observe the performance of a demodulator (detector) in a receiver under conditions widely divergent from those applying under standard test conditions (30% modulation). In addition, it is desirable to make provision for modulating the R.F. signal with different audio frequencies in order to obtain data on the overall fidelity of a completed receiver. To do this, it is necessary that the internal (400 cycle) modulation be cut out and terminals be provided for the connection of an external source of modulation, such as a beat-frequency oscillator. A change-over switch may be provided for this operation, and a typical modulator circuit, with switching, is shown in Fig. 3.

The transformer indicated in the circuit as MT has a ratio of 1-1 and its response characteristic must be such that all frequencies it is desired to modulate may be passed without discrimination. The tapped choke, marked AF, is actually portion of the oscillatory circuit associated with the modulator valve, and, together with the condenser "C" must tune to 400 cycles. Suitable values for these two components are:—

A.F. = Centre tapped 30 henry choke
C. = Moulded mica 0.02 microfarad Condenser

These values may require slight alteration if exactly 400 cycles is required, but, as the copper-oxide type of output meter usually used is fairly flat in its response, a few cycles either side is not important. The meter shown in Fig. 3 must be of the high resistance type, suitable for use on audio-frequencies, and should have a full scale deflection equal to the maximum voltage output from the R.F. oscillator, usually about 2 volts.

This meter may be calibrated directly in modulation percentage readings when the instrument has been finally adjusted, and is of great assistance in conducting detector overload and overall fidelity-tests. This calibration will not be absolutely accurate under all conditions, but will serve as a useful guide for most purposes.

The amount of audio frequency voltage developed across the secondary of M.T. is controlled by the potentiometer M.C., which has a total resistance of about 25,000 ohms. This operates on both internal and external modulation and enables complete control of the modulation percentage to be effected.

Modulation of the R.F. oscillator, in the circuit shown, is accomplished by connecting the secondary of M.T. in series with the high-tension supply to the R.F. oscillator. The fluctuating A.F. voltage across the winding is then in series with the high-tension voltage and modulation is effected by the resultant variation in plate current in the R.F. oscillator. The generated frequency of the R.F. oscillator is affected somewhat by this procedure, but at low modulation percentages the drift is not great enough to affect the overall calibration to any appreciable extent.

Measuring Oscillator Output

The next problem in the design and construction of a standard signal generator is that of providing a level indicator and compensating control whereby the R.F. input to the subdivision network may be kept constant or varied within predetermined limits. This may be accomplished in a number of different ways, and the particular method used depends to a large extent on the apparatus and calibration facilities available to the designer.

The main essential to consider is that the indicating meter must be absolutely free from frequency discrimination, as any error in this direction will result in serious inaccuracies in the final calibration of the instrument. The compensating control, or carrier control as it is usually termed, is not quite so critical in this respect, as it is connected between the output of the oscillator and the indicating meter.

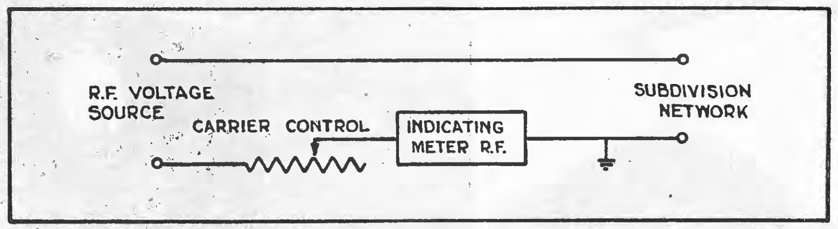

Fig. 4—Series Carrier Control and Meter Connection.

Two typical circuits for carrier control and R.F. output measurements are shown in Figs. 4 and 5. The first of these is the series method, and has the carrier control, indicating meter and subdivision network connected in series across the R.F. voltage source. The carrier control in this case takes the form of a non-inductive rheostat with a resistance value of about 250 ohms. The indicating meter is then wired in series, and has an effective resistance of about 50 ohms. The sub-division network is then connected between the free side of the meter and the R.F. voltage source.

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RADIO LABORATORY EQUIPMENT—(Continued)—

For all usual purposes, we can assume an input impedance to the sub-division network of 150 ohms. From this it will be seen that, if the maximum output required from the generator is one volt, the meter will need to have a full scale deflection of 350 millivolts (R.M.S.) at least, and preferably a little more. The actual scale indications should, however, be changed to show the voltage that is being developed across the subdivision network. Further details of this procedure will be given later under the heading of "Calibration." Extra voltage, above the total required here, is necessary in order to allow some latitude in the setting of the carrier control, so that our original figure of 1.5-2 volts output from the oscillator will be in order. The power required from the oscillator under these circumstances will be approximately 10 milliwatts if the lower voltage is used and 13.5 milliwatts if 2 volts is developed at the R.F. voltage source.

This system has been found very satisfactory in practice and several reputable manufacturers have adopted it for use in their equipment.

An alternative system is shown schematically in Fig. 5 and is typical of the shunt method of connection. In this system the carrier control, indicating meter and subdivision network, are connected in parallel and across the R.F. voltage source. Obviously, less voltage is required from the oscillator with an arrangement such as this, and if provision is made for an R.F. supply of 1.25 volts all contingencies will be taken care of.

It is, however, desirable that the carrier control present a constant impedance to its associated input and output circuits, and some arrangement such as that shown in Fig. 5 is necessary. The carrier control, in this circuit, takes the form of a modified "T" pad with a rheostat arm of 150 ohms, and a potentiometer arm of twice that value, both non-inductive. These two should be ganged together and completely shielded, both from each other and the remainder of the equipment, if satisfactory control is desired on the higher frequencies.

As the meter is shunted across the subdivision network, it should place no appreciable load on the system, and should be of the high resistance type. In this circuit the meter must indicate the full R.M.S. value of the R.F. voltage supply and less sensitivity will be required than in the circuit of Fig. 4. A full scale rating of a little over one volt will be quite in order. This is a decided advantage, as it allows of the use of a more robust meter assembly and also allows an appreciable saving in initial cost to be made.

The subdivision network may also have a higher input impedance than that required for the system of Fig. 4, and a value of 300 ohms is usually found to be quite satisfactory.

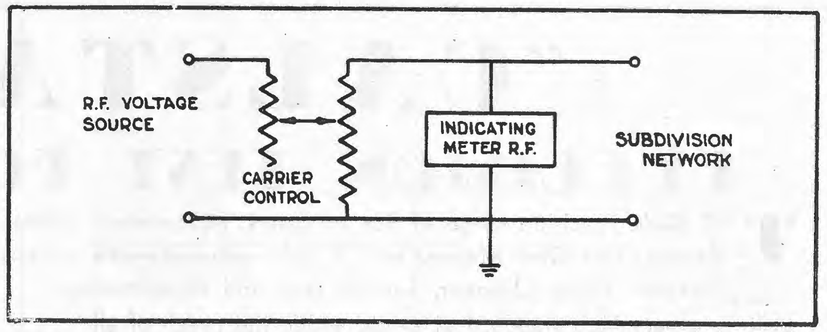

Fig. 5—Shunt method of Carrier control and meter connection.

A little calculation will show that the resultant input impedance presented to the R.F. voltage source will be in the neighbourhood of 150 ohms, and, as the maximum voltage from this source need not exceed 1.25 volts, the power required will be approximately 10 milliwatts for an output of one volt at the terminals of the generator.

Indicating Instruments

Two types of meter are available for use as indicating instruments which satisfy the requirements specified for the two circuits detailed above. The first of these is a thermocouple type milliammeter, either self-heating or indirectly heated.

The self-heating type is usually of higher resistance than the indirectly heated type and is thus more suitable for use in the circuit of Fig. 5. As the full scale deflection required from the meter in this circuit is one volt, no difficulty should be experienced in obtaining a suitable instrument.

The indirectly heated instrument fulfils the requirements of Fig. 4 admirably, as it is desirable to use a low resistance instrument in the position indicated. Actually, no insuperable difficulty exists in the use of a high resistance instrument in the series circuit, but a little thought will soon show that as the meter resistance is increased, so will the voltage from the R.F. source have to be increased, and, in addition, the power required goes up proportionately.

Another point that must be considered in this connection, is that, while it is perfectly practicable to develop as much as four or five volts, with 20 or 30 milliwatts of available power, at the R.F. coupling coil, it is much more difficult to effectively screen a circuit developing this much energy and so prevent stray fields and leakage.

The second type of indicating instrument available is that old standby, the vacuum-tube voltmeter. Several very distinct advantages are found in the use of this type of meter, and also some quite definite disadvantages.

The main advantage is its versatility. Firstly, it can be arranged to have a practically infinite input resistance, which is ideal for a circuit such as Fig. 5, and at the same time, equally accurate indications may be obtained when readings are taken across a shunt resistance of a few ohms, as would apply in Fig. 4.

The next advantage is that of economy. In this country at least, a reliable thermocouple milliammeter is quite an expensive proposition, and a very accurate vacuum-tube voltmeter may be built for a fraction of the cost of the self-contained instrument.

The disadvantages may be classified under two headings. The first of these is the difficulty of obtaining a perfectly flat response over a very wide range of frequencies, such as must be considered when dealing with a modern standard signal generator covering all communication spectra. Various factors, such as input capacitance to the tube used, and

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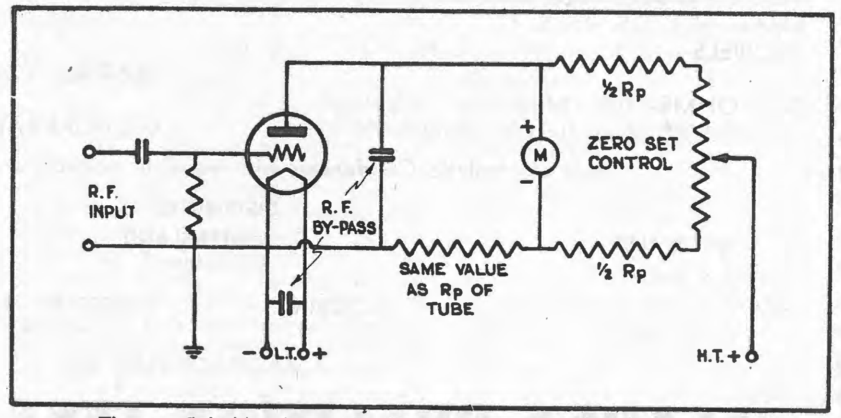

Fig. 6—Suitable V.T.V.M. Circuit for use in signal generator.

stray capacities due to the extra wiring necessary, are responsible for this frequency discrimination, and, while they may be minimised by careful choice of the tube used, and debasing it, together with careful attention to wiring, some error will still exist on the higher frequencies.

The remaining consideration with regard to the use of a vacuum tube voltmeter is its dependence for its accuracy on the voltage supply to the tube and the ageing characteristics of the tube employed. These may also be minimised by careful design, but a difficulty still exists in that no tube lasts forever, and some day the tube will have to be replaced, with a resultant upset of the original calibration. This may be painting the picture a trifle blackly, but it is for the individual designer to decide whether the merits outweigh the demerits and vice versa. We are merely endeavouring to present both sides of the question for consideration.

For the guidance of those who desire to use the vacuum-tube voltmeter method of measurement, a schematic circuit diagram is shown in Fig. 6 which has been designed with the above points in mind. The circuit is of the bridge type, three legs being provided by resistances, and the fourth by the plate resistance of the tube. Although no definite constants are shown, the ratios given for the resistances in the plate circuit should be adhered to. As the operation of the circuit hinges upon the variation of the plate resistance of the tube when a signal is applied, the grid leak and condenser should have the values usually used for rectification, that is, about two or three megohms and 500—1,000 mmfd. respectively.

The Subdivision Network

Although we have left the subdivision network last on our list, it is by no means the least important, as the value of the completed signal generator as a tool is dependent to a very large extent on the characteristics of this portion of the assembly.

The subdivision network, or attenuator, as it is generaly known, is essentially a constant impedance potential divider. Throughout the preceding paragraphs we have detailed the provisions necessary to ensure obtaining a modulated R.F. output of one volt, and, although it would be perfectly feasible to reduce this to a tenth of that value by means of the carrier control and still obtain accurate indications on the level meter, modern radio technique calls for signal levels of the order of a microvolt and less. The function of the attenuator, then, is to subdivide the compensated and measured output of the oscillator into any desired fraction of the total.

The subdivision network as a whole, is usually made up of two units, one of which is known as a slide-wire, and the other as a multiplier or the attenuator proper.

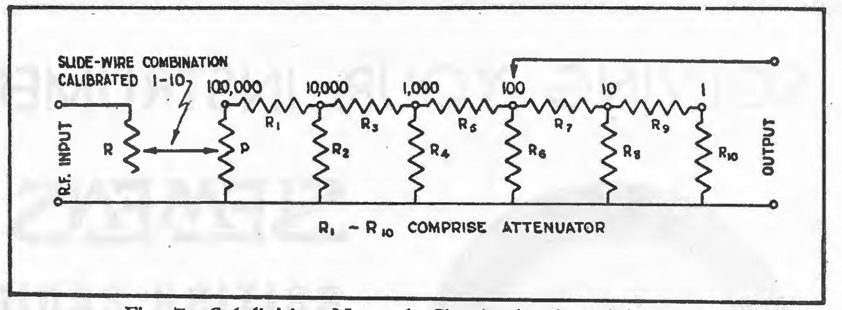

Fig. 7—Subdivision Network Circuit showing slide wire and attenuator.

The slide-wire is basically a constant impedance potentiometer, and serves to divide the voltage input to the subdivision network into convenient fractions, usually tenths.

In this case it is provided with a dial which is calibrated from one to ten.

The multiplier, or attenuator, serves to still further divide the output from the slide wire into further fractions and is usually arranged to provide progressive reductions in tenths. Thus, in the example we have been treating so far, where the maximum output is a volt and the minimum is a microvolt, the progressive steps would be tenths, hundredths, thousandths, tenths of thousandths and hundredths of thousandths.

It will readily be seen that with these steps and the slide wire calibrated as above any fraction of the original output from a millionth (one microvolt) to the total output available may be obtained.

Calculation of Attenuator Constants

This system is illustrated diagrammatically in Fig. 7 and while no constants are given, the procedure for calculating them is quite simple.

We have already specified that the input impedance for a series network shall be somewhere in the neighbourhood of 150 ohms, and it follows from this that the rheostat arm of the slide wire combination should have a total resistance of that value.

The value of the potentiometer arm is not quite so easily arrived at, but it is only necessary to remember that R_1 and R_2 of the attenuator net-work are in parallel with it, and must be considered when arriving at the potentiometer resistance. Usual values for R_1 and R_2 will total somewhere in the vicinity of 300 ohms, and so it will be seen that, in order to present an impedance of 150 ohms to the R.F. voltage source, P must have a value of approximately 300 ohms as well.

To calculate the remainder of the resistance values we must start at the other end of the network and work back.

Most standard signal generators have an impedance of 10 ohms at the output terminals, and retain this impedance up to signal levels of 10,000 microvolts or so. This means that R_4, R_6, R_8, and R_{10} should all have an effective value of 10 ohms.

Bearing this in mind, we can set the value of R_{10} at 10 ohms and work from that. As the attenuator is to be calibrated in decade steps (reductions to a tenth each time) we can treat R_9 and R_{10} as two sections of a voltage divider. Mental arithmetic will show that R_9 should have a resistance of 90 ohms in order to give the desired reduction. The effects of current are negligible and need not be considered.

A slightly different problem is presented in the case of R_8. Here we have a similar case to that experienced in calculating the value of P in the slide-wire combination. R_8 must have an effective resistance of 10 ohms, and knowing that R_9 and R_{10} total 100 ohms, simple mathematics show us that

$$10 = \frac{R_8 \times 100}{R_8 + 100}$$

Transposed

$$R_8 = \frac{100 \times 10}{100 - 10} = 11.11 \text{ ohms}$$

From then on the procedure follows the same rules, bearing in mind the fact that each series resistor forms a voltage divider with the shunt resistance immediately on its right, until we reach R_2.

A somewhat higher output impedance is desirable here, as the minimum voltage obtainable from this tap is 0.01 volt, and in addition, it is required to keep the shunt resistance across P as high as possible. With these factors in view, we can set the value of R_2 at 25 ohms, and calculate R_1 accordingly.

If a shunt network is used instead of the series network used as a basis for the above calculations, it will be necessary to increase the values of both "R" and "P" in the slide-wire combination. In order to attain an input impedance of 300 ohms to the entire sub-division network, "R" and "P" must have values of 300 and 600 ohms respectively. The shunt resistance of the attenuator proper must also be increased proportionally, and to do this satisfactorily it will be necessary to increase the value of R_4 as well

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as R_2. An increase of R_4 to 25 ohms and R_2 to 60 ohms, with proportionate alterations to R_3 and R_1 will do the job nicely and result in a smooth increase of resistance without any sudden jumps.

It is needless to say that all of these resistances should be as nearly non-inductive as it is possible to make them. Several methods of accomplishing this are possible, but one of the simplest is to wind the units on mica cards about a quarter of an inch wide and as thin as is consistent with mechanical rigidity. The wire used may be 40 g. B. & S. Eureka, double silk covered.

Great care is necessary in shielding the separate steps of the attenuator and the complete unit, and a very satisfactory procedure, is to divide the steps into two banks, each shielded from the other. By placing the steps 1 to 100 in one compartment and 1000 to 100,000 in another, the effects of stray coupling from the high voltage tapping are minimised. The controls for the two sections are of course ganged together in such a manner that the six steps are consecutive.

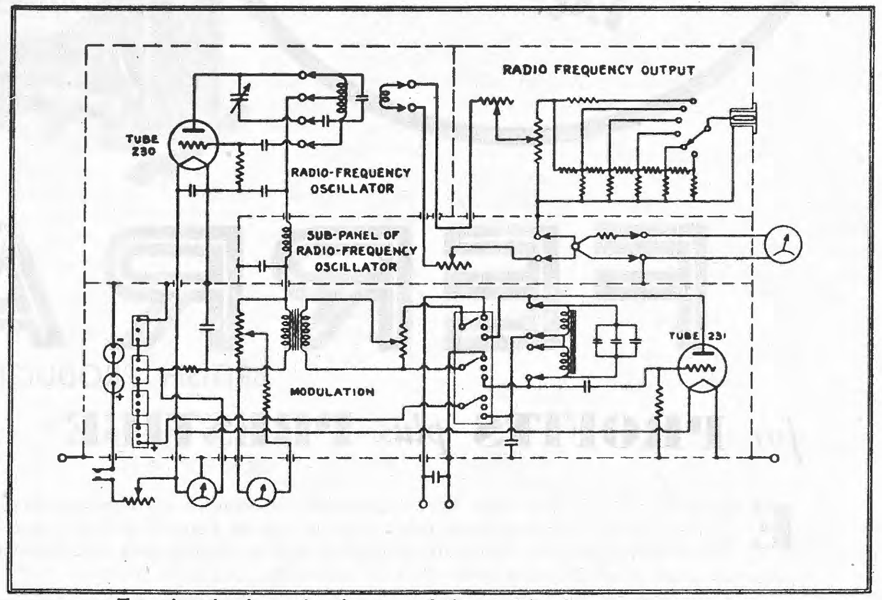
The same precautions are necessary in the assembly and shielding of the slide wire combination as were observed in the construction of the carrier control, with the additional proviso that, as the dial is to be calibrated, it must be very securely locked to the spindle to prevent any slipping.

General Assembly Details of Signal Generator

For the benefit of those who contemplate building up a complete instrument of this nature, a complete circuit diagram of a well-known standard signal generator is shown in fig. 8, and will serve as a guide to the assembly of the various units. Most of the constructional precautions which must be exercised have already been dealt with under the various section headings and need not be repeated.

Too much emphasis cannot be laid on the necessity for complete shielding in an instrument of this description, and, in this connection, a few words relative to the method of assembling the various components, and earthing low potential portions of the circuit, will be in order.

It will usually be found that the most effective screening will be obtained by assembling each individual unit of the signal generator in a separate box. No circuit grounds should be made to this box, and the boxes themselves should be earthed to one point on the instrument case. The circuit should be wired up as though no grounds were possible at any point, that is, with insulated wire for all ground potential leads, and earthing made at one point only. This point should be as near as possible to the earthing point for the screening boxes, and should be at the place where the output leads emerge from the instrument. By this means it is possible to avoid the setting up of any current flow in the screens themselves and direct radiation will be, to a very large extent, avoided. In addition, inter-circuit coupling will be minimised, and greater control over individual unit characteristics may be exercised.



Functional schematic diagram of General Radio signal generator. This circuit is typical of the best in standard signal generator design, as there are probably more of this company's instruments used for radio engineering than any other.

It is almost unnecessary to say that all power supply components, whether battery or mains, must be built into the same case as the instrument, and should be just as completely shielded.

Calibration

The calibration of the completed instrument is quite the most important phase of the entire treatment when dealing with signal generators if any semblance of "standard" performance is to be realised.

Such matters as leakage oscillator stabilisation and permanence of control settings come under the classification of "construction," and must be attended to before calibration of any kind is attempted. Also under this heading comes the "calibration" of the attenuator proper; as the ratios of attenuation at each step are dependent entirely upon the care expended on the construction of the resistors used and the shielding which is employed. Methods have been devised for the accurate calibration of attenuators, but the procedure is somewhat beyond the facilities available to most technicians.

Attenuator Calibration

If accurate calibration of the attenuator is required it will be necessary to make arrangements with some laboratory well equipped with precision instruments to do the job. If, however, an approximate check only is required, quite a reasonable job can be done with the aid of a modulated R.F. oscillator, a sensitive receiver without A.V.C. and which uses a linear demodulator such as a diode, and an ordinary output meter. It will be necessary to arrange the oscillator so that no trace of signal from it can be picked up on the receiver unless the two are connected. The attenuator to be tested is connected between the oscillator and the receiver in the same manner as it would be in the completed generator. Be careful to see that the receiver volume control is adjusted to a point where no possibility of overload exists, and adjust the attenuator to its maximum setting. A slight readjustment of the receiver volume control will ensure that the indication shown by the output meter is at a point which is easily dividable.

Reduction of the attenuator setting by one step should then result in the indication shown by the output meter dropping to a tenth of its former value. The output of the oscillator should then be

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SIGNAL GENERATOR—(Continued)—

increased until the output meter indication returns to its former value, or, if this is impracticable, the receiver volume control setting can be increased until the same result is achieved. The attenuator setting can then be reduced by another step, with a similar result to that obtained previously if all is in order. This procedure can then be repeated until all of the steps of the attenuator are checked. From an accuracy viewpoint, there is much to be said against this method of attenuator ratio testing, but, as long as the precautions detailed with regard to the oscillator and receiver are observed, the results achieved will be quite accurate enough to provide a useful check against the resistances and shielding employed in the construction of the attenuator. In any case, it is the only handy method available to most technicians and, as such, justifies its description.

The R.F. Level Meter

The calibration of this instrument is most important, as even a slight error here will offset any efforts made to ensure accurate calibration elsewhere in the instrument.

If a completely calibrated meter is purchased, be careful to ascertain its correct radio-frequency resistance before proceeding with the construction of either the slide-wire or attenuator. This applies particularly to a "series network," as detailed above, for it is quite evident that the actual proportion of voltage developed across the input to the subdivision network depends entirely on the resistance of the meter in this circuit. Once this is known, however, the resistance ratio required to give one volt across the subdivision network can easily be determined.

If a vacuum-tube voltmeter is built for the job it will be necessary to calibrate it against a standard instrument while it is actually connected up into the generator, in the same manner as it will eventually be used. The input resistance does not matter greatly here, as in a "shunt network" this will be the input resistance of the tube used and will not affect matters greatly. In a "series network" it will be necessary to shunt a resistance of the required value across the input to the V.T.V.M., and, as this can be wound to any required value it is better to make the slide-wire and attenuator first and adjust the meter shunt resistor and meter calibration to suit them, as they are by far the most difficult to make and alter if it is necessary to make any adjustments.

The Slide Wire

This may be calibrated by means of an accurately calibrated vacuum-tube voltmeter and an R.F. oscillator capable of delivering about one volt of R.F. energy. The slide-wire must be set up, with the attenuator connected to it, exactly as it would be in the completed generator. The R.F. level meter used in the generator can be used at the input side to keep a check on the R.F. voltage being fed to the slide-wire. The R.F. oscillator in the generator will serve as the source of R.F. energy. The calibrated vacuum-tube voltmeter (which should be of the R.M.S. voltage indicating type) is connected across the potentiometer winding of the slide-wire, i.e., across the input to the attenuator proper. With the slide-wire set at its maximum position the reading on this meter should be the same as that on the R.F. input meter. If it is not, check over the rheostat and potentiometer arms of the slide-wire carefully, as a voltage difference at this point, with the control at its maximum setting, indicates that some source of R.F. loss exists in the circuit and the most likely cause of this will be an "above zero resistance" setting on one of the legs of the slide-wire combination.

At this point it will be as well to refer once more to the shunt resistor used with a vacuum tube voltmeter in a series network. Providing that no R.F. losses exist between this resistance and the vacuum tube voltmeter used for calibrating the slide-wire, it is quite evident that the **actual** indication shown by the R.F. level meter does not matter greatly. What really matters is the fact that this reading, whatever it is, shows that **the voltage indicated by the calibrating voltmeter is being developed across the input to the subdivision network.** If a calibrated R.F. level meter is being used it is, of course, desirable that the resistance proportioning should be changed to bring the meter indication to the correct point, but if the meter is uncalibrated or has a scale which is known, will have to be changed in any case, this will not be necessary. In this case, it will only be necessary to adjust the R.F. input until one volt is indicated by the calibrated voltmeter and use the corresponding indication on the R.F. level meter as the one volt mark.

This procedure can also be followed if an error is made in resistance proportioning when using a thermo-couple meter with a fixed input resistance, for it will be far less trouble to have the meter scale altered than to rebuild almost the entire subdivision network.

Having ensured, by the above means, that the indications shown by the R.F. level meter and the calibrating voltmeter are properly co-ordinated, the actual calibration of the slide-wire can be proceeded with. This calibration should preferably be carried out with the correct voltage input to the slide-wire, i.e., one volt, and at a frequency somewhere near the centre of the broadcast band (.1000 Kc/sec.).

The slide-wire control is steadily rotated towards the minimum setting and the position of the dial carefully noted for each tenth of a volt reduction. The R.F. input to the slide-wire must, of course, be kept constant at one volt.

As a result of this, ten positions of the slide-wire dial will be found where the voltage delivered to the attenuator proper is progressively one-tenth of the total voltage less than the previous setting. Actually these positions will be 1.0, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2 and 0.1 volt respectively. However, for purposes of simplification in reading the actual output from the completed generator it is better to mark the dial as a **multiplier** instead of a **divider** and make the calibration points 10, 9, 8, 7, etc. The slide-wire indication may then be read off directly as a multiple of the particular attenuator setting in use at any time. For example, if the attenuator used has a maximum attenuation ratio of 100,000 and it is supplied with one volt of R.F. input, the lowest setting will deliver 10 microvolts. In this case it would be necessary to make each attenuator step as delivering an output ten times higher than those shown in fig. 7. The slide-wire could be calibrated in fractions so as to indicate reductions to a tenth of these values, but it is obviously much simpler to make the whole combination read directly by marking the attenuator as shown in fig. 7, and the slide-wire dial from one to ten. One microvolt is thus obtained by setting both the attenuator and slide-wire controls at "one." Two microvolts will be delivered at the output when the attenuator is at "one" and the slide-wire at "two," and so on. Ten microvolts can be obtained by two combinations of the dials, i.e., with the attenuator at "one" and the slide-wire at "ten" or vice versa. This applies to all of the attenuator settings. It is advisable to calibrate the slide-wire dial with intermediate settings, and if the dial is divided into 100 divisions it will be possible to obtain intermediate outputs between the decade steps very easily. Eleven microvolts, for instance, would be obtained with the attenuator set at "ten" and the slide-wire at 1.1.

While calibrating the slide-wire dial it will be as well to check for frequency discrimination by going over the calibration at, say, 200 Kc/sec. and 5 or 6 megacycles. If the resistors used have been made truly non-inductive and all shielding is in order, the settings at these frequencies should be identical with those obtained at 1000 Kc/sec. If they are not identical, but are reasonably close, a note can be made of the percentage difference and used as a correction factor later on, when the generator is in service. Should the error be great it will be necessary to go over all shielding very carefully and in addition check over the construction of the various "non-inductive" resistances. Probable faults in the latter will be found in the use of terminating connections which are too large (thus giving rise to capacity leakage across the resistor, especially at the higher frequencies) and too close spacing of the turns of wire used in the actual resistive element itself.

Frequency Calibration

Although reference has already been made to the frequencies used for calibration purposes, this was not intended as an indication that complete frequency calibration of the generator should be

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carried out before proceeding with the adjustment and calibration of the subdivision network. The frequencies given were merely intended to serve as a guide to suitable checking positions for the output calibrations. Actually, the frequency calibration of the generator should be left until all adjustments concerning the subdivision network have been completely finalised, as there is always a possibility that a variation of the load imposed by the subdivision network on the oscillator will vary the developed frequency slightly.

Frequency calibration is preferably carried out by reference to a standard, although quite reasonable accuracy may be obtained by reference to station heterodynes and harmonics. Calibration curves for frequency should be made on a large scale, as it is obviously useless to plot a curve which cannot be read to at least the same degree of accuracy as the tuning dial itself.

Modulation Percentage Calibration

The only remaining factor to consider is that of modulation percentage calibration. A meter is provided (in the design outlined) which will serve as an accurate indication of the modulation effected by any audio frequency, but only at the carrier frequency used when the instrument is calibrated. As the carrier frequency is shifted, even though the audio input remains constant, errors will be introduced, which, although not serious at low modulation percentages, will necessitate the use of some other means of modulation percentage calibration at high modulation levels if sufficient accuracy is required to make the indications of any value for the correlation of performance data.

This inaccuracy is due to the fact that the conditions under which the R.F. oscillator operates change with frequency, and, consequently its output also. Even though the oscillator is fairly well stabilised and its output is maintained constant within a few per cent., the error will still be there as it is fairly obvious that a fixed amount of A.F. energy cannot possibly modulate different amounts of R.F. to the same extent, no matter how small the difference is.

However, the problem is not so serious that it calls for the use of a more elaborate modulation percentage meter as it is possible to make use of the R.F. level meter for the purpose.

It is a matter of common knowledge that the average amplitude of a modulated wave increases as the depth of modulation is increased. This increase in amplitude is by no means directly proportional to the increase of modulation depth, and is scarcely measurable at low modulation percentages. For percentages over about 40, however, an appreciable increase will be noted, and will take the form of an increased indication on the R.M.S. type R.F. level meter used in the signal generator. Actually, the one volt indication on the R.F. level indicator will increase by about 30%, when the carrier is modulated 100%. This increase is independent of frequency and may be accepted as an accurate indication of the modulation percentage under all conditions (providing the modulation depth is over 40%) once calibration has been effected.

From this it can be seen that all modulation depths up to 100% can be covered by the two meters already on the instrument, as the accuracy of the modulation meter proper is quite sufficient for low percentage modulation, assuming, of course, that some degree of stabilisation of the R.F. oscillator output has been effected.

A peak-voltage indicating vacuum tube voltmeter will be required for the actual calibration of the modulation meters. This is connected across the output of the signal generator and indications of the **peak** modulated and unmodulated carrier voltages obtained. The **unmodulated** carrier input to the subdivision network, i.e., the indication on the R.F. level meter, must be kept constant at one volt while this is being done. The actual unmodulated carrier input to the calibrating voltmeter is not important, but should preferably be fairly high in order to reduce the possibility of error in both indications and calculations.

If the unmodulated carrier input to the calibrating meter is kept constant, the peak voltage indication obtained for this factor will serve for all calculations. Several indications of the peak modulated carrier voltage are required, however, and these should be taken with various values of audio input (as shown by the modulation meter in its function as a voltmeter) to the R.F. oscillator. The results obtained by this procedure should be carefully tabulated and will serve as the basis of a graph which will be used for the final calibration.

After obtaining the fixed peak voltage of the unmodulated carrier and the various values of modulated carrier voltage, it will be necessary to convert these voltage figures into terms of current flowing in the output circuit of the generator. The resistance, or impedance, of this circuit is already known as it is merely the **effective** shunt resistance of the attenuator tap which is being used to feed the calibrating voltmeter. Alternatively, if the peak-reading V.T.V.M. being used has a resistance-capacity isolating circuit for its grid input, the resistance is that of the grid resistor of the V.T.V.M. This part of the calculation then boils down to a simple application of Ohm's Law where the current is found by dividing the peak voltage already ascertained by the resistance.

Having done this, the modulation percentage for any peak modulated carrier voltage (and therefore for any corresponding audio input) may be determined by the following formula:—

$$M\% = \frac{(Im - Iu)\ 100}{Iu}$$

where "M%" is the modulation percentage; "Im" is the peak value of the modulated current and "Iu" is the peak value of the unmodulated current.

The results of the solution of this formula for the various values of modulated peak current may then be plotted against the original values of audio input in the form of a graph. The meter readings for various even modulation percentages (i.e., 30%, 40% and so on) may be determined from this graph and recalibration of the meter in terms of modulation percentage effected.

These meter calibrations, as pointed out before, will only be accurate at the carrier frequency at which they were taken, although they will hold for all modulation frequencies, so it will be necessary to make use of the increased indications shown on the R.F. level meter at the higher modulation percentages in order to provide modulation calibrations which will hold at all carrier frequencies.

It will be noted that very little, if any, increase of the R.F. level indication occurs until the modulation percentage is increased beyond about 40%. Above this figure the increase will be quite definite and it is only necessary to carefully note the increase for each progressive 10% increase in modulation depth. These increases may be permanently inscribed on the R.F. level meter scale. This calibration may be effected by making use of the calibrations worked out for the modulation meter if the original carrier frequency is retained. Quite surprising divergences between the modulation percentage calibrations on the two meters may be noticed at the higher modulation levels when the carrier frequency is changed, and, in order to avoid confusion, it might be as well to only calibrate the modulation meter to about 50%. The R.F. level meter calibrations become effective at this point, and, as these are the only accurate ones under all conditions at the higher levels, they may be used.

The data dealing with the calibration of various components has been necessarily long, as this phase of the construction of a signal generator is most important. In any case, the data supplied is not limited in application to signal generators only, but will be of value to engineers working in many fields of radio endeavour.

Applications of the Signal Generator and Associated Equipment

In the preceding article, the practical and theoretical requirements underlying the construction of a standard signal generator suitable for laboratory use in radio receiver engineering were dealt with.

To recapitulate, the design outlined provided for the construction of an instrument capable of developing a radio-frequency signal at any frequency between 100 kc/sec. and 25 megacycles. Provision was made for maintaining the maximum amplitude of the signal constant at one volt, and, in addition, a subdivision network incorporated in order to enable any fraction of the signal down to one microvolt to be obtained. Internal 400 c.p.s. modulation at any percentage up to a hundred could be applied to the radio frequency signal, or if desired, modulation from an external source could be effected.

Dummy Antennae

Whether an instrument has been constructed or one is already available, we have now reached a point where a generator of radio-frequency energy is available which may be used for conducting practically any test on a radio receiver, and, moreover, may be used to obtain stage by stage comparative figures to assist in the design of any new equipment.

The question of coupling this instrument to the receiver then arises, and for this purpose, a device known as a "dummy antenna" is usually employed.

On broadcast frequencies the aerial used for signal pick-up purposes consists, in effect, of a combination of inductance, capacity and resistance, all of which are effectively in series across the input terminals of the receiver. It follows that if we wish to duplicate reception conditions when coupling the signal generator to a receiver, the coupling device used must contain these three essentials. The circuit arrangement employed is shown in Fig. 1.

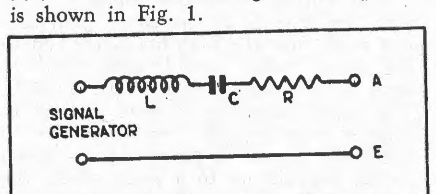

Fig. 1—Circuit of Dummy Antenna.

Standard specifications for receiving aerials place the effective height, for comparison purposes, at four metres, and it is therefore desirable that the dummy antenna used should have constants which will duplicate an aerial of this size. Under these circumstances the resistance required will be 25 ohms, the capacity 200 mmfd. and the inductance 20 microhenries.

It must be remembered, however, that the output impedance of the signal generator is also in circuit, and, as the example dealt with has an output impedance of ten ohms at the lower signal levels, this value must be deducted from the value of the resistance incorporated in the dummy. The resistance winding used should be as nearly non-inductive as possible, and, in addition, the container for the dummy should be of metal in order to prevent any radiation from (or "noise" pick-up by) the dummy itself.

On short waves, a somewhat different problem presents itself, as we find that an aerial used for short wave reception acts almost as a pure resistance. The value of this resistance varies according to the frequency being received, but 400 ohms is a fair approximation for frequencies over 3 megacycles. As this is only an approximation there is no necessity to take the output impedance of the generator into account, and a non-inductive resistance of 400 ohms will therefore be found suitable for use as a dummy when conducting tests on the higher frequencies.

Receiver Output Measurement

As stated before, the measurement of the sensitivity of a receiver calls for the development of 50 milliwatts of energy at the output terminals of the receiver.

This may be measured in two ways, the particular method used being dependent on the apparatus available. The first of these is by means of a copper-oxide rectifier type of A.C. voltmeter of the type usually known as an "output meter" and the second of which is by means of a vacuum-tube voltmeter connected across the primary of the input transformer of the loud speaker. In either case it is necessary to connect a blocking condenser of 0.5 mfd. capacity in series with the meter network to prevent the D.C. flowing in the plate circuit upsetting the readings.

In addition, it is essential that the complete measuring network have an impedance equal to the optimum load resistance of the output valve in the receiver under consideration. The actual voltage indication on the instrument which corresponds to an output power of 50 milliwatts may be easily calculated from the formula—

$$E = \sqrt{W \times R}$$

where E is the output voltage corresponding to the power required, W is the power required in watts (in this case 0.05 watts) and R is the output load resistance.

Sensitivity Tests

The measurement of receiver sensitivity is probably the most generally known application of the standard signal generator, and is also the simplest.

This operation is preferably carried out in a fully shielded room so that no extraneous noise is introduced to the receiver with consequent upsetting indications. The receiver is connected up in the normal way, as though being set up for normal reception and the output indicator connected. The signal generator output is then fed into the input (A and E) terminals of the receiver through the dummy aerial and the output adjusted until the receiver output indicator shows the required 50 milliwatts. The readings of the generator multiplier and microvolt dials are then tabulated and the procedure repeated at several points on the waveband under consideration.

Standard check points on the broadcast band are at 600, 1000 and 1400 kc/sec., although more frequent checks may be made. The sensitivities so obtained may then be plotted on single squared paper against frequency and a curve obtained showing the variation of sensitivity from point to point. A typical sensitivity curve is shown in fig. 2. All receiver controls are, of course, set at their maximum positions for this test. Sensitivity measurements taken in this manner are what is known as "absolute" sensitivities, and indicate the actual sensitivity of the receiver to signals impressed upon its input terminals.

The expression "microvolts per metre" is used to refer to the field strength of any station in a particular location. The "absolute" signal strength available from any given field strength is obtainable by multiplying the field strength by the effective height of the receiving aerial in metres.

The effective height of an aerial is dependent on a number of factors, such as its "form factor" and its actual location, and, in any case, is rather difficult to determine. Average conditions place it at

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APPLICATIONS OF SIGNAL GENERATOR—(Continued)—

about half the actual height in metres, and from this a fair approximation may be made. However, the problem is not one which will be met with very frequently in receiver design, as station field strength contours are distinctly rare.

Selectivity Measurements

Next in importance to receiver sensitivity measurements are determinations of its selectivity, or, shall we say, rejectivity to unwanted signals. Measurements of this nature may be classified under two headings, adjacent channel selectivity and image ratio.

Adjacent channel selectivity is essential in all types of receivers as selectivity of this type is necessary to prevent stations from spreading into one another. Insufficient adjacent channel selectivity is usually referred to as "broadness of tuning."

"Image ratio" is the term applied to the ratio between the signal received from a station by a superheterodyne receiver when it is tuned to the fundamental and when it is tuned to the "image spot" or "repeat point" at twice the intermediate frequency away from the fundamental.

In practice it is usually found more convenient to determine the ratio by measuring the response for a given signal at the fundamental and then to measure the signal required at the image point to give the same response with the receiver tuning adjustments at their original positions. The ratio of the two signals is then termed the "image ratio" of the receiver.

The determination of the image ratio of a receiver is quite important when dealing with the design of superheterodyne receivers, as by this means it is possible to fairly accurately forecast the number of "double spots" and "heterodyne whistles" likely to be encountered in the operation of the receiver.

In order to ascertain the adjacent channel selectivity of a receiver the apparatus is connected up in the same manner as when sensitivity tests are being made. A sheet of "single-log" graph paper will be required for the tabulation of results and preliminary ordinates may be marked on the log scale up to 10,000. The reference level is arranged in the centre of the single squared side of the paper and provision should be made for detuning up to 40 or 50 kc/sec. on each side of the resonant frequency. These markings are clearly shown in fig. 3, which depicts a typical selectivity curve taken on a receiver.

Having done this, the receiver is tuned into resonance with the output of the generator at the frequency where it is desired to make a test. Two different procedures may then be adopted, the first of which is to detune the signal generator a fixed amount, say 5 kc/sec., and

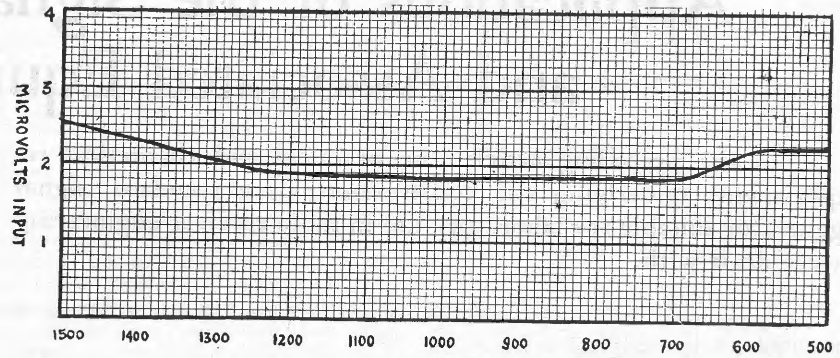

Fig. 2—Typical Sensitivity Curve of Receiver.

bring up the generator output until the original response is obtained in the receiver. The generator is then detuned another 5 kc/sec. and the output brought up still further. These results are, of course, tabulated and the procedure repeated until the signal level being delivered is 10,000 times higher than the original signal, or the signal is detuned 40 or 50 kc/sec. from the original position. The procedure is then repeated on the other side of the original position, that is, the detuning is carried out on the other side of the reference frequency being used.

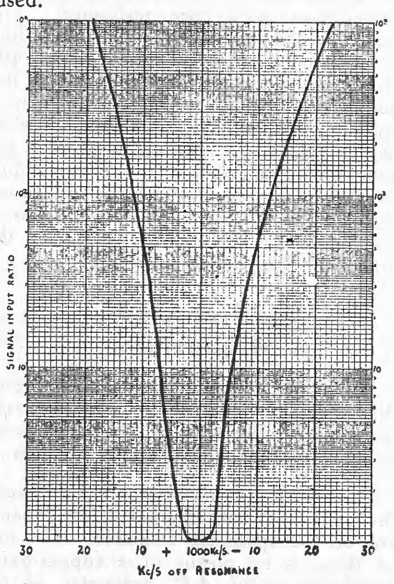

Fig. 3—Typical Selectivity Curve.

The second method varies only in detail and merely consists of increasing the signal output by a fixed amount each time and detuning the generator until the original output level is reached. The plotting method is exactly the same in each case, and the use of either system is a matter for individual preference. Whichever method is used it is absolutely essential that the receiver control settings and tuning be left in exactly the same positions throughout the entire test. A curve may be taken in this manner at two or three points on each band and the overall selectivity of the receiver thus determined.

The determination of image ratio has already been outlined roughly, but a little more detail is necessary to ensure that no misunderstanding exists.

As explained before, the image point of any signal, on a superheterodyne receiver, is situated at a frequency exactly twice the intermediate frequency away from the fundamental. As modern receiver practice decrees that the oscillator in a superheterodyne shall operate at a higher frequency than the signal being received it follows that if the receiver is tuned to a point twice the I.F. lower than the signal the oscillator will again be in a position to beat with the original signal and develop a "difference frequency" equal to the intermediate frequency used in the receiver, providing of course, that the signal frequency circuits are not sufficiently selective to reject all trace of the original signal at the new tuning position. If they are not, then a signal will be heard and a condition known as "double-spotting" arises. The obvious remedy is to make the signal frequency circuits so selective that all trace of the original signal is eliminated before the image point is reached. This is not always possible, however, especially when intermediate frequencies around the 175 kc/sec. mark are used.

It is very valuable, therefore, to be able to determine the amount of image interference which may be expected from any particular signal, as it is often possible to make some adjustments which will minimise the trouble.

The normal procedure adopted is to tune the receiver to the signal generator at a point near the high-frequency end of the band under consideration, and to work on the lowest signal level possible. The signal generator is then retuned to a point twice the I.F. lower than that to which the receiver is tuned and the signal output brought up to a point where the output indicator on the receiver shows the same response as was originally obtained. The ratio of the two signal levels is then the image ratio of the receiver. Ratios higher than 2000 are usually found satisfactory for normal reception conditions, although some locations may require an image ratio of ten to twenty times that amount to completely eliminate all trace of double-spotting.

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APPLICATIONS OF SIGNAL GENERATOR—(Continued)—

Fidelity Tests

Next in line after the determination of the sensitivity and selectivity of the receiver comes the determination of its fidelity. There are three divisions under which the determination of receiver fidelity may be classified and, while two of these are well within the capabilities of the average laboratory, the third is rather an involved procedure, and will be outside the capabilities of the average range of equipment.

The first classification is that of the determination of the audio frequency amplifier response of the receiver. This test merely consists of checking the audio frequency response from the input of the first audio amplifier to the output of the final stage. The second classification is that of overall fidelity from the aerial input of the receiver to the output of the final amplifier, while the third is an actual acoustic test, obtained by feeding a modulated R.F. signal into the aerial terminal and actually measuring the sound pressure vibrations set up by the loud speaker itself. This final test is the one that is outside the capabilities of most laboratories, as the "set-up" necessary includes not only the modulated R.F. oscillator, together with a beat frequency oscillator for generating any desired audio frequency, but also necessitates the use of a microphone situated near the speaker in an acoustic chamber designed to avoid stray reflection and standing waves which would otherwise be picked up by the microphone in addition to the true output from the speaker itself. In addition to the microphone it is necessary to have an amplifier, of which the audio frequency characteristics are known, and also a power level type of output indicator which will give a true indication of the actual sound impulses picked up by the microphone.

The first two tests, however, are comparatively easy to carry out, and are extremely valuable from a developmental and engineering point of view, especially if each is taken and regarded with relation to the other test.

For the audio frequency amplifier response test, the only apparatus necessary is a beat-frequency or audio frequency oscillator capable of developing the audio frequency between the limits of about ten and ten thousand cycles, together with a copper oxide rectifier type output meter, which may be matched to the output tubes in the receiver. This test not only applies to the audio frequency channel in a receiver, but may also be used to determine the fidelity of amplifiers used for public address work or recording.

A.F. Oscillators

We have not yet described the construction or operation of a beat frequency oscillator, but for the moment it is sufficient to say that a beat frequency oscillator is, in effect, an audio frequency signal generator, and most of the remarks in regard to the control and operation of a standard signal generator of the R.F. type apply to the audio frequency instrument. In each case an oscillator is provided capable of developing a signal of known frequency, together with a means for measuring or regulating the output of the oscillator, and also an attenuation network for obtaining any desired fraction of the total output. Two types of audio frequency oscillators are used, these being known either as an audio frequency oscillator or a beat frequency oscillator. The first type consists of a single valve (with one or more amplifying stages) which oscillates at the required frequency. This type of instrument is only used for special tests nowadays and is fairly expensive to construct on account of the fact that very extreme precautions are necessary to ensure constancy of output over the audio frequency range, and also that the wave form developed is perfectly pure and free from harmonics. The second type of instrument, usually known as a beat frequency oscillator, is far more simple to construct and, moreover, far more simple to calibrate. The output is particularly free from harmonics, and an instrument operating on the beat frequency principle is fairly stable in operation. As its name implies, this instrument operates by virtue of the "beat" effect noticed when two waves of different frequencies are mixed together. When this is done, two resultant waves are formed, neither of which has the frequency of the original wave but are equal to the sum of and the difference of the two original frequencies. In the beat frequency oscillator this principle is made use of to produce an audio frequency beat note, and to do this two radio frequency oscillators are built, one of which is tuned to a fixed frequency, usually in the neighbourhood of about 100 kc/sec. or even lower, and the other of which is variable 10 or 15 kc/sec. from resonance with the fixed oscillator.

It will readily be appreciated that when the two oscillators are operating on the same frequency no beat will exist and a condition known as "zero beat" applies. However, as the variable oscillator is shifted slightly from the resonant frequency, beat notes will be set up in accordance with the difference between the two frequencies, and by careful proportioning of the tuning constants it is possible to spread the range from zero to 10 or 15 kc/sec. (that is, 10 or 15,000 cycles) over a calibrated scale of 360 degrees or more. The variation is usually arranged over a logarithmic scale so that the low frequency beat notes are spread further apart on the scale. The constancy of output amplitude exhibited by this type of oscillator is immediately apparent, but particular precautions are necessary to ensure that the attenuator used to subdivide the output resulting from the beating of the two waves does not discriminate against any of the frequencies developed. It will be remembered that this precaution also applies in relation to radio frequency oscillators and it is necessary to adopt very similar methods to those employed in the construction of radio-frequency attenuators in the audio frequency attenuator. It is also usually found necessary to incorporate one or more stages of amplification between the heterodyne oscillators and the output, not only to amplify the output but to act as buffer stages to prevent any interference with the operation of the oscillators due to varying loads being imposed on the output. The output available from various types of beat frequency oscillators varies in accordance with the service for which they are intended, but the average oscillator designed for radio work, has an output of about 50 milliwatts across a 5,000 ohm load.

A.F. Amplifier Tests

As mentioned before, the audio frequency oscillator is connected to the input of the first amplifying stage for audio amplifier fidelity tests and an output meter of the rectifier type is connected to the amplifier output. The amplitude of the audio frequency signal fed into the amplifier is kept at a point below the input overload point of the amplifier and a frequency control is then rotated over the entire range. The audio frequency response measured on the output meter may then be plotted against the audio frequency input in cycles. Four hundred cycles is usually used as the reference level and the gain or loss with reference to that point plotted in decibels up or down. For this purpose a decibel calibrated output meter is an advantage, but once the voltage ratios are known as measured on the ordinary type of voltage calibrated output meter it is a simple matter to convert the ratios so obtained to decibels.

Receiver Fidelity

Overall fidelity tests, as measured from the aerial terminal of a receiver to the output of the final amplifier, are conducted with the aid of the standard signal generator modulated by a beat frequency oscillator instead of the built-in 400 cycle oscillator in the generator. The previously used decibel or voltage calibrated output meter is still connected to the output terminals of the receiver. To commence with, the radio frequency output of the generator is tuned to a pre-determined frequency on the band that it is desired to test on, and the volume control of the receiver adjusted to a point which delivers any convenient amount of audio frequency output at 400 cycles. Four hundred cycles is again used as the reference level, and for comparative tests a modulation percentage of 30 is used. The setting of the output meter for this adjustment is carefully noted and the signal generator is then switched over to external modulation from the beat frequency oscillator. The beat frequency oscillator is then tuned to 400 cycles and its amplitude control or the modulation control on the signal generator adjusted until the output meter gives exactly the same deflection as was obtained from the 30 per cent. modulation supplied by the built-in 400 cycle oscillator on the signal generator. Having thus established a duplicate set of conditions to those applying at 400 cycles with

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APPLICATIONS OF SIGNAL GENERATOR—(Continued)—

the standard signal generator modulation, the frequency of the audio oscillator is then varied between the maximum and minimum limits. The response, as noted on the output indicator, is again plotted against frequency with reference to 400 cycles. The resultant curve gives the overall modulated R.F. fidelity of the receiver. If the audio output of the receiver at 400 cycles is adjusted to the same level as was used for the audio amplifier fidelity test, it is possible to super-impose the two curves and thus ascertain the amount of attenuation or distortion of the audio frequency characteristics caused by the radio frequency end of the receiver. Tests may then be taken at various percentages of modulation until the overload point of the audio amplifier is reached. Some interesting figures will be obtained in this way and it will be possible to note just what degree of overload distortion is taking place in the audio amplifier of the receiver, and also at what frequency overloading takes place first. In addition it is possible, by careful notation of the difference between the audio channel fidelity and the overall modulated R.F. fidelity to determine the exact "band-response" of the tuning circuit of the receiver and, if necessary, adjustments can be made to counteract any deficiencies which might exist.

The R.F. band-response of a receiver may be measured directly bv means of a cathode-ray oscillograph and a special frequency modulated oscillator, but that is almost a complete subject in itself and will have to be treated separately.

Stage Gain Measurement

Measurements of the nature are of particular value when designing new receivers, and it is possible by this means to have each stage operating at its optimum point and thus avoid one particularly efficient stage carrying one or two others which are operating well below their peak point. The instruments necessary for this test are the standard signal generator for radio frequency and intermediate frequency measurements, of a beat frequency oscillator for audio frequency measurement, as well as a vacuum tube voltmeter for output indication.

The vacuum tube voltmeter is preferable for stage gain measurements on account of the fact that it may sometimes be necessary to measure the gain of resistance coupled stages or other intermediate stages where it is not desirable to disturb the existing interstage coupling arrangement. A suitable type of vacuum tube voltmeter should be calibrated in R.M.S. voltages with full-scale ranges of 1, 10 and 100 volts. The R.M.S. calibration is necessary on account of the fact that signal generators and beat frequency oscillators are usually calibrated in R.M.S. output readings. The coupling arrangements for the input of the signal generator or beat frequency oscillator to the input of the stage under measurement are dependent entirely on the existing circuit arrangements. Thus for an I.F. or R.F. amplifying stage it will be necessary in most cases to keep the existing tuning arrangement in the circuit intact and arrange for coupling by means of the usual primary coil associated with input circuit of the stage. The output indication is then obtained across the plate load of the valve, whether it be choke or a tuned circuit. It is essential that a high impedance input type of vacuum tube voltmeter be used for this type of service as a low impedance at this point will result in a complete upsetting of the characteristics of the stage being measured. It is also desirable that the accuracy of the vacuum tube voltmeter be checked against the input from the signal generator. This may easily be carried out by using a low voltage range and setting it against the maximum output of the generator. For audio frequency stage gain measurement the same precautions are necessary. It is desirable, in addition, to make sure that the output of the beat frequency oscillator is correctly matched to the input of the transformer or to the input of the stage being measured. If the output of the beat frequency oscillator does not match the primary of the transformer preceding the stage to be measured (or in the case of a resistance coupled stage, the output of the beat frequency oscillator does not match the plate impedance of the preceding valve) it will be necessary to introduce a matching circuit composed of either a tapped inductance or a multi-ratio transformer capable of being adjusted to the desired impedance. These precautions are particularly necessary if it is desired to obtain the characteristics of the stage over a wide range of frequencies.

A.V.C. Characteristics

It is often necessary to ascertain the exact effect of the automatic volume control circuit incorporated in a receiver. To measure the effect of A.V.C. in a receiver it is necessary to make use of the standard signal generator again and the copper oxide type of output meter. "Double-Log" graph paper will be necessary for plotting a curve to tabulate results obtained from a test such as this and the ordinates required will be power output along one side and the voltage input along the other side.

Although standard specifications call for tests of this nature to be carried out at 30 per cent. modulation, it is usually desirable that a test of this nature be taken at a figure somewhere near 70 or 80 per cent. modulation, as this figure approximates the average modulation used in broadcasting stations nowadays. It is obviously rather futile to check A.V.C. on a modulation percentage less than half of the average used, as it is normally the audio frequency component of a modulated wave that determines the overload point of a receiver. With 30 per cent. modulation no overload might be shown up at any point, whereas, with the modulation increased to over twice this value overload will be much more likely to occur. A test conducted under these conditions will more nearly approximate actual working conditions. With the signal generator connected to the aerial and earth terminals of the receiver the output of the generator is then reduced to the threshhold of sensitivity of the receiver. The volume control of the receiver is then adjusted to its maximum position and readings on the output meter noted. The output of the generator is then increased in ratios of ten until a stationary or falling indication on the output meter shows that the overload point has been reached. The procedure is simplified somewhat if an output meter is available which is calibrated directly in milliwatts for the load resistance used. However, the more usual instrument will be an ordinary type of output meter calibrated directly in volts, and in this case it will be necessary to convert the voltage indications so obtained into milliwatts or watts. This is quite simply done by squaring the voltage reading and dividing the figure thus obtained by the resistance of the output network. A preliminary calculation based on the maximum output rating of the final amplifier in the receiver will give a guide as to where the overload point may be expected to occur. Should it be found that the overload point is reached before this figure is reached it may be taken as a fairly definite indication that something is seriously wrong with the constants of the circuit being tested and it will be advisable to check over the operating conditions of the receiver very carefully before proceeding any further.

Radio Inductive Interference

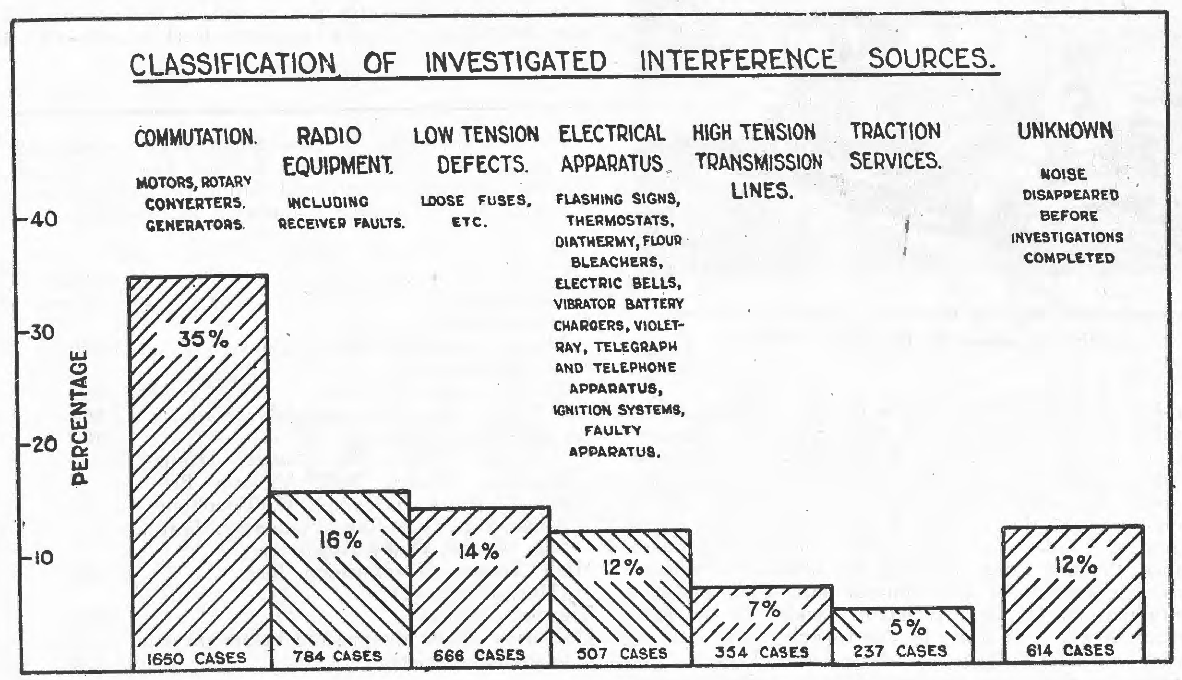
by H. K. BURBURY, Radio Inspector

A paper delivered before the Institution of Radio Engineers (Aust.), Science House, Sydney, 2nd July, 1935.

THE object of this paper is to place on record, for the benefit of those interested, a summary of the experience gained from six years' practical work on the investigation of the cause and remedies of radio inductive interference. No attempt is made to discuss the theory involved in the cause of the phenomenon or the mathematical requirements for its suppression. Radio inductive interference has been defined as any noise reproduced by the loud-speaker of a broadcast receiver which does not originate at the transmitter; and so long as this is intended to exclude noise caused by defects in the receiver, the term seems aptly applied. In Australia the work of investigating complaints of radio interference has been voluntarily undertaken by the Postmaster-General's Department, the execution of this charge being under the direct control of the Senior Radio Inspector in each State. Stated briefly, the policy at present in force is to invite complaints from listeners experiencing unsatisfactory reception; locate the apparatus or defect responsible for the poor reception; and then, where practicable, demonstrate or supply particulars of a suitable remedy. As this work grew in volume it was found that while the majority of complaints were genuine and warranted investigation, a large number were of a frivolous nature, the investigation of which represented so much wasted time; in others the information supplied was too vague to be of any value. It was for this reason that the Wireless Reception Questionnaire was introduced. Listeners complaining of interruptions to the broadcast services are now asked to obtain a Questionnaire Form from their nearest Post Office, and after answering as many of the questions as possible, forward it to the Radio Inspector's Office. From the information thus supplied, it is often possible to diagnose the trouble without personal investigation and the listener is acquainted of the requirements by correspondence or by telephone without further delay. When such a course is not practicable, the listener is advised that a Radio Inspector will call and investigate the complaint at an early date. During the past five years over five thousand of such complaints have been investigated, and in approximately 95% of the cases a remedy has been demonstrated or details of a remedy supplied. The present rate is over 150 cases per month. In carrying out this policy the Department looks for a full measure of co-operation from power supply authorities and the radio trade, as it must surely be evident that all three parties benefit mutually from any improvement in conditions that permits of greater use of radio.

Referring to the definition of radio interference, quoted above, if this be accepted, then noise due to atmospheric disturbances must be included, but as there seems to be no simple way by which the broadcast listener might minimise their effects, they must be considered an excusable omission from any discussion in a paper of this kind.

The only other form of interference with which we are not particularly concerned in this paper is inter-station interference, which obviously is a matter of the design of the receiver and the correct functioning of the transmitter. The balance of interference experienced by broadcast listeners has frequently been designated man-made static and this seems a very fitting title for the raucous noises produced by the hosts of electrical appliances in every day use to say nothing of those produced by unsuspected defects on electrical networks. Whenever the steady flow of current in an electrical circuit is suddenly interrupted a spark takes place at the point of interruption, and to those familiar with the theory of spark transmitters, it will not be difficult to appreciate that, by virtue of stray capacity and inductance, radio frequency energy is generated. The decrement of these wave trains is generally very high, but varies with the characteristics of the circuit; the tuning therefore will be broad and so the effects will be almost uniform over a wide range of frequencies. Taking the broadcast spec-

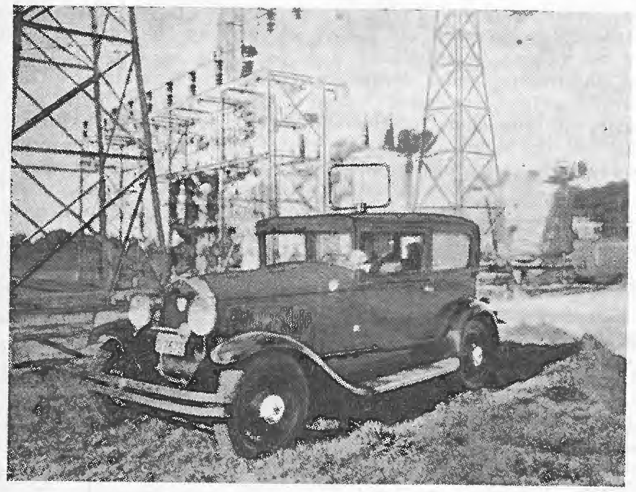


RADIO INTERFERENCE—(Continued)—

trum, there seems to be a definite peaking of the noise effects in the vicinity of 1000 k.c. (300 metres) with sudden attenuation below this frequency and slight attenuation above it to the limit of the band, 1500 k.c. (200 metres). The deleterious effects on broadcast reception are therefore so serious that strenuous efforts are being made throughout the world to-day to reduce the noise level to a satisfactory minimum, i.e., to obtain a satisfactory signal to noise ratio at reasonable distances from the transmitter. The interfering radio frequency energy can reach the broadcast receiver via two different paths. In some cases the energy travels back along the supply wiring from the point of origin and so enters the broadcast receiver via the power mains. In these cases the use of a line filter is a definite advantage. In the majority of cases, however, the interference is picked up on the receiver aerial by virtue of its proximity to the electrical network carrying the interfering radio frequency energy. The advantages of an outdoor aerial at once becomes apparent. An indoor aerial is surrounded by the network of house wiring, and as this network is radiating noise energy, obviously the amount of noise passed to the receiver will be much greater than if the aerial were used at some point remote from the house network. In addition to this, the amount of broadcast signal picked up will be considerably greater by virtue of the larger dimensions of the outdoor aerial. In many cases of radio interference the use of an efficient outdoor aerial presents a complete solution to the problem.

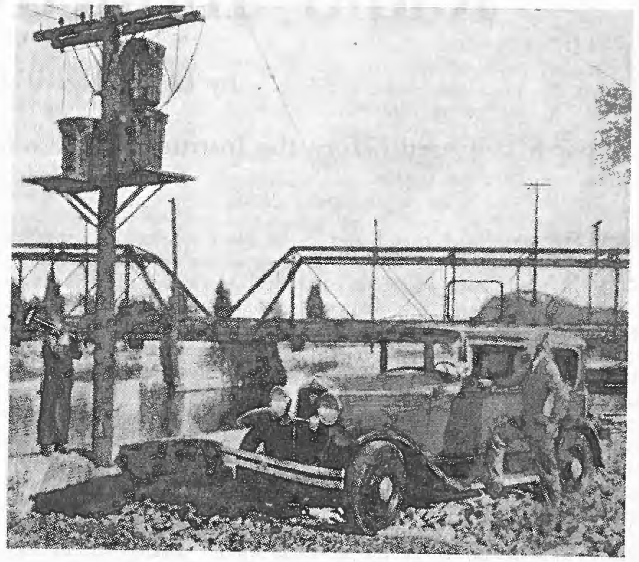
The Portable Detector

When the line filter and the outdoor aerial fail, steps must then be taken to reduce the noise at the point of origin. A portable radio receiver of the battery type is used to locate sources of radio interference whose whereabouts cannot be



The equipment used for detection purposes is carried in the car shown in the illustration.

determined by enquiry. The search is usually greatly facilitated by observing the characteristics of the noise at the listener's residence, then, by the process of elimination, rejecting all sources whose noise it is known from experience does not coincide with the noise under observation. Indeed, by the careful application of this method, it is only on rare occasions that the source of noise cannot be named as soon as it is heard. For instance, the first thing noted by the observer is whether the interference consists of a continuous buzz, an intermittent buzz, continuous crackle or intermittent crackle. If the noise is continuous, it will most likely be due to either commutation, high tension insulator leakage, or electro-medical plant. As each of these has distinctive peculiarities in its noise characteristic, it is a fairly easy matter for an experienced observer to



Poles carrying H.T. equipment are subjected to vibration while observations are made on a portable receiver.

reject the two noises which are not applicable. If the interference consists of short buzzing noises or crackling at regular intervals it will more than likely be due to a flashing electric sign or a thermostat controlled heat oven or incubator. If the noises have no definite periodicity they may be attributed to tramway interference, or a defect on the electric supply circuit of some nearby building. In confirmation of the above system it is found that only in one case in every twenty is it necessary to use the portable receiver to search for sources of interference, the identities of which are not known before the search is started. More often than not the source can be located by enquiry after recognising the type of apparatus responsible. When enquiry fails, however, or in the cases of defects and excessive high tension insulator leakage, the portable receiver is a necessity. Preliminary observations are made on either side of the street and the side of lower noise level eliminated from the search. On the other side, the portable receiver is taken from house to house (or pole to pole in the case of high tension interference) until a change in level is indicated. If the

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Statistics show that in New South Wales commutator type electric motors are responsible for one-third of all the interference complaints investigated during the past five years. The complete list of interfering sources is as follows:—

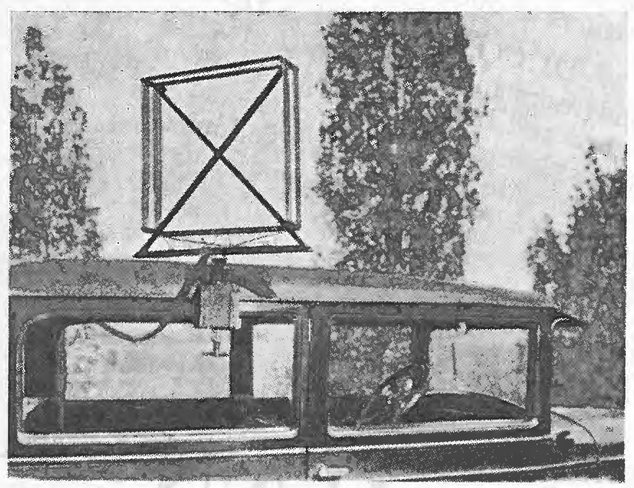
Source.	Complaints Investigated	Percentage
Commutation—		
Motors, Generators, Rotary Converters	1,650	35%
Radio Equipment—		
Including receiver faults	784	16%
Low Tension Defects (loose fuses, etc.)	666	14%
Electrical Apparatus	507	12%
Flashing Signs, Thermostats, Flour Bleachers, Electric Bells, Vibrator Battery Chargers, Telegraph & Telephone Apparatus, Violet-Ray, Diathermy, Ignition Systems, Faulty Apparatus.		
High Tension Transmission Lines .... (Normal leakage)	354	7%
Traction Services	237	5%
Unknown—Noise disappeared before investigations completed	614	12%
	4,182	

RADIO INTERFERENCE—(Continued)—

change is a decrease in noise, obviously the observer has been walking away from the source of interference. If the process is repeated in the opposite direction, a point of maximum intensity will soon be reached beyond which there will be another decrease in noise. Circuits in this locality are then opened one at a time until the disappearance of the noise in the portable receiver indicates that the correct source of trouble has been located. In cases of excessive high tension insulator leakage, the pole of maximum intensity is reported to the responsible authority.

Motors

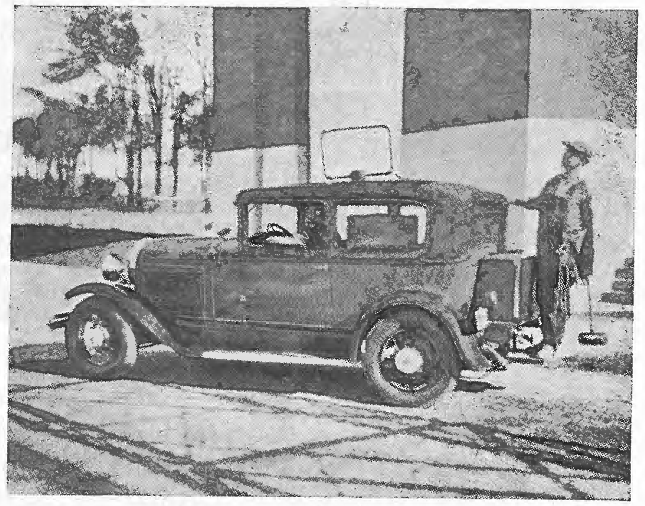
Provided that there is no excessive sparking due to uneven commutator surface, the interference caused by universal type motors can be reduced to a satisfactory level by connecting a 0.1 mfd. condenser from each brush to the frame of the motor. The condensers must be of the non-inductive type, and in order to keep the inductive reactance of the by-pass circuit at a minimum, the condenser leads must be kept as short as possible. Condensers should be designed to withstand a test of several times the voltage of the line across which they are to be connected; 2,000 volts D.C. test is generally specified for 240 volts A.C. supply. In this respect it is interesting to note that surges on telegraph lines from a 50 volt battery will sometimes exceed 200 volts. An alternative method of reducing motor interference and one usually recommended in obstinate cases consists in the use of two choke coils connected one in each leg of the supply to the motor and as close to the motor as practicable. For motors of fractional horsepower it is customary to use two honeycomb coils of 150 or 200 turns. Care must be taken when using coils to ensure that no part of the wiring between coil and motor is coupled by stray capacity to any wiring on the line side of the choke as this would form a by-pass for the radio frequency surge and the effect of the coils would be greatly reduced. The choke coil method has often succeeded in reducing the radio interference to a satisfactory level where condensers have failed to effect



The type of frame aerial used by the Department of Marine in Canada for locating sources of interference.

any appreciable improvement. One outstanding case in New South Wales is that of 125 horse power 3 phase no-lag motor controlled by the Water & Sewerage Board in Newcastle. This motor has 3 slip-rings and a commutator and the resultant radio interference extended over a wide area. With the co-operation of the Board, condensers were connected from all brushes to frame, but the reduction in noise was disappointing. It was not possible to give any definite assurances that choke coils would be effective, as no motor of this size had, to our knowledge, ever been treated for interference.

Some idea of the coil requirements can be gathered from the fact that the normal running load of the motor is 225 amperes, but the coils would need to be capable of carrying a momentary short circuit load of 1000 amperes. The stresses associated with such a load are terrific. However, with commendable enterprise the Water & Sewerage Board decided to make the experiment, and in due course, three coils were constructed and installed, one in each phase between switchboard and motor. Each solenoid consists of an inner and an outer coil totalling forty turns of 3-8 copper rod mounted on a robust hardwood frame eighteen inches in diameter. The results proved highly satisfactory. In all cases broadcast listeners living in the immediate vicinity of the pumping station, whose reception had previously been limited to local Newcastle Stations, are now able to listen to the



A fully-equipped car leaving for observation work. The mallet is used by the linesman for setting in vibration the poles under suspicion.

Sydney stations free from interference. The necessarily elaborate construction of these coils compared with coils required for lighter loads greatly added to their cost and this fact alone makes the undertaking a splendid example of unselfish co-operation on the part of a body whose only reward could be the grateful appreciation of the listeners concerned and the Postmaster-General's Department.

Flashing Signs

Interference from flashing electric signs is traced by checking the periodicity of the noise on the seconds hand of a watch and then checking the flashes of any signs in the neighbourhood. The remedy is to connect two 0.1 mfd. condensers across the leads to the flasher mechanism with centre-point earthed, and in cases of severe interference to insert choke coils in series with each of the mains. Most of the big signs in Sydney have now been treated in this manner; the numerous sign companies, displaying a sympathetic interest in the problem, instal condensers as standard equipment, then follow with choke coils if required.

Electric Incubators and Telegraph Apparatus

Thermostats on electric incubators were a great source of trouble to broadcast listeners in the poultry farm suburbs, but to-day most of the better known makes of incubators are equipped with suppressor apparatus before going to the market. About four years ago, the writer, at the invitation of Messrs. Standard Waygoods Ltd., spent some time at their engineering works experimenting with various suppressor arrangements to determine the minimum requirements for satisfactory reception. The broadcast receiver used for the tests was connected to the same power point as that supplying the incubator so the test was much more severe than would be encountered in actual practice. It was found, however, that a spark quench consisting

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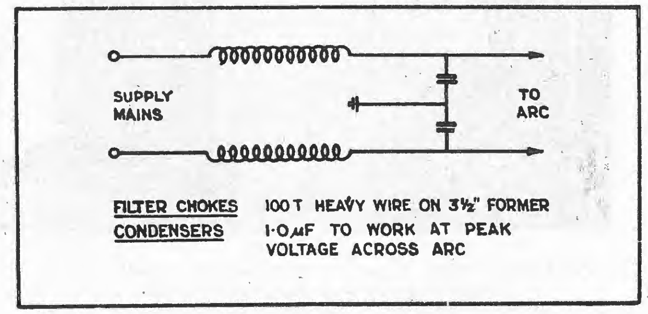
RADIO INTERFERENCE—(Continued)—

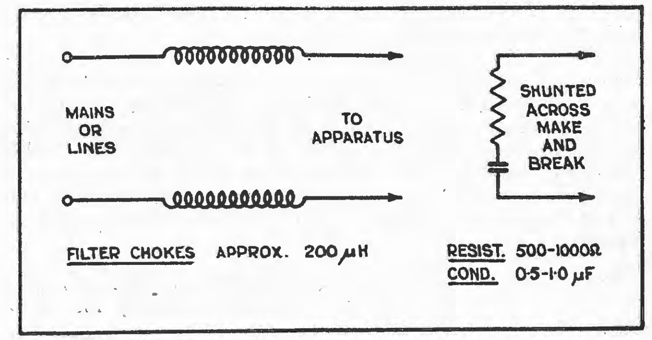
of a 1 mfd. condenser with a 700 ohm non-inductive resistance in series connected across the thermostat and two coils of approximately 200 microhenries connected one in series with each lead to the thermostat gave complete elimination of interference on all local stations. This apparatus is now installed as standard equipment on all incubators manufactured by this company and other incubators and thermostat controlled ovens are similarly treated as required. The same remedy with slightly different values is used for suppressing interference from electric signalling devices, railway and Post Office telegraph and telephone apparatus and vibrator battery chargers. As an example



of the distance that interference from thermostat controlled electrical apparatus will travel, a case which was dealt with a few years ago at Warrawee will be quoted. Listeners in the vicinity of the Warrawee railway station were first to complain. The noise was evident only at night and was intermittent but occurred at regular intervals. As the area is purely residential, no flashing signs were visible. The first night's observations with a portable receiver indicated maximum intensity at a street pole on which was mounted an electric light. The council were asked to overhaul the fittings for possible defects but none was found and the noise was just as bad the next night. The pole proved to be a false maximum and suggested nodes and antinodes of interference energy along the elevated wires carrying the radio frequency currents. Proceeding further, beyond this pole there was a dip in noise level at two subsequent poles and then a sudden rise to a value exceeding anything previously heard. A short distance further on, while the noise was still increasing in strength, the bowser lights of a garage in Lane Cove Road came into view. It was then observed that the noise in the headphones corresponded with the flashing of a 60 watt globe on one of the petrol bowsers. Lane Cove Road is about a quarter of a mile from the railway station here. The case had its humorous side, as when the garage proprietor was informed of the work in hand, he switched his own wireless set on and said that he had been looking for the same cursed noise for months past. When he finally overcame his amazement, the offending lamp was plucked from its fitting and thrown far into the night.

Electric Flour Bleachers

An electric flour bleacher consists of a totally enclosed metal chamber in which a continuous high tension arc is created. The ozone from this chamber is then drawn off and used for bleaching purposes. The resultant broadcast interference consists of a continuous roar not unlike that caused by electro-medical plant but quite different from that produced by electric motors. Broadcast reception in many New South Wales country towns was seriously hampered by bleacher interference from their local flour mills, which in many cases extended over a radius of one mile from the mill at sufficient level to prevent all daylight reception. As these conditions were reported the matter was taken up with the companies concerned and in all cases suitable suppressor apparatus has now been installed. The remedy consists of two choke coils of 100 turns of No. 16 D.C.C. on 3½ inch diameter formers connected one in series with each leg of the primary supply to the bleacher transformer shunted by two 1 mfd. condensers in series with centre-tap to the earthed frame of the bleacher.



Bells and Battery Chargers

Interference from electric bells, vibrator battery chargers, telegraph and telephone equipment is remedied by connecting a spark quench (condenser and resistance) across the make and break contacts with radio frequency choke coils of suitable current carrying capacity in series with the line. Bells and battery chargers are rarely met with as interference sources, but telegraph and telephone apparatus has been responsible for serious interference in country towns. Until steps were taken to suppress them, key clicks, produced at the key and relay contacts, were radiated by the overhead telegraph wires and commutation noise from the telephone ringing motor generators was similarly transmitted by the telephone circuits. A common spark quench for telegraph apparatus consists of a 0.5 mfd. condenser in series with a 500 ohm resistance across the sparking contacts. Honeycomb coils of 200 turns are then used as chokes in the line to complete the remedy.

Diathermy Apparatus

Probably the most severe and the most obstinate to remedy in the way of radio interference is that produced by diathermy apparatus. The plant virtually consists of a complete spark radio transmitter inasmuch as current at high voltage is fed into a condenser and discharged across a spark gap in series with an inductance. The radio frequency energy thus produced in this oscillatory circuit is transferred to an open radiating circuit through an oscillation transformer, one end of the secondary of which is connected to an electrode applied to the patient and the other end to earth. The resultant radiation of interference is therefore high compared with the other sources of noise, and the usual precautions taken to prevent the noise energy from feeding back along the supply mains are not sufficient to prevent radio interference on nearby broadcast receivers. It is necessary in addition to guard against direct radiation from the open oscillatory circuit referred to above. The only completely effective way to achieve this is to use a metal screen of sufficient dimensions to house the apparatus, the operator and the patient. Other methods for reducing the radiation have been advocated from time to time, but it is significant that each mentions screening as the only completely effective remedy. Such a screen is in use at premises in Burwood Road, Sydney, and was constructed to specifications supplied by the Radio Inspector's Office. One or two others are in use in New South Wales, but on account of

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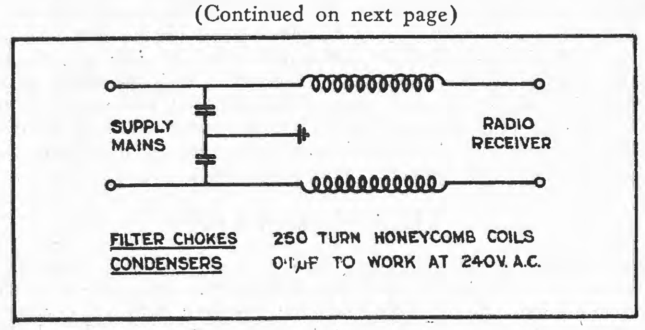
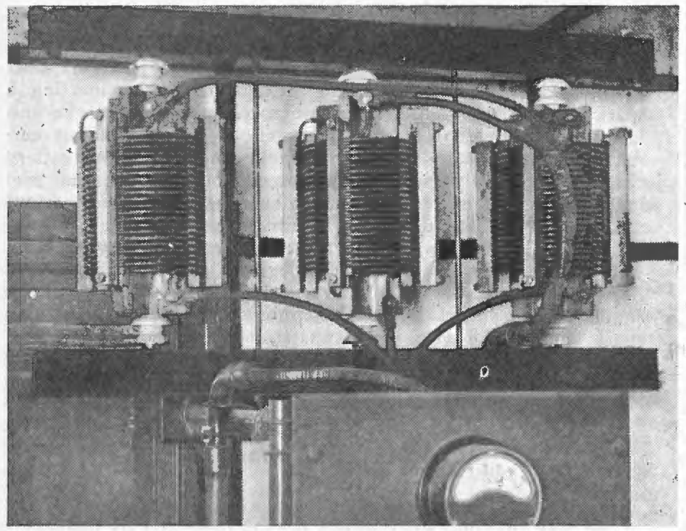


the high cost of installation, it is not always possible to persuade the owner to adopt this remedy.

Listeners in country towns often experience broadcast interference from home lighting plants. The remedy consists in installing suitable resistances (about 20,000 ohms) in series with the high tension ignition circuit at each spark plug. This effectively suppresses the ignition clicks while the interference from the generator commutator is eliminated by installing two 1 mfd. condensers across the brushes with centre point to frame.

When interference is traced to defective electrical apparatus the matter is reported to the responsible authority for attention.



Three R.F. choke coils installed on a 125 H.P. motor at the Water & Sewerage Board pumping station, Newcastle, N.S.W. It was the original intention to install the coils at the point of entry of the power supply to the building, but when it was found that only one motor was responsible for the interference, the coils were designed to carry the load of the offending unit, this somewhat simplifying the problem of design. Those shown above were designed to carry a load of 225 amperes.

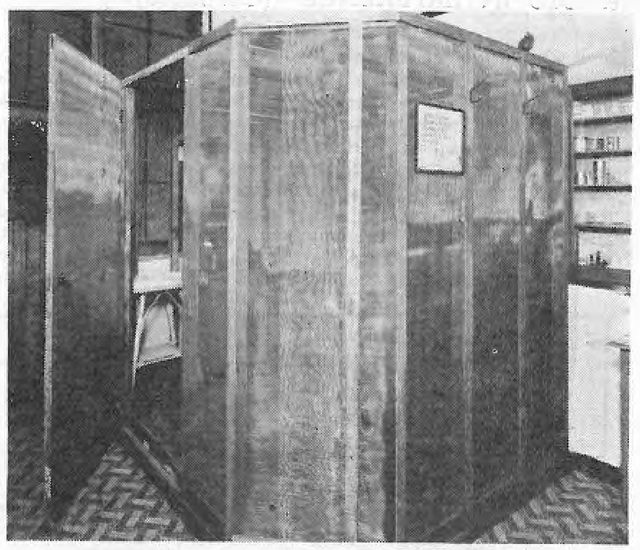
In 16% of the 5,000 odd complaints investigated during the past five years the trouble has been traced to defects in the listeners' own broadcast receivers. If the defect is a simple one, capable of immediate repair, it is rectified, but the usual course is to volunteer to report the trouble to the listener's radio dealer.

Low Tension Defects

Faults on low tension circuits, such as arcing connections on electrical fittings, loose fuses, etc., produce interference of an irregular crackling nature, and in some cases the effects extend over a wide area. Usually, however, the interference is confined to one or two houses on either side of the one in which the fault is located. The attenuation seems to vary directly as the density of the reticulation network. It is generally possible for the investigator to remedy the fault as soon as it is found and only in rare instances is it necessary to call in the services of a licensed electrician. This type of trouble is responsible for 14% of the total complaints.

High Tension Fry

Listeners living along the routes of high tension transmission lines invariably experience interference described as high tension fry. It is caused by the insulator leakage currents sparking at various points on their way to earth. The leak-



An exterior view of the complete screen installed in a consulting room at Burwood, N.S.W.

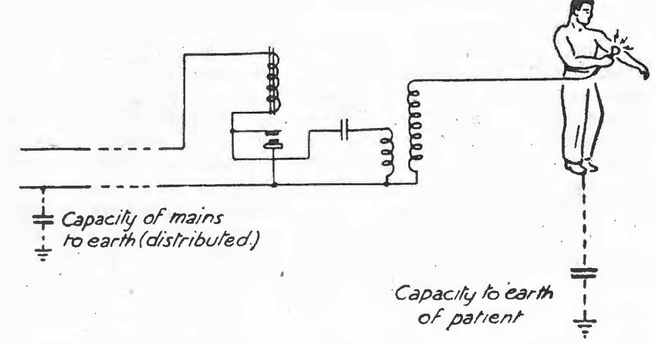
age currents are not necessarily due to defective insulators but pass over the surfaces of the insulators due to deposits of dust and soot during long dry spells of weather, or, in the coastal regions due to deposits of moisture and sea salt. The Newcastle City Council have found it expedient to wash their high tension insulators periodically, solely with a view to minimising surface leakage losses. There is another leakage loss, however, that can only be reduced by increasing the size of the insulator, and that is the leakage due to the capacity of the insulator as a dielectric between the cable on the outside and the metal insulator pin on the inside. By virtue of this capacity, currents are passed through the insulator and together with the surface leakage currents cause sparking where the insulator pin connects with the cross-arm and where the cross-arm is bolted to the pole. The cumulative effects of many miles of transmission line where this pernicious but unavoidable sparking is taking place, manifests itself in the form of a low purring noise commonly referred to as high tension fry. In hot dry regions this sparking has been responsible for pole-top fires and for this reason the cross arm bolts and the insulator pins are sometimes treated with a paint of high conductivity so as to keep the resistance of the path of the leakage currents to earth as low as possible and so minimise sparking. Wherever interference is recognised as high tension fry, it is customary for the investigator to follow the route of the transmission line for some distance either way, making observations on a portable receiver to satisfy himself that there is no abnormal leakage due to a defect on the line. If the interference is of uniform strength at all poles, it is safe to conclude that the noise is due to normal leakage; but if the noise shows signs of increasing in strength at subsequent poles it is followed to the pole of maximum intensity and then reported to the responsible authority. The writer has proved on numerous occasions that the greater part of high tension interference is not due to direct radiation but does most harm when it transfers its effects to the 240-415 volts circuits. This happens when the low tension wires are carried on the same poles as the high tension and so come within the interference field of the latter. The effects will then travel great distances along the low tension circuits and be radiated from the house wiring to be picked up on the lead-in and other parts of broadcast receiver aerial. Except on cross country routes high tension and low tension cables are invariably carried on the same poles. The harmful effects of high tension interference can usually be reduced to a satisfactory level by using an efficient out-door aerial and a line filter in the power supply to the receiver. High tension fry is responsible for 7% of the total number of complaints investigated in New South Wales.

(Continued on next page)

RADIO INTERFERENCE—(Continued)—

Electric Trams

Another form of interference sounding not unlike clicks from a telegraph key, but which fortunately is confined to the cities, is that due to the electric trams. Broadcast listeners living alongside the routes of the trams or the routes of the electric supply cables feeding the trams experience this trouble. The noise is easily recognised by experienced observers as the clicks generally occur in groups of several minute explosions with



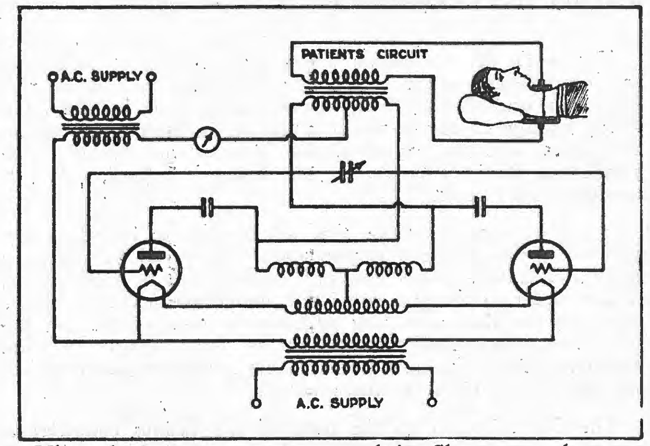
Theoretical circuit of diathermy equipment showing its similarity to a common spark transmitter.

comparatively long periods of silence and so lack the even continuity of morse signals. As with high tension interference so with tramway noise, the direct radiation is small compared with the amount of noise that reaches the broadcast aerial via the low tension house supply wiring. This is made possible by the practice of carrying tramway feeder cables and low tension services on common poles. The same remedy applies, i.e., an outside aerial of liberal dimensions and a line filter. In recommending these precautions it is safe to predict complete freedom of noise on all local stations anywhere in the Metropolitan areas of Newcastle and Sydney, New South Wales. In some suburbs of Sydney the tramway power cables do not follow the tramtracks but cut across country, as it were, to supply adjacent services. It is often difficult to convince listeners in these areas that their interference is due to the electric trams as they might be some miles distant therefrom. The trouble, of course, is caused through both tramway and domestic supply mains being carried on the same poles and the latter coming within the influence of the field of the former. Radio interference is generated at the tram as the motorman moves the control arm over the starter studs and this is reflected back along the supply wires and the effects induced into any circuits coming within their fields. The statistics show that traction services are responsible for only 5% of all radio noises in New South Wales.

The inventory of interfering sources is now complete as the balance of the complaints—12%—is disposed of under the heading of "trouble disappeared." They represent cases where the interference had disappeared of its own volition before the Radio Inspector's investigations were completed.

Legislation

It is felt that a paper of this kind would not be complete without some reference to the methods employed to induce owners of interfering electrical plant to install suppressor apparatus and the advisability of having this phase of the problem controlled by legislation. The wisdom of such a course has been debated in all the leading European countries and has been subjected to lengthy discussion in the United States of America. Some idea of the difficulties involved may be gleaned from the fact that numerous International Conferences have been held during the past two years but as yet no finality has been reached regarding the major aspects of the problem. In June, 1933, a Conference of The International Electro-technical Commission held in Paris, appointed a Special Committee to study technical questions relating to broadcast interference. The



Ultra short wave generator used in Short-wave therapy treatment. No radio inductive interference is caused by apparatus of this type.

activities of this Committee are not generally known to all parties interested in broadcasting, especially in countries remote from Europe, and this perhaps is responsible for the impression in some quarters that no progress is being made, and that the question as a whole is not receiving consideration. Obviously the question of legislation is outside the scope of the International Electro-technical Commission, so the object of their interest in the matter is to investigate the technical details essential to such legislation and to determine, for international enlightenment, whether the compulsory suppression of radio inductive interference is feasible. Sub-Committees have been appointed to report on the desirable and practical numerical limits to the interference with reception due to electrical apparatus and the most effective and practical method of measuring the interference from electrical apparatus.

Regarding the former it is interesting to note that the following resolution was unanimously adopted:—

> "No protection is, so far, being considered in the case of wanted signals having a field of less than 1 millivolt per metre."

It will be noted that the figure 1 millivolt per metre is agreed upon only for the purpose of the present experiments and is not intended to represent the lower limit of useful signal strength. In Australia, experience shows that signals of .25 millivolt per metre provide reasonably fair service.

Regarding the method to be used in measuring the interference for the purpose of fixing a permissible value of the interfering voltage, three dissimilar methods are being investigated, in England, France and Germany respectively. In the British method the interfering field is measured at the site of the listener's receiving aerial. In order to ascertain the interference produced by a machine or any electrical appliance, the field is measured at a number of points about two metres away from the machine or appliance.

In the French method, the low frequency currents produced at the loud-speaker terminals by a test signal and by the interference are measured successively by means of a standard receiver comprising a linear detector and amplifier.

In the German method, the high frequency voltage produced at the terminals of the interfering electrical appliance is measured, and the attenuation of the interference between the source and the input terminals of a receiver is evaluated, thus enabling the interfering E.M.F. applied to the receiver to be calculated.

Tests are now being carried out for the purpose of selecting one of these three methods or of establishing any other method which may be proposed for international use. A recent report of these activities shows that, after carrying out a few tests, the Experts Committee arrived at the conclusion that the three methods and the three groups of apparatus could not be compared on a common qualitative and quantitative basis.

(Continued on next page)

RADIO INTERFERENCE—(Continued)—

The work of establishing a practical method of measuring the interference for recommendation to those countries desiring legislation and that of fixing a permissible value for the interfering voltage of any electrical appliance, is, therefore, proceeding apace, and the report of the International Special Committee on Radio Interference set down for April, 1935, is awaited with interest.

It can be seen, therefore, that any attempt to introduce legislation at this juncture is premature. It would be necessary for the Act to stipulate the permissible value of interference, and in order to obtain a conviction under the Act, it would be necessary for the controlling authority to measure the interference from the offending appliance to show that it exceeded the permissible value. At present there is no recognised method of determining either of these values.

The determination on the parts of the various countries to arrive at some practicable means of enacting legislative control of interference sources suggests, by implication, that the present method of co-operation and persuasion is completely abortive. Such, however, is far from true. In the first place (as reference to the statistics will show) only 47% of the sources of interference require the installation of special apparatus to effect suppression. The balance is due either to defects which are remedied as soon as they are located or to causes, the effects of which, it is possible to avoid by adopting certain precautions at the receiving end (tramway noise, high tension fry, etc.). The 47% requiring suppressor apparatus refers to commutator plant and electrical apparatus which in its normal condition causes radio interference. Fully 50% of this is owned by Municipal bodies, Government Departments or private companies of high standing all of whom unhesitatingly adopt any approved measures within reason to render innocuous the plant under their control.

There remains then a bare 23½% of cases where it is difficult but by no means impossible, to persuade the responsible parties to instal suppressor apparatus for the purpose of eliminating radio interference. This surely is ample justification for a continuance of the present policy which every day shows hope of still greater success. For this success the Department realises its indebtedness to those Government Departments, Municipal bodies, private Companies and individuals, appreciating their co-operation in the past and anticipating a continuance of that help without which its present policy would be rendered considerably less effective.

British Standard Specifications for Suppression Equipment

THE standard, which is known as B.S. 613, is very complete in its treatment, all classes of interference suppression devices being dealt with, except those for application to traction equipment.

Twenty-two recommended circuits are given, which are reproduced herewith.

It will be noticed that in every case a suffix is given to the condenser notation, such as "A" or "B." This denotes the category under which the condenser suitable for the position falls with regard to voltage rating. This rating naturally varies with the supply voltage of the device on which the condenser is used, but condensers for position "A" should have a 1500 volt D.C. test rating between terminals and a 1500 volt A.C. test rating between terminals and metal casing, when used on supply lines up to 250 volts D.C. or A.C. For use on supply voltages between 250 and 500 volts voltages between 250 and 500 volts A.C., condensers for position "A" must have a test rating of 2000 volts A.C. between both terminals and to the metal casing. The final "A" rating, that for condensers used on D.C. lines between 250 and 500 volts, also applies to condensers used for position "B" on all supply voltages. The test rating in this case must be 1500 volts A.C. between terminals and between terminals and casing.

Any inductances used must be capable of withstanding a test voltage of 2000 volts A.C. applied between windings and between windings and earth.

The circuits are to a large extent self-explanatory and no constants are given.

However, an outline of the appliances to which each suppression circuit is applicable should be of interest and prove a useful guide to the use of the circuits.

Fig. 1 is what might be termed a basic filter circuit and is applicable to almost any apparatus operating from a D.C. source. Fig. 2 is a modified version of the same circuit and is used in cases where severe interference is being developed and it is desirable to prevent any of it being **radiated** via the mains. Fig. 3 is applicable in most cases where it is required to prevent any interference from **reaching** an appliance, such as a radio set, via the mains. Figs. 4 and 5 are useful in cases where an earth is not convenient and Fig. 7 is a variation of these two, for use in cases where severe interference is being experienced from A.C. or D.C. apparatus.

Figs. 6, 8 (a) and 8 (b) might almost be termed A.C. versions of Figs. 1, 2 and 3, as they are found to be somewhat more effective on A.C. operated apparatus than the other three circuits.

The circuits shown in 9 (a) and 9 (b) are of particular value where intense interference is experienced from any appliance operating on either A.C. or D.C. The former is suitable for use when a satisfactory earth is not available. Fig 9 (b) reversed, makes an ideal line filter for radio receiver use. Fig. 10 is applicable wherever a vibrating contact is creating interference, although in severe cases it may be necessary to elaborate the system somewhat and use the arrangement of Fig 12. Fig. 11 is a switch filter, and is of assistance in suppressing interference created by thermostats and similar control devices. Neon signs creating a noise can usually be quietened by the use of the circuit given in Fig. 13. L in this case is an iron cored choke of 50 henries inductance, and the centre of the H.T. secondary of the transformer is earthed.

Every little while one comes across a rotary or vibrator type battery charger, and, if it isn't already filtered, it certainly needs it. Figs. 14 and 15 are alternative circuits, and the use of one or the other will usually cure the complaint.

The amount of interference created by mercury arc type rectifiers is fairly well known to most radio engineers, especially if they have used some of the smaller versions in receiving sets. Three recommended circuits for treatment of commercial arcs are shown in Figs. 16 (a), (b) and (c), the circuit used being dependent on the severity of the interference.

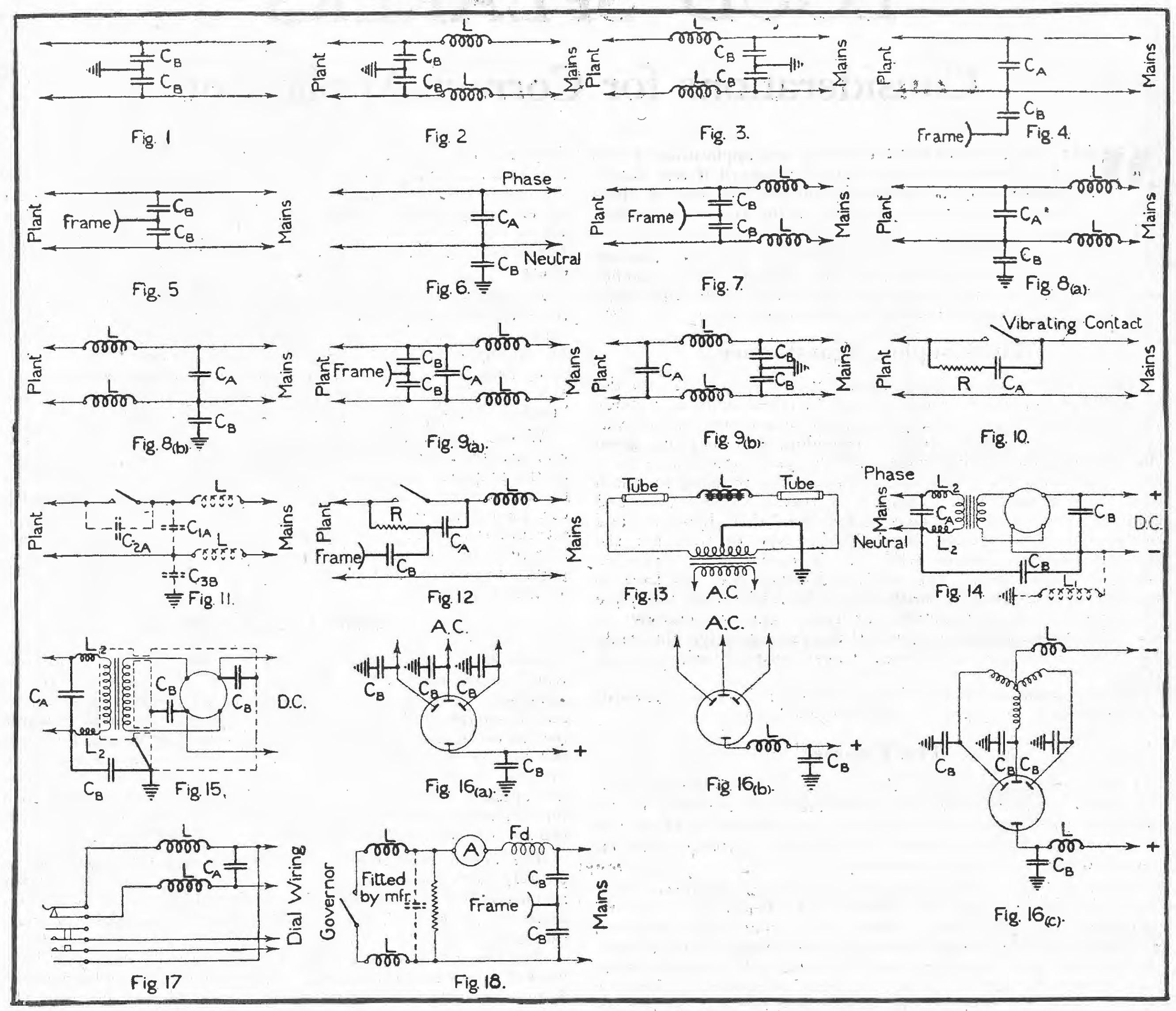
Those annoying clicks sometimes heard when a nearby telephone is dialled can be silenced very easily by the use of a circuit such as Fig. 17, but it might be as well to ascertain what the Post Office has to say about the matter first.

Fig. 18 is the last on the list and refers to the circuit arrangement necessary to suppress interference arising from the use of teleprinters ticker tape machines and similar apparatus.

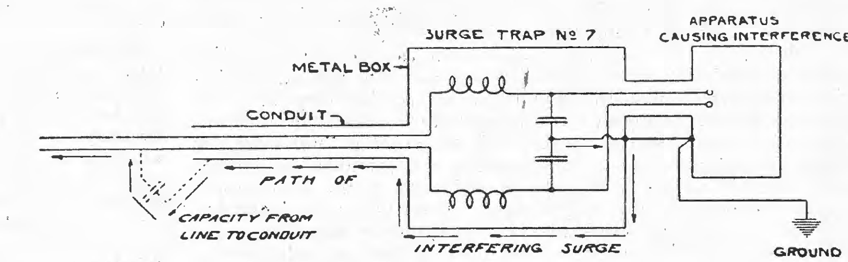
A careful perusal of these circuits should be of great value to any engineer or serviceman who has anything to do with installation or maintenance of electrical apparatus of any kind. Experience will dictate the actual constants to be employed in each case, and, when something new arises, the "cut and try" method of determination often proves to be the most satisfactory.

(See diagram on next page)

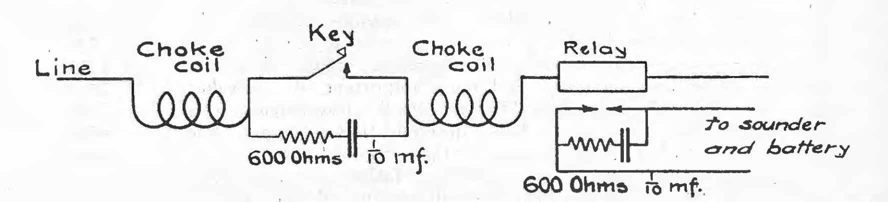
CIRCUIT DIAGRAMS FOR SUPPRESSION EQUIPMENT



This shows a standard type of suppressor filter. Where supply wiring to interfering apparatus is run in conduit earthed to the metal covering of the appliance precautions must be taken to guard against the condensers and metal coverings acting as bypass for the R.F. energy back to the conduit and so out into the electric supply wiring. This condition is illustrated above so it becomes necessary to remove the condensers from their present position between coils and interference source and reconnect them across the line at the electric supply end of the coils.



Interference caused by telegraph or telephone equipment and any thermostatically controlled electrical device is usually corrected by installing a spark quench across the make and break contacts. In many cases, however, it is necessary in addition to use choke coils at the points illustrated in the diagram.



LOUD SPEAKERS

Considerations for Correct Application

MANY factors enter into the design and application of loud speakers which must be carefully observed if any degree of fidelity is to be achieved, and not the least of these is correct matching of the reproducer to the receiver to which it is connected.

Matching is not only a matter of ensuring that the coupling transformer has the correct ratio. The subject goes far deeper than that, and includes consideration of cabinet size and shape and the power supply available for field energisation.

The Coupling Transformer

The matter of the coupling transformer is largely one for the speaker manufacturers, and they can be relied upon to provide the right transformer for any particular output stage which will match their voice coil assembly, **providing that they are given the correct data on that stage.** A few years ago it may have been quite in order to say that a speaker was required to match a 47 (for instance) and leave it at that. Modern tube and receiver design calls for more detail than that, however, and to-day one must specify not only the type of tube but the circuit conditions under which it is operating if optimum efficiency is required. The receiver designer does not have to indulge in any abstruse mathematics to realise that the plate resistance of an output tube, or tubes, depends **entirely** on the operating conditions, and that, consequently, the plate load for maximum undistorted power output varies accordingly.

Careful attention to this factor will go a long way towards the realisation of greater reproducer efficiency.

The Cabinet

Once upon a time (no, this is not a fairy story!) when "dynamic" speakers were first introduced to an admiring world, designers who used them could tell you without thinking just how much baffle area would be required to ensure even response down to a given frequency.

Without casting any aspersions on to-day's technicians, it is quite safe to say that the number who know the "cut-off" frequency of their radio cabinets is a very small minority. Probably the others think that it doesn't matter, but it does. An old formula, which provides a reasonable approximation, tells us that the side of a baffle necessary to ensure reproduction of any frequency without attenuation must be equal to a quarter of the wave-length of that frequency. Since sound travels at somewhat over 1,100 feet per second in still air, a little calculation shows us that the "cut-off" frequency of the average radio cabinet is about 80 cycles.

This does not necessarily mean that no frequencies under this will be reproduced, but it does mean that the attenuation of frequencies below this will be so severe that they will contribute practically nothing to the over-all response. In addition, it also means that the speaker will be running "unloaded" at lower frequencies, and, consequently, the motional impedance of the voice coil will be reduced and, with it, the load impedance presented to the output stage. Distortion must inevitably follow, as well as overloading of the output stage on these frequencies. This, in turn, will tend to set up audio modulation of the power supply with a whole string of repercussions such as oscillator drift and amplitude distortion in other stages. The overall response of the receiver is thus affected.

From the foregoing it should be fairly obvious why the cabinet enters into speaker matching. Firstly, it is useless using a speaker which will reproduce a frequency lower than the cabinet cut-off and secondly, and more important, if a speaker is used which will reproduce "below cut-off" frequencies, it is essential that the audio stages be so designed that no appreciable audio output is fed to the speaker at these frequencies.

Two alternatives are thus available. Either use a speaker which cuts off somewhere near the cabinet cut-off, and, preferably, has the design improved on the "top" register or design the audio end in such a way that it "matches" the cabinet. A combination of both these systems is desirable, if the ultimate in efficiency is to be achieved, and this is another instance where full co-operation between the speaker and receiver manufacturers is desirable and can have nothing but a beneficial effect.

In connection with this subject, it is of interest to note that the overload point of any amplifier channel is set by the low frequencies, often before anything like peak rating is reached by the upper register. Elimination of unusable "lows" therefore, besides having the effects mentioned above, will also enable greater attention to be paid to the reproduction of the "highs" in their correct proportion.

Where frequencies below the normal "cut-off" of the cabinet are required, it is quite obvious that neither accentuation of the amplifier response, or peaking of the speaker response at these frequencies will be of any help. The only methods which can be employed are the increase of the cabinet size and the introduction of artificial speaker loading by means of acoustic labyrinths or re-entrant baffles. This latter subject is one of great importance, and further details are appended at the end of this section.

Field Energisation

This is the third and last, but not least, of the conditions which must be satisfied if satisfactory "matching" is to be achieved. The problem of providing adequate field energisation is complicated somewhat by the present-day trends towards the universal use of the speaker field as a filter choke, but even the voltage requirements of the receiver do not absolve the designer from the necessity of ensuring adequate energisation of the speaker field magnet. Obviously, it is useless going to a lot of trouble perfecting the receiver circuit if the field supply to the speaker only allows it to operate at half-efficiency.

The actual arrangement of the field and filter networks is entirely dependent on the receiver designer, as all speaker manufacturers provide the maximum and minimum field energisations permissible, together with a recommended "normal" rating.

Analysis of a number of speakers available on the local market shows that the average recommended ratings lie between 5 and 10 watts and that the resistances used vary between 750 and 8,000 ohms. A table is given below which shows the voltage and current requirements which must be supplied if five or ten watts of energisation is to be supplied to speaker fields over a range of resistances between the limits mentioned.

A word of warning must be added, however, against too much energisation. Actually saturation of the field magnet will not affect speaker performance directly, but the heat developed is bound to have a serious effect. Not only is the majority of the heat concentrated in the centre of the coil where it will have a tendency to distort the voice coil, but heat will reduce the insulation properties of the covering on the wire used and lead to premature breakdown. So, on this count, if no other, adhere to the manufacturers' rating.

Voltage and Current Ratings for Five and Ten Watt Field Energisation

Resistance	5 Watts	10 Watts
750	60 v — 85 mA	85 v — 120 mA
1200	75 v — 70 mA	110 v — 95 mA
2000	100 v — 50 mA	145 v — 75 mA
2500	110 v — 45 mA	160 v — 65 mA
4500	150 v — 35 mA	220 v — 45 mA
8000	200 v — 25 mA	290 v — 37 mA

(Continued on page 234)

LOUD SPEAKERS—(Continued)—

These ratings are only approximate, but will provide a useful guide. Ratings between the five and ten-watt limits may be found by the formula:—Watts = voltage by current, or, if the current is unknown, watts = voltage squared and divided by the resistance of the field coil in ohms; where "voltage" is the voltage drop across the speaker field and "current" is the total current drain through the field coil in amperes (e.g. 100 mA should be expressed as 0.1 ampere).

The resistance calculation chart provided in the earlier section on resistances for radio receivers will prove very useful for the purpose of determining field energisation details, as only two known quantities of the four involved are required in order to obtain complete particulars.

Speaker Coupling Transformers

Determination of Correct Ratio

It is sometimes necessary to determine the correct step-down ratio which will be required in a coupling transformer for matching the voice coil of a "dynamic" speaker to an output tube.

The necessity will seldom arise in ordinary receiver manufacture as the speakers used are normally supplied with coupling transformers already fitted, the specifications of which are attended to by the speaker manufacturers after being supplied with the necessary output tube data, as detailed in the first section of the above article.

The information will be of value, however, to designers of P.A. equipment and also to servicemen who wish to run a remote speaker from the transformer that feeds the speaker at the receiver.

The data necessary for the determination of transformer ratio are the optimum plate load of the output tube (supplied by the tube manufacturers on their characteristic charts) and the **motional** impedance of the voice coil in question.

Having obtained these, the correct transformer ratio is easily determined as it is the **square root** of the ratio of the tube plate load to the voice coil impedance. An example will help to clarify this. We will assume that the tube in use has a rated plate load of 4,000 ohms and that the voice coil an impedance of 10 ohms. The ratio of these is 400 to 1; the square root of 400 is 20, so that a transformer with a ratio of 20 to 1 will be required.

When working out the ratio required for matching to a push-pull stage, it should be remembered that the plate load figure is the plate-to-plate load resistance and not that of only one tube.

The motional impedance of a speaker voice coil may not always be known. Actually, it is a variable factor dependent on the baffling (or rather, the loading) of the speaker, the D.C. resistance of the coil and its reactance. In most cases, however, it will be found that the motional impedance remains constant over the audio frequency range at a value equal to about 1.3 times the D.C. resistance of the coil, when the D.C. resistance of the coil is under 10 ohms. For D.C. resistances above 10 ohms the ratio of motional impedance to D.C. resistance will increase and will not be so constant. However, practically all moving-coil speakers use low-resistance voice coils nowadays and the 1.3 multiplication factor will provide a reasonably accurate evaluation for motional impedance once the D.C. resistance is known. This may readily be ascertained by means of a low-reading ohmmeter.

The Acoustic Labyrinth

All radio engineers will be interested in the following description of the Acoustic Labyrinth by Dr. Ray. H. Manson, Chief Engineer of Stromberg-Carlson (U.S.A.). This article forms part of a paper on "High Fidelity" by Dr. Manson which appeared in the January, February, April and May (1936) issues of the "Radio Review of Australia."

Avoiding Cabinet Cavity Resonance by the Acoustical Labyrinth

It was found early in the development of a high fidelity type of radio receiver in the Stromberg-Carlson Laboratories that smooth over-all response could not be obtained when the loud speakers were enclosed in the usual way in a radio cabinet.

After a long period of research by Stromberg-Carlson Engineers a complete remedy for cabinet cavity resonance distortion (boominess in reproduction) was found in what is known as an **"Acoustical Labyrinth"** which, by the way, is an exclusive Stromberg-Carlson development.

The essential feature of the Acoustical Labyrinth System consists of the prevention of the sound coming from the back of the loud speaker from being discharged into the interior of the cabinet.

This is accomplished by the application of a housing around the rear of the low frequency speaker; this housing communicating with free air through a conduit lined with a material having a high value of acoustic absorption. Due to the fact that this conduit must have considerable length and ample (rectangular) cross-sectional area, and at the same time fit into a limited space in the radio cabinet, it is made in the form of a labyrinth as shown in fig. 1.

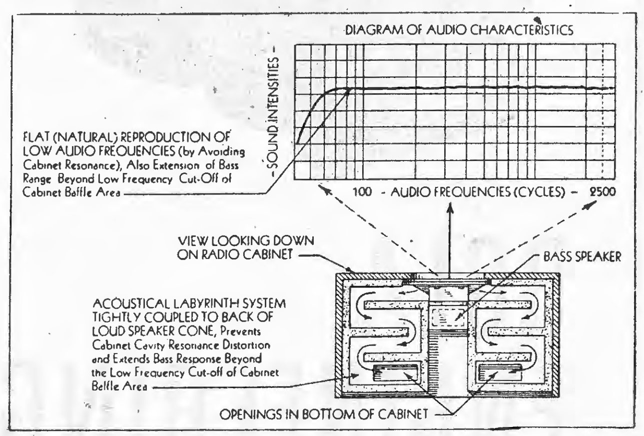


Fig. 1

This diagram shows the type of Labyrinth used in one Stromberg-Carlson Receiver. It consists of two separate units symmetrically connected to the openings at the rear of the loud speaker, with the other ends of the conduits discharging through openings located in the bottom, and at the rear of, the cabinet. This provides a balanced acoustical load to the back of the speaker cone, preventing any uneven action that might drive it out of line.

Besides completely doing away with the boomy type of reproduction produced by cabinet cavity resonance in the ordinary receiver, the Acoustical Labyrinth makes it possible for the first time in radio, to place a radio cabinet tightly against a wall without change in its acoustical operating characteristics. Also, corner of room locations, or any other desirable position for the receiver can be selected to suit the listeners without experiencing the usual difficulties of sound wave interference that occurs with all other radio receivers (not using the Acoustical Labyrinth) that radiate freely from both front and back of the loud speaker.

Increasing the Low Frequency Range

Up to the time of the introduction of the Acoustical Labyrinth the only method for effectively extending the low frequency range in a radio receiver using a dynamic type of speaker, was to increase the baffle area of the cabinet. For a given size (baffle area) of cabinet, the Acoustical Labyrinth can be so proportioned as to reinforce the low frequency response just below the natural cut-off due to baffle limitation.

This extension of bass frequencies is obtained by making the air column in the Labyrinth resonate at a frequency just below the baffle cut off of the cabinet, and to broaden the tuning of this Labyrinth air column by scientific design of the shape of conduit, the orifice of the conduit, and the absorbing materials employed, so that the resulting low frequency response is smooth and completely free from distortion peaks.

(Continued on page 236)

LOUD SPEAKERS—(Continued)—

The application of the above feature of the Acoustical Labyrinth gives a more extended low frequency (bass) range, than would be otherwise possible for a given cabinet. This is clearly shown by comparing the flat and extended low frequency (bass) audio characteristics of the speaker system employed in fig. 1 with the limited and sharply sloping low frequency (bass) audio characteristics of a regular speaker system, as shown in fig. 2. The cabinets employed in both of these examples are of the same size and shape, so that the excellent performance shown in fig. 1 is due to the beneficial effect of the Acoustical Labyrinth.

Increasing Power Handling Ability of Loud Speaker

In addition to the two important improvements in reproduction already ascribed to the Acoustical Labyrinth, it has been found that the power handling ability of the loud speaker at low frequencies (bass response) has been greatly increased over that of a regular cabinet installation. This is due to the augmented acoustic load afforded by the conduit of the Labyrinth Unit. Thus, low frequency (bass) speakers are capable of greater undistorted sound outputs than would be the case if these speakers were operated in console cabinets, less the Labyrinth.

Accuracy of Loud Speaker Cone Action

In the ordinary design of dynamic speaker, mounted in a cabinet with both sides open to the air, there is a tendency for the cone to continue to vibrate after the actuating impulse is stopped, especially for the low frequency sounds. In ordinary speech and musical reproduction extra sound impulses are set up that are the result of persistence of cone motion and tend to produce "blurred" or "fuzzy" reproduction which a musician might characterise as lacking in "firmness."

The enclosing of the rear of a speaker by the Acoustical Labyrinth makes it possible to employ the "damping" effect of the column of air in the Labyrinth conduits to overcome persistence of motion of the speaker cone. Thus, a single impulse of sound at the broadcast station microphone will be reproduced as a single impulse of sound, when an Acoustic Labyrinth is used, and a "thump" sounds like a "thump" and not a "buzz."

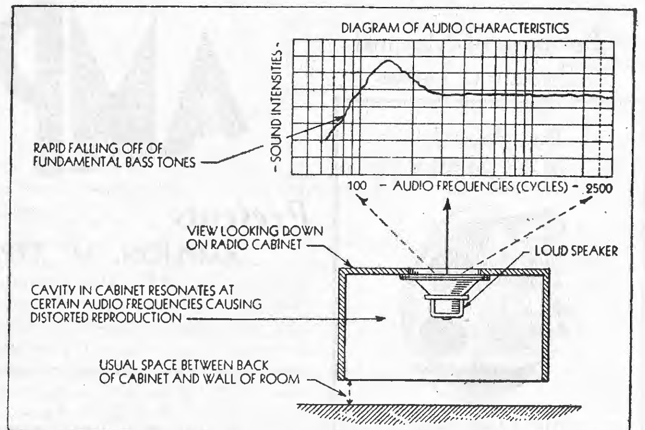


Fig. 2

To make this correction of persistence of loud speaker cone motion completely effective, the bass speaker should have an exceptionally strong magnetic field, which, combined with a very low impedance audio output circuit in the radio chassis and correct voice coil design, provides very efficient electro-acoustic damping for the cone assembly.

The final result of these two corrective measures from the standpoint of the listener is a more natural or "firm" quality of musical reproduction and a startling accuracy of reproduction of impulsive sounds.

The four important advancements in fidelity of reproduction made possible by the Acoustical Labyrinth described in this and the three preceding sections of this paper assure better reproduction of all radio programmes. In other words, it is not necessary to have a so-called "high-fidelity broadcast" in order to obtain a very noticeable improvement in reproduction, over that of receivers not provided with the Acoustical Labyrinth.

(Continued on next page)

Recent Receiver Circuit Developments

THE various factors underlying the operation of the modern superheterodyne receiver are sufficiently well-known by this time and require no elaboration. However, several important contributions have been made from overseas to circuit design practice in the course of the past twelve months or so, which can be classed as refinements. A brief description of the major points in the operation of these refinements follows.

High Fidelity

THE term "high fidelity" has been so much abused recently that the average reader will be inclined to wonder whether there is "such an animal." There is, and it is the subject of an R.M.A. (U.S.A.) standard which must be reached before the term may be used in its true sense.

As the means for the realisation of "high fidelity" are many and involved, it will serve the purpose of this resume to detail the standard requirements.

Strictly speaking, the standard refers to broadcast transmitters, and, in this respect, has been sponsored by the Federal Communications Commission of U.S.A. The fact that it refers to transmitters does not affect the receiver end as, obviously, if a receiver is to be termed "high-fidelity" it must be capable of reproducing the transmission of a "high-fidelity" transmitter without distortion of any kind.

Frequency response is the first consideration, and in this respect the standard says that the audio component shall not depart more than 2 decibels (plus or minus) from that at 1,000 cycles between 50 and 7,500 cycles.

Distortion or Harmonic content is next on the list and here the standard specifies that the total harmonic content shall not exceed 5% (r.m.s.) for transmitters modulating up to 85%. 95% modulated stations must not exceed a harmonic content of 10%.

There are two other provisions, relating to permissible noise level and volume range, but these are of no immediate interest as the receiver designer is largely in the hands of the broadcast station engineer in these respects.

Variable Selectivity.—X.P.S.

The consideration of "high-fidelity" brings variable selectivity to mind, as it was largely on account of high-fidelity requirements that "X.P.S." or "expanding selectors" (as variable selectivity systems have been termed in U.S.A.) were developed.

It is readily apparent that if a receiver is to reproduce all frequencies up to 7,500 cycles, without attenuation, its tuned circuits must be capable of passing a band-width of 15 Kc/sec. (unless single side-band transmission is employed). However, all stations are not of the high-fidelity type, and, moreover, are mostly only separated by 10 Kc/sec. It follows then, that a large amount of interference would be picked up by a receiver adjusted for high-fidelity operation. To overcome this difficulty, expanding selector or variable selectivity systems have been developed, which, in their simplest forms, vary the band-width of the I.F. tuned circuits of a receiver from about 6 Kc/sec. to the 15 Kc/sec. necessary for high-fidelity reception. The "sharp" position makes greater selectivity available than is normally necessary for "standard" reception so that clear reception may be obtained in congested areas. More elaborate devices control the high-frequency cut-off of the audio channel and the R.F. tuner band-width as well as the I.F. stages.

Some form of variable selectivity control is a valuable adjunct to any receiver even if its audio channel is not capable of high-fidelity reproduction. The reason for this will be quite clear when it is remembered that the requirements for selectivity and fidelity of reproduction are diametrically opposed. Consequently, the design of a receiver intended for use under all conditions must be a compromise between the two, with the balance somewhat in favour of selectivity. The selectivity required for distant reception is naturally considerably higher than for local reception, and a "production" receiver must be adjusted for use under the worst possible conditions. As a result, local reception will usually suffer in quality, due to the percentage of side-band cutting which must ensue when selectivity is carried to the point necessary for interference-free distant reception. The provision of a control for the variation of selectivity will overcome this difficulty and allow the full range of frequencies radiated by locals to be received without attenuation while still having sufficient selectivity "on tap" for distant reception.

Several types of devices have been developed, the most popular of which consists of a mechanism for varying the spacing of the coils in the I.F. transformers of a receiver. Other devices consist of variable damping across the tuned circuits (by means of a variable resistor) or coupling the various tuned circuits by mutual inductors, the value of which is variable.

Automatic Selectivity Control.—A.S.C.

Automatic selectivity control is a variant of the expanding selector area, the only fundamental difference being that the control is automatic instead of being manual.

This type of control takes advantage of the fact that the carrier of a local station is many times stronger than that of a distant one. The system is operated by the variable damping method (i.e., selectivity is varied by means of variable damping across the tuned circuits); the damping being applied by shunting the plate-filament resistance of a vacuum tube across the tuned circuit under consideration. Biassing this tube to "cut-off" will result in the shunting (or damping) being negligible while reduction of the bias to zero will have the reverse effect.

In practice, the shunt tubes are fixed-biassed to cut-off, or thereabouts, thus ensuring maximum selectivity under "no-signal" conditions. A diode rectifier of the A.V.C. type is arranged to deliver a **positive** voltage to the grids of the shunt tubes; the magnitude of this voltage being dependent on the carrier strength. This voltage tends to neutralise the "cut-off" bias already applied, with the result that the degree of damping applied to the tuned circuits is increased and the band response is broadened. Apart from the obvious advantage of a system such as this, there is another advantage in that, due to the reduced band-width when a weak signal is being received, the normal increase in noise noticed on an A.V.C. equipped receiver when a station fades, is largely eliminated.

Disadvantages of the system are the extra number of valves required (one for each controlled circuit) and the extremely critical circuit adjustment required.

Automatic Tuning Correction.—A.T.C.

Almost as a natural corollary to A.S.C. comes automatic tuning correction, or control as it is sometimes termed. The function of this system is to relieve the listener of the delicate job entailed in accurately tuning a modern receiver and also to maintain accurate tuning of the receiver over long periods of time. The system operates by virtue of the Miller Effect—the grid input capacitance of a vacuum tube varies in accordance with its amplification factor—and is worked in conjunction with two filters in the I.F. circuit which are tuned to the extreme frequency limits of the I.F. band response.

RECENT RECEIVER CIRCUIT DEVELOPMENTS. (Continued)—

The input capacity of a vacuum tube is shunted across the tuned circuit of the receiver oscillator. This tube is biassed to somewhere near its mid-point and therefore its input capacity is at an average value. If the I.F. channel is designed to have a band width of 10 Kc/sec., one of the filters is tuned to the I.F. plus 5 Kc/sec., and the other to the I.F. minus 5 Kc/sec. The response of these filters is arranged so that it tapers to zero at the correct I.F.

Mistuning the receiver by 5 Kc/sec. from a wanted carrier will cause the developed I.F. to be 5 Kc/sec. high or low with reference to the correct I.F. A portion of the signal is therefore accepted by the appropriate filter, which in turn feeds an associated diode rectifier. The voltage from this rectifier is fed to the control tube on the oscillator, resulting in a change of its input capacity in a direction governed by the filter and rectifier which is operating at the time. This in turn changes the oscillator frequency and corrects the tuning error. Obviously, one rectifier is designed to develop positive control voltage and the other negative. Tuning corrections up to plus or minus 20 Kc/sec. may be made by this system, but, in practice, the range of correction is adjusted in accordance with the channel allocations of the stations being received. A point which must also be borne in mind is that if the receiver is tuned midway between a strong and a weak station, the strong station will be the one "tuned in."

The system is really very simple in its operation and only requires two extra valves for its operation, a triode and a twin-diode. Provision is usually made for cutting out the A.T.C. until manual tuning has been accomplished. The value of a system such as this is most pronounced on "high-fidelity" receivers where ordinary resonance indicators are useless due to the essentially flat response of the tuned circuits over an appreciable band-width. Another advantage, apart from the correction of manual mistuning, is that the effects of oscillator drift (due to temperature and voltage changes) are also corrected.

Volume Expansion

One of the most interesting innovations made during the past year or so is that of "volume" or "contrast" expansion.

It is a fairly well known fact that the volume range of an orchestra or band is considerably greater than that which can be handled by the amplifying circuits used in broadcasting or recording. Consequently, the electrical output of the microphones used for pick-up purposes must be "monitored" until a usable volume range is reached. This means that the "low" passages must be lifted and the "loud" passages cut back.

The extent of this range compression may be appreciated from the fact that the volume range of a full orchestra or brass band may be in excess of 60 D.B. (1,000,000 to 1). Somewhere near 40 DB. (10,000 to 1) is about the maximum that can be handled by a transmitter or in recordings, and a range of 30 DB. (1,000 to 1) is nearer to the average. From this it will be seen that "compression" of the volume range by about 20 to 30 DB. must be effected. Much of the original beauty of the musical selection is thus lost and this constitutes one of the major bars to true high-fidelity.

The volume expansion circuits which have been introduced recently, provide a means for correcting this difficulty as, by their use, expansion ratios of up to 10 or 20 DB. may be obtained in the reproducing amplifier and much of the original contrast restored.

In essence, the expansion system consists of a "reversed A.V.C." circuit applied to one or more of the tubes in the audio channel used for reproduction, either of radio signals or the output of a gramophone pick-up.

In practice, a portion of the audio signal is fed into a subsidiary audio amplifier and the output of this amplifier rectified so that positive voltages of an amplitude dependent on the audio signal level are developed. One of the tubes in the main amplifier is of the extended cut-off type with linear grid control characteristics and is normally biassed so that its amplification is very low. The positive voltages developed by the subsidiary amplifier and rectifier are applied to this tube in opposition to the steady bias and tend to neutralise it. A certain amount of delay is provided in the rectifier circuit so that no control voltage is developed until a predetermined signal level is reached. As a result of this, soft passages remain exactly as they are, their level being controlled by the normal volume control. Loud signals, which exceed the delay level, neutralise a portion of the bias on the main amplifier and result in its gain ratio being increased. Loud signals are thus made louder, the degree of increase being regulated by the characteristics of the system.

The volume expansion system has proved remarkably successful when applied to the reproduction of phonograph records as the "compression" at the recording studios usually follows a definite rule and recording limitations are well defined.

Queer effects are likely to be obtained when the expander is used for the reproduction of broadcast signals, however, as no two stations have the same modulation capabilities and the type of matter broadcast is so varied in its nature that no definite compression law can be followed.

The system is of great interest, however, and maybe one of these days linear law "compressors" will be used instead of control room operators at broadcasting stations.

A point which must be borne in mind is that there is a definite limit to the degree of expansion which it is possible to use. This limit is set by the peak output of which the reproducing system is capable. For the purpose of illustration, we will assume that 10 milliwatts is the minimum level which can be used for soft passages. A volume range of 30 DB. (1,000 to 1) means that a maximum power of 10 watts will be required. Expansion by another 10 DB. means that the volume range goes up to 10,000 to 1 and, as a result 100 watts of peak power will be required for satisfactory reproduction. This is a most important consideration and limits the application of volume expansion to fairly high-power audio systems.

Automatic Bass Compensation.—A.B.C.

It is well-known that the ear is rather insensitive to sounds of very low frequencies when the sound intensity falls to low values. One result of this is that when the volume level on an ordinary receiver is reduced to a satisfactory value for home reception the music sounds thin, as though the low notes were missing. The automatic bass compensation circuit has been designed to overcome this defect of the ear.

Compensation is accomplished by the use of a supplementary A.F. amplifier which only amplifies the low notes, but has a gain of several times that of the original amplifier. The gain of this supplementary amplifier is controlled by a special audio A.V.C. system fed from the **output** of the main amplifier. A sharp cut-off tube is used in the first stage of the "bass" amplifier and the bias developed at high signal levels is sufficient to make this tube inoperative. The overall response is therefore that of the main amplifier alone. As the signal level is reduced, the bias drops too and the "bass" amplifier begins to operate and feeds a greater proportion of low notes into the main amplifier channel. By this means the bass response is kept aurally constant. Peaking of the low-frequency response of the "bass" amplifier is accomplished by using tuned choke coupling, the resonant frequency being chosen so that it is somewhere near the lower limit of the main amplifier response.

Two tubes, a sharp cut-off "high mu" tube and a duo-diode triode (low mu) are necessary for the operation of the system. the low mu triode section being used to couple the output of the bass amplifier to an intermediate A.F. stage in the main amplifier system.

The above descriptions cover the major innovations which have been made in broadcast receiver design overseas during the past twelve months or so. Very few examples, if any, of the various systems are yet to be found in Australian radio receivers, but a general idea of the systems and their operation should prove useful and will pave the way for a better understanding of the principles involved when they are introduced.

SHORT WAVE RECEPTION

List of Stations

It should not be thought that all the stations listed in the accompanying list will always be audible in Australia. It is only during periods of good conditions that it will be possible to hear the majority of them, and during the periods of bad conditions which are bound to occur it is sometimes impossible to hear with good strength more than three or four stations transmitting speech. In addition to the stations listed, numerous amateur 'phone stations in Australia and New Zealand can be heard between 75 and 85 metres (4000-3500 k.c.) at night, particularly in the winter months. In addition, on some evenings and during the week-ends, amateur 'phones may be heard on the so-called 40-metre band (41-42.8 metres, 7300-7000 k.c.). The third popular amateur band runs from 20.83 to 21.43 metres (14.400-14,000 k.c.), but is mainly used for Morse Code work.

Short Wave Broadcasting Bands

IT should be particularly noted that there are definite frequencies around which the short wave broadcasters are located. These are:—

16,000	Kc.	19 metres
12,000	,, ...	25 ,,
9,500	,, ...	31 ,,
6,000	,, ...	49 ,,
4,300	,, ...	70 ,,

Standard Times

Referred to Greenwich Time

Great Britain, France, Portugal, Belgium, Spain, Ireland	Greenwich time. ,, ,,
Austria, Denmark, Germany, Italy, Norway, Switzerland	1 hour fast.
British South Africa, Egypt, Turkey	$1\frac{1}{2}$ or 2 hours fast.
Japan	9 hours fast.
Australia	8, $9\frac{1}{2}$ or 10 hours fast.
New Zealand	$11\frac{1}{2}$ hours fast.
Canada and United States	4, 5, 6, 7 or 8 hours slow.

Short Wave Stations

Wave length and operating times of major overseas stations audible in Australia. All times given are Eastern Australian Standard Time.

75.00m.; CT2AJ, Azores. Thurs. and Sun. 8-10 a.m.
70.2 m.; RV15, Khabarovsk, U.S.S.R. Daily 6-11.15 p.m.
67.11m.; YDB, Sourabaya, Java. Daily 1.30-4.30 p.m.
51.28m.; YV5RMO, Maracaibo, Venezuela. Daily 8-10 a.m.
50.27m.; HVJ, Vatican. Daily 5-5.30 a.m.
50.00m.; XEBT, Mexico City, Mexico. Daily 10 a.m.-7 p.m.
50.00m.; RW59, Moscow, U.S.S.R. Daily 6-9 a.m.
49.83m.; DJC, Berlin. Daily 3-8 a.m.
49.83m.; CQN, Macao, China. Daily, evenings.
49.67m.; W1XAL, Boston, Mass., U.S.A. Sun. 8-10 a.m., Wed. Fri. 10-12 a.m.
49.59m.; GSA, Empire Station, Daventry, England.
49.5 m.; W8XAL, Cincinnati, Ohio, U.S.A. Daily 10 p.m.-4 a.m.
49.5 m.; W3XAU, Philadelphia, Pa., U.S.A. Relays WCAU. Daily 11 a.m.-3 p.m.
49.5 m.; VQ7LO, Nairobi, Kenya, Africa. Daily 1-6 a.m.
49.42m.; OER2, Vienna, Austria. Daily midnight- 8 a.m.
49.35m.; DJM, Zeesen, Germany.
49.33m.; W9XAA, Chicago, Ill., U.S.A. Relays WCLF, Mon. 5-7 a.m.
49.3 m.; 12RO, Rome, Italy. Mon., Wed., Fri. 9 a.m.-3 p.m.
49.2 m.; ZTJ, Johannesburg, South Africa. Daily.
49.18m.; W9XF, Chicago, Ill., U.S.A. Daily 7 a.m.-5 p.m.
49.18m.; W3XAL, Bound Brook, N.Y., U.S.A. Relays WJZ. Mon., Wed., Sat. 8-9 a.m.
49.10m.; GSL, Daventry, England. Empire Broadcasting.
49.10m.; VUC, Calcutta, India. Daily from 10.30 p.m.
49.02m.; YDA, Bandoeng, Java. Daily 8.30 p.m. to 12.40 a.m.
49.02m.; W2XE, Wayne, N.J., U.S.A. Relays WABC. Daily 1-2 p.m.
48.92m.; ZGE, Kuala Lumpur, Fed. Malay State. Sun., Tues., Fri., 9.40-11.40 p.m.
48.92m.; COCD, Havana, Cuba. Daily 9 a.m.-3 p.m.
48.86m.; W8XK, Pittsburg, Pa., U.S.A. Relays KDKA. Daily 7.30 a.m.-4 p.m.
47.50m.; HIZ, Santo Domingo, W. Indies. Daily 7.45-8.45 a.m.
46.69m.; W3XL, N.J., U.S.A. Experimental Service from Bound Brook Station.
46.52m.; HJ1ABB, Barranquilla, Colombia. Daily 7.30 a.m.-1.30 p.m.
45.38m.; RV72, Mancow, U.S.S.R. Daily 3 a.m.-8 a.m.
44.44m.; JPT, Nazaki, Japan. Daily 5-10 p.m.
42.86m. to 41.10m.; Band of wavelengths allotted to amateur transmitters.
38.48m.; HBP, Radio Nations, Prangins, Switzerland. Sun. only 8.30-9.30 a.m.
38.07m.; JVR, Japan. Daily 6-10 p.m.
34.29m.; ZCK, Hong Kong, China. Daily 8 p.m. to midnight. Relays ZBW.
31.8m.; COCH, Havana, Cuba. Daily from 2 a.m.
31.55m.; GSB, Daventry, England. Empire broadcasting.
31.54m.; VK3ME, Melbourne, Australia. Daily except Sun., 8-10 p.m.
31.48m.; LKJ1, Jeloy, Norway. Relays Oslo. Daily 8-11 p.m.
31.48m.; W2XAF, Schenectady, N.Y., U.S.A. Relays WGY. Daily 7.40 a.m.-noon.
31.45m.; DJN, Zeesen, Germany. Daily 6.35-10.15 p.m., 11 p.m.-2.30 a.m. and 8.15 a.m.-1.30 p.m.
31.38m.; DJA, Zeesen, Germany. Daily 11 p.m.-2.30 a.m. and 8.30 a.m.-noon.
31.36m.; VUB, Bombay, India. Daily except Tues. and Fri. 10.30-11.30 p.m.
31.35m.; W1XK, Millis, Mass., U.S.A. Relays WBZ. Daily from 10 p.m.
31.32m.; GSC, Daventry, England. Empire Broadcasting.
31.32m.; VK3LR, Lyndhurst, Australia. Daily ex. Sun. 6.15-10.30 p.m.
31.28m.; W3XAU, Philadelphia, Pa., U.S.A. Relays WCAU. Daily 3-10 a.m.
31.28m.; VK2ME, Sydney, Australia. Sun., 4 p.m.—Mon., 2.30 a.m.
31.27m.; HBL, Radio Nations, Prangins, Switzerland. Sun. only, 8.30-9.30 a.m.
31.13m.; I2RO, Rome, Italy. Tues., Thurs., Sat., 8 a.m.-10 a.m.
31.09m.; CT1AA, Lisbon, Portugal. Daily 6.30-9 a.m.
30.49m.; JYM, Japan. Irregular.
30.43m.; EAQ, Madrid, Spain. Daily, 8.15 a.m.-midday.

(Continued on page 241)

WORLD TIME CHART

Haw-aiian Is-lands	U.S.A. Pacific S.T.	U.S.A. Mountain S.T.	U.S.A. Central S.T.	U.S.A. New York, Wash-ington E.S.T.	Halifax, Buenos Aires	Rio de Janeiro, Brazil	London, Paris, Madrid	G.M.T. or G.C.T.	Sweden, Germany, Switzer-land, Italy	Petrograd, Con-stantin-ople, Capetown	Bagdad, Persia	India	Borneo, Java, Dutch E.I.	P.I., China, Western Austra-lia	Tokyo	Adelaide, South Aust.	Sydney, Mel-bourne, Eastern Aust.	New Zealand	Samoa
1.30	4.00	5.00	6.00	7.00	8.00	9.00	Midn.	0000	1.00	2.00	3.00	5.00	6.00	8.00	9.00	9.30	10.00	11.30	Noon
2.30	5.00	6.00	7.00	8.00	9.00	10.00	1.00	0100	2.00	3.00	4.00	6.00	7.00	9.00	10.00	10.30	11.00	12.30	1.00
3.30	6.00	7.00	8.00	9.00	10.00	11.00	2.00	0200	3.00	4.00	5.00	7.00	8.00	10.00	11.00	11.30	Noon	1.30	2.00
4.30	7.00	8.00	9.00	10.00	11.00	Midn.	3.00	0300	4.00	5.00	6.00	8.00	9.00	11.00	Noon	12.30	1.00	2.30	3.00
5.30	8.00	9.00	10.00	11.00	Midn.	1.00	4.00	0400	5.00	6.00	7.00	9.00	10.00	Noon	1.00	1.30	2.00	3.30	4.00
6.30	9.00	10.00	11.00	Midn.	1.00	2.00	5.00	0500	6.00	7.00	8.00	10.00	11.00	1.00	2.00	2.30	3.00	4.30	5.00
7.30	10.00	11.00	Midn.	1.00	2.00	3.00	6.00	0600	7.00	8.00	9.00	11.00	Noon	2.00	3.00	3.30	4.00	5.30	6.00
8.30	11.00	Midn.	1.00	2.00	3.00	4.00	7.00	0700	8.00	9.00	10.00	Noon	1.00	3.00	4.00	4.30	5.00	6.30	7.00
9.30	Midn.	1.00	2.00	3.00	4.00	5.00	8.00	0800	9.00	10.00	11.00	1.00	2.00	4.00	5.00	5.30	6.00	7.30	8.00
10.30	1.00	2.00	3.00	4.00	5.00	6.00	9.00	0900	10.00	11.00	Noon	2.00	3.00	5.00	6.00	6.30	7.00	8.30	9.00
11.30	2.00	3.00	4.00	5.00	6.00	7.00	10.00	1000	11.00	Noon	1.00	3.00	4.00	6.00	7.00	7.30	8.00	9.30	10.00
12.30	3.00	4.00	5.00	6.00	7.00	8.00	11.00	1100	Noon	1.00	2.00	4.00	5.00	7.00	8.00	8.30	9.00	10.30	11.00
1.30	4.00	5.00	6.00	7.00	8.00	9.00	Noon	1200	1.00	2.00	3.00	5.00	6.00	8.00	9.00	9.30	10.00	11.30	Midn.
2.30	5.00	6.00	7.00	8.00	9.00	10.00	1.00	1300	2.00	3.00	4.00	6.00	7.00	9.00	10.00	10.30	11.00	12.30	1.00
3.30	6.00	7.00	8.00	9.00	10.00	11.00	2.00	1400	3.00	4.00	5.00	7.00	8.00	10.00	11.00	11.30	Midn.	1.30	2.00
4.30	7.00	8.00	9.00	10.00	11.00	Noon	3.00	1500	4.00	5.00	6.00	8.00	9.00	11.00	Midn.	12.30	1.00	2.30	3.00
5.30	8.00	9.00	10.00	11.00	Noon	1.00	4.00	1600	5.00	6.00	7.00	9.00	10.00	Midn.	1.00	1.30	2.00	3.30	4.00
6.30	9.00	10.00	11.00	Noon	1.00	2.00	5.00	1700	6.00	7.00	8.00	10.00	11.00	1.00	2.00	2.30	3.00	4.30	5.00
7.30	10.00	11.00	Noon	1.00	2.00	3.00	6.00	1800	7.00	8.00	9.00	11.00	Midn.	2.00	3.00	3.30	4.00	5.30	6.00
8.30	11.00	Noon	1.00	2.00	3.00	4.00	7.00	1900	8.00	9.00	10.00	Midn.	1.00	3.00	4.00	4.30	5.00	6.30	7.00
9.30	Noon	1.00	2.00	3.00	4.00	5.00	8.00	2000	9.00	10.00	11.00	1.00	2.00	4.00	5.00	5.30	6.00	7.30	8.00
10.30	1.00	2.00	3.00	4.00	5.00	6.00	9.00	2100	10.00	11.00	Midn.	2.00	3.00	5.00	6.00	6.30	7.00	8.30	9.00
11.30	2.00	3.00	4.00	5.00	6.00	7.00	10.00	2200	11.00	Midn.	1.00	3.00	4.00	6.00	7.00	7.30	8.00	9.30	10.00
12.30	3.00	4.00	5.00	6.00	7.00	8.00	11.00	2300	Midn.	1.00	2.00	4.00	5.00	7.00	8.00	8.30	9.00	10.30	11.00

NOTE.—Crossing the midnight line from dark to light area and vice versa:—Crossing from LEFT to RIGHT indicates following day. Crossing from RIGHT to LEFT indicates preceding day.

E.g.—Wednesday 2 p.m. in Sydney is Tuesday 11 p.m. in New York. Wednesday 11 p.m. in Sydney is Thursday 12.30 a.m. in Auckland. Wednesday 11 p.m. in Sydney is Wednesday 2.30 a.m. in Honolulu.

SHORT WAVE STATIONS—(Continued)—

29.24m.; PMN, Bandoeng, Java. Daily from 8 p.m.
28.01m.; JVM, Tokio, Japan. Tues., Fri., 5-10.30 p.m.
25.6m.; FYA, Radio Colonial, Paris, France. Daily 7-9 a.m.
25.6m.; CJRX, Winnipeg, Canada. Daily 10 a.m.-3 p.m.
25.57m.; PHI, Huizen, Holland. Daily ex. Tues., Wed., 11 p.m.-1.30 a.m.
25.53m.; GSD, Daventry, England. Empire Broadcasting.
25.49m.; DJD, Zeesen, Germany. Daily, 1-5 a.m.
25.45m.; W1XAL, Boston, Mass., U.S.A. Daily, 5 a.m.-1 p.m.
25.4m.; I2RO, Rome, Italy. Sun., Wed., Fri., 6.30-8.30 a.m.
25.38m.; GSM, Daventry, England. Empire Broadcasting.
25.36m.; W2XE, Wayne, N.J., U.S.A. Relays WABC. Daily from 6 a.m.-1 p.m.
25.29m.; GSE, Daventry, England. Empire Broadcasting.
25.27m.; W8XK, Pittsburg, Pa., U.S.A. Relays KDKA. Daily, 7.30 a.m.-1 p.m.
25.23m.; FYA, Radio Colonial, Paris, France. Daily, 2-6 a.m.
25.09m.; ETA, Addis Ababa, Abyssinia.
25.0m.; RW59, Moscow, U.S.S.R. Daily 8 p.m.-6 a.m.
21.42m. to **20.84m.;** Band of wavelengths allotted to amateur transmitters.
20.55m.; JVH, Nazaki, Japan. Daily from 6 p.m.
19.84m.; HVJ, Vatican City. Daily 8 p.m.-midnight.
19.82m.; GSF, Daventry, England. Empire Broadcasting.
19.76m.; GSO, Daventry, England. Empire Broadcasting.
19.74m.; DJB, Zeesen, Germany. Daily, 6.45-10.15.
19.72m.; W8XK, Pittsburg, U.S.A. Relays KDKA. Daily, 11 p.m.-7 a.m.
19.71m.; PCJ, Eindhoven, Holland. Tues., Wed., experimental service.
19.68m.; FYA, Radio Colonial, Paris, France. Daily, 9 p.m.-1 a.m.
19.67m.; W1XAL, Boston, Mass., U.S.A. Daily, 1.30-4.30 a.m.
19.66m.; GSI, Daventry, England. Empire Broadcasting.
19.64m.; W2XE, Wayne, N.J., U.S.A. Relays WABC. Daily, 1-7 a.m.
19.63m.; DJQ, Zeesen, Germany. Daily 3.30-5.30 p.m., 10.30 p.m.-midnight.
19.60m.; GSP, Daventry, England. Empire Broadcasting.
19.56m.; W2XAD, Schenectady, N.Y., U.S.A. Daily, 5-6 a.m.
17.33m.; W3XL, Bound Brook, N.J., U.S.A. Daily 2-6 a.m.
16.89m.; DJE, Zeesen, Germany. Daily 11 p.m.-2.30 a.m.
16.89m.; W2XE, Wayne, N.J., U.S.A. Relays WABC. Daily 2-4 a.m.
16.87m.; W3XAL, Bound Brook, N.J., U.S.A. Relays WJZ. Daily, ex. Sun., Midnight-2 a.m.
16.88m.; PHI, Huizen, Holland. Daily, 10 p.m.-1 a.m.
16.86m.; GSG, Daventry, England. Empire Broadcasting.
13.97m.; GSH, Daventry, England. Empire Broadcasting.
13.94m.; W2XE, Wayne, N.J., U.S.A. Relays WABC. Daily, 10.30 p.m.-2 a.m.
13.93m.; GSJ, Daventry, England. Empire Broadcasting.
13.92m.; W8XK, Pittsburg, Pa., U.S.A. Daily, 10 p.m.-midnight.

Aerial Systems

IT is sometimes argued that, with the increasing sensitivity of modern receivers, it is unnecessary to pay much attention to the aerial system. This argument is entirely fallacious, particularly in the case of receivers equipped with efficient automatic volume control. The greater the signal strength collected by the aerial, the lower the sensitivity of the receiver (due to the A.V.C. action) and the lower the noise level. However, there are limitations, due to the apparent loss of selectivity when an exceptionally large aerial system is used, and it is this factor only which should govern the physical dimensions of the installation.

The main essentials of an efficient aerial are height, good insulation and a location clear of all nearby obstructions—particularly iron roofs and gutterings, structural steel formations, telephone and power wires, and trees.

In country districts where inter-station interference is negligible the antenna may be of considerable length to give increased sensitivity for daylight reception. The flat top in this case may be made up to one hundred feet long. Longer spans than this will not give very much gain in sensitivity.

The lead-in should be run to the receiver by as direct a route as possible. It should be kept well clear of the building—a distance of one foot will be sufficient. The earth lead should also be as short as possible and connected by a good ground clamp to a water-pipe near where it enters the ground. A gas-pipe should not be used, as the red lead and packing at the joints usually constitute quite a high resistance. Where water-piping is not readily available, an inch pipe should be driven several feet into moist ground. Alternatively solder a stout copper wire to a kerosene tin and bury the tin, well below the surface. If necessary a short pipe should be driven into the ground at this point so that the earth may be kept moist. Do not use an existing earth to which power or telephone systems are already connected. Apart from the possibility of introducing hum and electrical noises this practice can be definitely dangerous under certain conditions.

For the aerial itself, insulated wire should be used, either enamelled or rubber- and braid-covered. The lead-in should be made in one piece with the flat top by passing through the insulator, fastening and continuing down. It is desirable to use at least three insulators of the small egg type. It is also preferable to use an insulated earth wire to prevent intermittent contact with any metallic objects and consequent irritating crackles from the speaker. This applies particularly to short-wave reception. In fact, any two metallic objects or wires rubbing together will produce bad noises when listening on the short waves.

Other Arrangements

In locations where a long lead-in is necessary, and where the lead-in itself is likely to pick up interference on its way to the receiver, a special installation using a shielded transmission line is desirable. The primary of a special transformer is joined to one end of the aerial proper, the other side of the winding being grounded. The winding is untuned, and has characteristics such that its impedance is practically constant at broadcast frequencies. The secondary comprises a very few turns, indicating a very low impedance winding. To this secondary is attached the special transmission line, consisting of a twisted pair of wires shielded with copper braid which may be earthed. At the receiver end there is a similar transformer in reverse, the line being joined to the low-impedance primary while the high-impedance secondary is connected to the aerial-earth circuit of the receiver.

As long as the correct impedance ratios are maintained, the transmission line may be of any length and may take any route, being immune from external disturbances. **Neither this nor any other aerial system will prevent the reproduction of interference of any description collected by the aerial itself.**

The point is emphasised, however, that the better the aerial (as regards height and placement) the more likely is the signal to over-ride the noise level.

Short Wave Reception

A system such as the one just detailed is usually suitable for broadcast operation, and correct matching of the line to the aerial and receiver will ensure that there is practically no transmission loss. On short-waves, however, the capacity between the twisted leads and the earthed braiding will introduce serious losses and it is usually found advisable to make use of a "transposed" open wire lead-in.

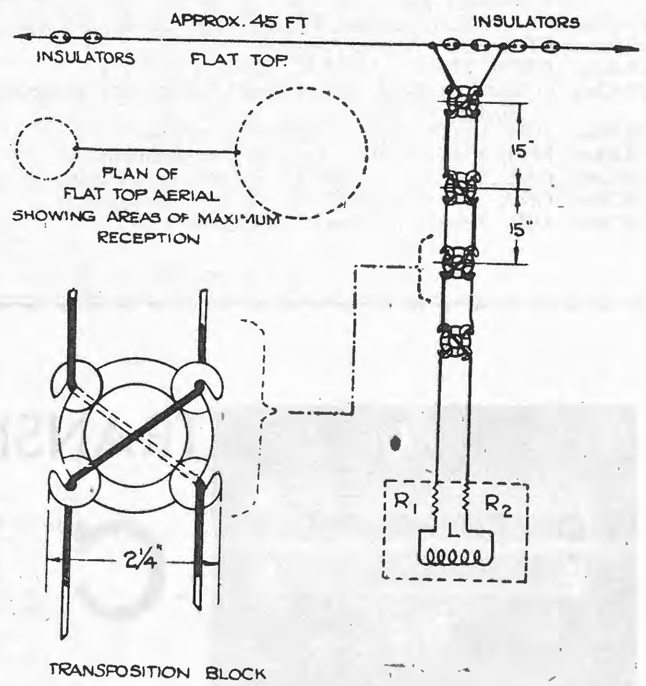


Fig. 1.

In a lead-in of this type the lead-in proper is brought down to the receiver in company with another lead which ends at the aerial, but is insulated from it. These two leads are spaced apart by special insulators and a change-over of position effected at each insulator. By this means, equal amounts of interference are picked up by the two down leads. A special matching transformer is fitted at the receiver end of the lead and all signals (noise or otherwise) are balanced out. The signal from the aerial is not interfered with (as there is no out-of-phase component to balance it) and it is passed on to the receiver. The diagram of fig. 1 will serve to show the method of attaching the lead-in to the aerial and the transposition of the two leads. Fig. 2 gives details of a suitable matching transformer with switching to change over between broadcast and short wave reception. The switch may be an ordinary D.P.D.T. type.

"Doublet" aerials are fairly popular when good short wave reception is required. The "doublet," in its simplest form, consists of a "half-wave" top, split into two (i.e., two quarter-wave sections) with a transposed lead-in connecting the two sections to the receiver. The general arrangement is shown in fig. 3. Neutralisation of the noise impulses and signals picked up by the lead-in occurs in a similar manner to that in the simple transposed lead-in. The signals picked up by the two halves of the aerial do not neutralise each other as they are "in-phase" and become additive when fed into the receiver through the matching transformer. Theoretically, an aerial of this type is "tuned" and will only respond to the frequency which it is de-

(Continued on page 244)

AERIAL SYSTEMS—(Continued from page 242)—

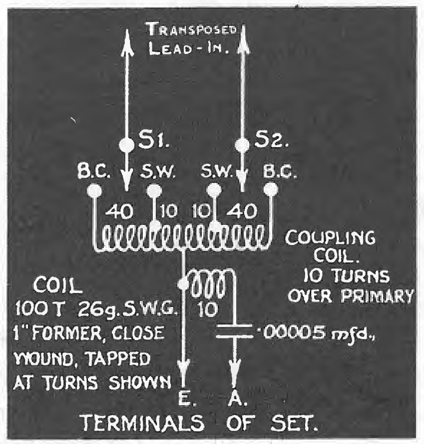


Fig. 2

signed for. However, there is always an appreciable amount of R.F. resistance present and this broadens out the response curve sufficiently to enable reception over a wide band of frequencies.

At frequencies very far from resonance the device functions as a plain "T" type aerial. The "peaking" effect comes in handy as a signal booster on the short-wave band, particularly at the resonant frequency or thereabouts. The directional characteristics of such an aerial can sometimes be used to advantage and arrangement of the aerial so that one of the dotted areas shown in the diagram points to a wanted station will often result in considerably improved reception from that station. Conversely, pointing one end of the aerial towards a troublesome source of interference will often result in a marked diminution of pick-up from that direction.

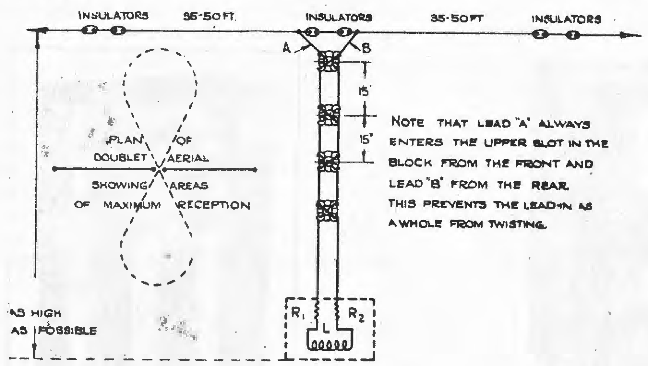


Fig. 3

A doublet aerial may be used with a twisted pair, instead of an open transposed, lead-in and, providing the length of the lead-in is correctly proportioned with relation to the length of the aerial, no transmission loss will result. **The twisted pair used is rubber-covered and weather-proofed but is not shielded.**

Correct proportioning of the lead-in length is necessary in this case so that none of the harmonies of the lead-in resonant frequency fall on the resonant frequency of the aerial. Should this occur, a large impedance would be presented to signals at, or near, the resonant frequency of the aerial and transmission losses would be increased enormously. Having determined a minimum length for the lead-in it is also necessary to increase its length, if such is necessary, in multiples. A minimum length of 110 feet is usually used for a 40 or 31 metre half-wave (two quarters) doublet. Should the lead-in length required not be as long as this it is necessary to coil up the unused wire but on no account must it be cut. Actually in practice, it is often found that a properly proportioned twisted pair lead-in will give a definite voltage gain at some frequencies.

Double-doublets

A variant of the "doublet" aerial is found in the "double-doublet." In this type of aerial two doublets of unequal length are crossed at their lead-in points and connection made between one side of one and the opposite side of the other. The reverse applies, so that, in effect, the entire arrangement is like two uneven "T" aerials crossed at their leading-in points.

The effect of this is to give the aerial two resonant frequencies and, if these are arranged so that they fall in the upper and lower parts of any desired frequency band, a fairly even response over that band is obtained. In practice the 16-50 metre band is covered by arranging the doublets so that they peak at about 20 and 40 metres. Should better reception be required at, say, 31 metres, the 40 metre doublet may be shortened until it peaks at 31 metres. This will cause a slight fall in response at 40 metres, but the gain at 31 metres may be worth it.

A transformer is usually required to match a double-doublet to the "transmission line" (lead-in) and, by careful design, this transformer may be peaked so that it helps to fill in the spaces between the peaks caused by the resonances of the aerial sections.

An alternative method of matching the line to the aerial is found in the "V" doublet. This type of aerial is an ordinary single-doublet with the two halves separated by insulators and a length of wire. The twisted pair transmission line is terminated at some distance below the flat-top and the two wires spread out in the form of a "V" until they reach the aerial wires. As the impedance of a transmission line increases with the spacing of its component wires it can be seen that a gradual change of impedance is effected by this means and very effective matching of the line to the aerial accomplished.

While many claims are made for the "noise reducing" properties of various aerial types, it cannot be emphasised too much that no aerial will reduce noise unless it is placed outside the field of interference. This can only be done by placing the aerial well above, or away from, buildings or electric power lines.

The lead-in, if properly neutralised (by transposition or twisting) will be "dead" as far as effective pick-up goes, and that is nearly all that can be claimed for "noise-reducing" systems.

It must be added, however, that the directional properties of a doublet may sometimes be used to advantage, and also that, provided reception is only required on one or two frequency bands of limited width, the aerial may be "peaked" so that it favours the sharply tuned signal instead of the flatly tuned noise or electrical interference.

Lightning Arresters

An efficient lighting arrester should be installed, meaning one with close contacts which will not move together or apart and will not be bridged over by a deposit of dust. From this point of view the vacuum type of guard is more desirable. For short-wave reception the capacity from aerial to ground (within the guard) should be as low as possible, consistent with reasonable protection.

In the case of shielded or transposed lead-ins as previously described, it will be desirable to fit a guard to each wire of the pair in the usual manner.

A lightning arrester provides a definite safeguard against the possibility of a surge from a nearby flash burning out the aerial coil. It is, of course, of no avail in the case of a direct hit, but, contrary to popular opinion, an aerial presents no hazard in this respect. A lightning arrester is particularly valuable in open locations or in the country, where the energy radiated from a nearby flash is not so quickly dissipated by inducing surges in power and telephone wires and metal structures.

S.A.A. Wiring Rules

It should be remembered that there are sections of the S.A.A. Wiring Rules and Radio Code which apply specifically to the installation and erection of aerials for radio receivers. These rules also cover the connection of earthing systems and should be followed carefully to ensure that the installation conforms with the requirements in every way.

The relevant sections of the S.A.A. Wiring Rules and Radio Code will be found in another part of this Annual.

Power Supply for Country Receivers

ALTHOUGH "battery" receivers have been improved very considerably during the past few years, both from the performance and economy points of view, the question of power supply is still of paramount importance and must receive proper attention if any degree of efficiency and reliability is to be achieved.

Power supply for country receivers is obtained from three general sources, usually termed the "A," "B" and "C" supplies. Several means are available for obtaining each of these and some details concerning them, their operation and maintenance should provide a basis of knowledge which will assist materially in the better understanding and handling of battery receivers and associated equipment.

The "A" Supply

SECONDARY cells, or accumulators (almost invariably of the lead-acid type) are the most popular means for supplying the heating current to the valves of battery receivers. This type of cell delivers a voltage of about two, when fully charged, and can be recharged from a D.C. source when discharged. Further details of the maintenance procedure necessary for the efficient operation of this type of cell will be given later.

An alternative is found in the use of "air-depolarizer" primary cells. This type of cell is self-generating and may be reactivated by replacement of the electrolyte when it is completely discharged. The cell operates in the same manner as the old type of Leclanche cell, but instead of using manganese dioxide as a depolarizer to remove the film of nascent hydrogen gas which forms on the positive (carbon) electrode, this electrode is made of special porous carbon which allows a free circulation of air. Depolarization is thus carried out bv the oxygen of the atmosphere and a steady flow of current over long periods may be obtained.

Typical ratings for air depolarizer cells are 300 and 500 ampere hours at average drains of 0.3 to 0.5 amperes. It will thus be seen that an "aircell" battery has a useful life of about 1,000 hours per charge.

As the cell can then be refilled at moderate cost and it uses a non-destructive electrolyte it would appear that the system provides many advantages, particularly in locations remote from charging facilities.

The terminal voltage of an "aircell" (or "Carboncel," to use the commercial designation) ranges between 1.0 and 1.2 volts, depending on the load, so that two cells, with a rheostat in series, will be required to provide the two volts necessary for the operation of most battery receivers.

The "B" Supply

In spite of intensive developmental work on mechanical converter systems, energised by means of the "A" battery, for providing high-tension voltage, the use of dry batteries remains almost universal for this service.

"Dry batteries" are really banks of modified Leclanche type cells which use a jelly-type electrolyte instead of a liquid. The terminal voltage of this type of cell is about 1.5 volts so that quite a large number of them must be connected in series to provide the 135-180 volts high-tension required for modern receivers. The current drain is light, however, and the cells may be made quite small.

Dry "B" batteries are usually rated in accordance with the maximum current drain that is likely to be required from them and as a result we find that a "light duty" battery is made to deliver up to about 6 mA. satisfactorily; a "heavy duty," 16 mA. and a "super-power," 25 mA. or thereabouts. The imposition of a greater current drain on a battery than that for which it is rated will not only accelerate its discharge out of all proportion to the actual overload, but will also result in a very definite drop in terminal voltage after only a few hours' use. This is on account of the fact that the depolarisation action inside the cell has definite limitations and a current overload will upset the normal balance between polarizing and depolarizing actions.

"B" batteries of this type should be stored and installed in a cool, dry place, as heat tends to actually dry up the electrolyte and moisture sets up leakage between cells and across the entire battery.

Accumulator "B" Batteries

Accumulator "B" batteries of the lead-acid type have been used for many years but have not gained popular favour on account of their weight and delicate nature. The fact that they contain an acid electrolyte is also a disadvantage. Even so, there are many applications where an accumulator "B" battery of this type proves very useful and quite a number are to be found giving excellent service. The maintenance and operation of this type of battery follows the lines of the low voltage "A" battery very closely and the remarks which will be made later with respect to "A" batteries are equally applicable.

A relative newcomer to the high-tension supply field is found in the Milnes' nickel-cadmium accumulator unit. This unit is built up of a number of cells of the Edison alkali accumulator type in series and features a number of advantages not possessed by the lead-acid type of unit.

Foremost among these is the absence of an acid electrolyte. Caustic potash (the electrolyte used) is quite as destructive to organic materials as sulphuric acid but it has little or no effect on any metal except aluminium. In addition it does not creep and will not give off corrosive fumes even under the heaviest charge or discharge conditions of the cell. Edison designed the nickel type secondary cell for traction work so that it is naturally light in weight; its "charge" and "discharge" characteristics are non-critical and it can be left undischarged for long periods without danger of sulphation or kindred effects. The high-tension unit uses nickel and cadmium electrodes instead of the original nickel and steel, the idea being to keep the internal resistance of the unit down to a low level.

The terminal voltage of a cell of this type is about 1.25 volts so that more cells are required for a given voltage than would be if lead-acid cells were used. However, each cell weighs about one-third as much as a "lead" cell so that the overall weight is reduced very considerably.

The particular type of Milnes' Unit available in Australia is fitted with a very ingenious series-parallel switching arrangement for the cells so that it may be converted from a 120 volt unit to a 5 volt unit. This enables the unit to be recharged from a 6 volt accumulator without any difficulty and so simplifies maintenance problems enormously. The voltage of the cells rises slightly when fully charged under "no-load" conditions so that the charging operation is self-regulating: charging automatically ceases when the cells are fully charged if a 6 volt source of supply is used.

Mechanical Converters

Several types of mechanical converters have made their appearance lately, these taking the form of a small motor-generator or vibrator-interruptor unit which operates from a 6 volt "A" battery and supplies the necessary high-tension voltage for the set.

(Continued on page 246)

POWER SUPPLY FOR COUNTRY RECEIVERS—(Continued)—

The vibrator system appears to be the most efficient, one particular example providing sufficient "B" power for a five-valve set with an expenditure of only 0.8 amperes from a 6 volt accumulator.

"Gen-e-motor" systems are only a little less efficient than this and, actually, the adoption of one or the other devolves largely into a matter of reliability.

As a six-volt battery is necessary for the operation of these units it is also necessary to arrange the receiver valve filaments so that six volts are required for their heating (unless, of course, one likes to tap the battery at two volts). The six-volt tubes at present available are comparatively wasteful of filament power and it is usually found advisable to use two-volt tubes and wire the filaments in series-parallel. By this means the total filament drain of a receiver may be reduced to somewhere near the 0.25 ampere mark and the drain of the "B" supply unit makes up the total to only a little over one ampere. "Automatic" bias voltage may be obtained from the series drop across the filaments so that systems such as these have much to commend them, providing of course, that the increased "A" drain does not make battery charging unduly frequent.

The "C" Supply

Little needs to be said about the "C" or bias supply to modern receivers save that without some means of providing the all-important negative bias to the various tubes the best efforts of both the "A" and "B" supply systems are not of much use.

Voltage only is required from the "C" supply, unless a bleeder network is intentionally placed across it for the purpose of voltage division, so that only small cells are required if dry batteries are used for the purpose.

Quite a large percentage of receivers to-day use "automatic" biassing systems, however, and the separate bias battery is rapidly becoming a thing of the past.

For small sets using a pentode output tube, or other system where the "B" drain is constant, the most popular method of obtaining "free" bias is by means of a resistor in series with the "B" return lead. This resistor may be tapped in order to obtain any bias voltage up to the total drop across the resistor.

It is essential, however, that the resistor be efficiently by-passed by a condenser, otherwise degenerative effects will occur through the resistor being common to the plate circuits of all the tubes in the receiver. It must also be remembered that the voltage developed across the biassing resistor reduces the effective plate voltage.

This type of bias system is useless for receivers using Class "B" output stages due to the variation in the drain of the receiver at different signal levels. In receivers of this type it is necessary to either use a battery for bias or a bleed network across section of the "B" supply. This bleed network is tapped on to the "B" battery at a point sufficiently positive to ensure that the correct amount of bias voltage is available. This positive tapping on the "B" supply is then connected to the usual "B" negative terminal and the free end of the battery is left for bias connections. The drain of the bleed network is usually arranged to be the same as that of the receiver at average volume level so that the section of the battery used for bias runs down at the same rate as that used for "B" supply, and so maintains the voltage ratios constant. A switch must be provided to ensure that the bleed network is open-circuited when the receiver is switched off.

The final method of obtaining automatic bias is by means of series-parallel filament wiring. Obviously, if three two-volt tubes are wired in series across a six-volt battery the filament of the tube at the positive end of the combination is four volts positive with relation to the negative battery lead. Consequently, four volts bias for that tube may be obtained by returning its grid to the negative lead. Two volts bias can be obtained by using the junction of the second and third tube filaments as the return point. Intermediate voltages between zero and the maximum can easily be obtained by shunting a moderately high resistance voltage divider across the appropriate filaments. This particular system finds a useful application in the design of "batteryless" receivers, as mentioned before.

In addition to these methods of obtaining automatic bias there is another factor which is tending to eliminate bias batteries. This is the introduction of "zero bias" tubes for battery receivers. These tubes are designed to operate satisfactorily without the application of grid bias at all. So far, only radio frequency tubes have made their appearance, but who knows when the trend will become a habit?

Maintenance and Charging of Accumulators

From the above notes it will be seen that the "A" supply is steadily assuming greater importance in the operation of battery receivers. "B" batteries are being replaced by mechanical converters which derive their motive power from the "A" battery and bias is being largely derived from portion of either the "A" or "B" supply.

As an accumulator of the lead-acid type is almost universally used for "A" supply, some details concerning its efficient maintenance and charging will not be out of place.

General Maintenance Hints

1. Keep the outside of the battery clean and dry. Dampness or dirt permits the charge to leak away, and in time accumulates sufficiently to corrode the terminals.
2. Also see that the vent plugs are kept in place and tight.
3. It is considerably easier to prevent corrosion than it is to get rid of it. Cover all metal surfaces which are connected together with a film of pure vaseline—not grease.
4. Only distilled (not merely boiled) water should be used. Glass, earthenware, rubber, lead or wood receptacles which have not been used for any other purposes are suitable for transporting distilled water.
5. Add distilled water regularly to each cell, until the level of the liquid is ½-in. above the tops of the plates. Never allow the acid to fall to a level below the tops of the separators.
6. The intervals at which water should be added depend largely on the operating conditions. The best time to add the water is just before the cells are to be given a charge.
7. The solution (electrolyte) is a mixture of distilled water and pure sulphuric acid. Ordinarily, the loss in volume of electrolyte is from the loss of its water. Some water is lost by evaporation, but most of the loss is due to the action of the charging current, which decomposes the water, forming gases which are given off through the vent holes. Acid is never lost from the battery by evaporation or decomposition. It will, therefore, never be necessary to add new electrolyte unless some should get outside the cell through carelessness by leaving the vent plugs out or loose, or by bringing the level too high when adding water.
8. Never use a battery in a leaky condition—instantly have the jar replaced.
9. Never examine a battery with a naked light—the hydrogen and oxygen gases which emanate from a battery are highly explosive.

Charging Accumulators

It is essential that a new or replacement cell should be given its correct initial charge. Fortunately this is usually attended to by the makers, so it is only necessary to fill the cells with sulphuric acid of the specific gravity (Sp. Gr.) recommended by the makers and allow to stand for at least four hours when

(Continued on page 248)

ACCUMULATORS—(Continued)—

it will be ready for service. A light freshening charge is desirable at this stage. Information as to correct specific gravity level of acid and charge rate, may be had from the maker's catalogues if it does not accompany the battery. The acid should never be allowed to fall to a level which exposes the plates to the air while if filled brimful the cell will probably overflow on recharging. Unless acid has been spilt, only distilled water should be added to top up to the correct level. If however, acid has been spilt, the amount lost should be replaced by acid of the same Sp. Gr.

After charging, all moisture or acid should be carefully wiped off the tops and cases of batteries with a damp cloth, and it is desirable to grease exposed lead parts with pure vaseline to prevent corrosion. Indications of full charge are several and are listed in their order of importance.

Sp. Gr. of the Acid. This remains constant when further charged above the full charge and may vary from 1.220 to 1.300, being usually higher for small batteries.

Voltage of Each Cell. With charging current on, this is from 2.65 down to 2.3 for old cells.

Gassing. A sulphated cell will gas throughout its charge, but the gassing which indicates a full charge comes off in much larger bubbles.

Colour of Plates. Fully charged, the positive plate is a dark chocolate and the negative a slate grey.

Battery testers consisting of a voltmeter and a shunt which draws a certain current from the battery are useful in ensuring that the voltage is measured in the "on load" condition. A freshly charged battery should show from 2 to 2.05 volts which gradually drops to 1.85 volts at the end of the discharge period.

Sulphation consists of a white deposit on the plates and is also indicated by a low Sp. Gr. and a loss of capacity. It is caused by undue demands on the battery when almost discharged or long standing in a discharged state. This is one of those faults which is better prevented than cured and if the batteries are kept fully charged no trouble of this nature should be experienced. However, if sulphate is formed, the accumulator should be charged at a very low rate for a long period until the sulphate is converted into useful material and the S.G. of the electrolyte reaches its former value. If this process has no effect then the cell should be scrapped.

When mixing new acid for batteries it is important to add the acid to the water and stir with a glass rod. If water is added to concentrated sulphuric acid (also known as oil of vitriol) a dangerous explosion is liable to occur due to the intense heat generated. A table for mixing is given below. Concentrated acid has a Sp. Gr. of 1.835.

Acid Mixing Table

Sp. Gr. Required	Water Parts by Volume.	
1.300	24.7	
1.290	26.0	
1.280	27.5	To be mixed with 10 parts by volume of concentrated sulphuric acid.
1.270	29.0	
1.260	30.0	
1.250	32.2	
1.240	34.0	
1.230	36.0	
1.225	37.2	

It is to be noted that when an accumulator operated at a higher temperature than that specified the maximum permissible Sp. Gr. is lower, otherwise a shortened life is the result.

Charging Plants

The type and size of plant which is installed will be governed entirely by the amount of charging which is to be done. Where direct current mains are available charging can be accomplished by one of two systems. The simpler is to insert an appropriate series resistor to cut down the current to the required value. In practice this would consist of some sort

When Battery is	In N.S.W., Vic., S.A. & Tas.		In Q'land, W.A. and N.T.	
	Sp. Gr.	Max. Temp.	Sp. Gr.	Max. Temp.
Fully Charged	1.250 (1.240-1.260)	110°F.	1.220 (1.210-1.230)	125°F.
Half Discharged	1.180 (1.170-1.190)	"	1.150 (1.140-1.160)	"
Fully Discharged	1.120 (1.110-1.130)	"	1.090 (1.080-1.100)	"

The Sp. Gr. should always be measured with a reliable hydrometer.

of rheostat or possibly open framework of wire, connection to which could be made by means of clips. Direct charging from the mains is not an economical proposition unless a large number (more than 50 say) of cells have to be charged, and even in this case the charging current will have to be regulated so as not to ruin the smallest cell in circuit. A suitable motor generator set will charge these batteries in parallel and prove a far more economical installation despite its higher initial cost.

However in the majority of instances supply is A.C., in which case we can class the suitable plants under five heads: (i) Rotating machinery, e.g., motor generators, motors driving dynamos, synchronous rectifiers; (ii) Vibrating rectifiers; (iii) metal rectifiers; (iv) valve rectifiers; (v) mercury arc rectifiers.

The cost of upkeep and attention to the last three named is very low, since there are no moving parts and replacements of the rectifying units are rare, providing that they are operated within their rating. In any class of charging equipment it is important not to overload any portion of the apparatus. A good motor generator set will give long service with little attention beyond regularly oiling or greasing the bearings and cleaning the commutator and brushes; this last item being particularly important to ensure efficient running of the plant. The contacts of vibrating rectifiers also need a regular touching up. With mechanical rectifiers it is essential to instal an automatic cut-out similar to that on a car, so that if the generator stops running (on the failure of the line voltage or for some other reason) the batteries will not discharge back through the generator.

A valve or thermionic type charger is usually found to be the most satisfactory proposition for the radio dealer on account of its low initial cost, simplicity of operation and high efficiency. Service on this type of charger becomes a matter of replacing a tube occasionally and, apart from this the operation is very nearly a matter of "instal and forget." No useful purpose would be served by detailing the construction of a tube-type battery charger as this type can usually be purchased complete as cheaply as it can be made.

Treatment of Batteries

A systematic system of time keeping and charging currents should be adopted to avoid over- or under-charging and consequent complaints. After charging the cells should be carefully wiped down, paying particular attention to the tops, where acid spray and dust accumulate. Terminals and connecting links should be plentifully greased with vaseline after cleaning with a file or emery paper where necessary.

In old batteries an internal short circuit may have developed by reason of buckled plates or a sludge of once active material forming in the bottom of the cell.

Outward indications are the same as for a sulphated cell, i.e., refusal to charge and gas properly, permanent low density of the acid and low voltage readings compared to the other cells, both on charge and discharge. There is, of course, no white deposit. Sludge may be largely removed by several fillings with water and vigorous shakings, followed by immediate emptying of the cell. By this means the fine sludge is re-

(Continued on page 261)

The Construction and Operation of a Modulated Test Oscillator

ONE of the most essential instruments in the "kit" of a serviceman or dealer nowadays is a modulated oscillator in some form or other.

Details have already been given, in an earlier section of this Annual, of the constructional requirements of a signal generator for laboratory use, and many of the requirements there specified apply equally well to the construction and operation of less elaborate instruments.

In order to cover the field properly, however, details are given, in the following pages, of the construction and operation of two modulated oscillators which will satisfy service requirements very satisfactorily.

General Requirements

Modern radio receiver design and engineering calls for the coverage of a very wide band of frequencies, and unless the test equipment to be used is capable of covering this band, a complete check of the operation of the receiver cannot be made.

Intermediate frequencies of 175 kc/sec. and under, are commonly in use, and quite a number of dual-wave and all-wave receivers in use and production to-day, tune as low as 15 metres (20,000 kc/sec.). As the range between these two limits is very nearly all in use, it will be seen that the complete service oscillator should be capable of developing a signal on any frequency between these limits, and, what is equally as important, developing a signal of which the frequency is readily ascertainable.

This, then is our first requirement, and, as a result, any type of oscillator which uses harmonics for coverage of portion of its band is definitely unsuitable, unless some means of calibration is adopted which allows of ready determination of the harmonic which is being used. As calibration of this nature is outside the scope of the average man, we will proceed on the assumption that a fundamental frequency coverage is essential.

Modulation

The next consideration is that of modulation. Obviously, it is of no use feeding a pure R.F. signal into the average receiver, as no audible note would be heard, and, unless some means of carrier resonance indication is incorporated in the receiver, alignment would not be practicable. This means then, that some means of modulating the R.F. signal with an audio-frequency note must be incorporated in the oscillator. Quite a lot of divergent ideas exist as to how this should be done, but, actually, all that is required is a fixed frequency modulation at a fixed percentage. This percentage should be somewhere near the average used by broadcasting stations, and, if we place the figure at around 50%, we will satisfy normal requirements. The frequency used is not of very great importance, but as 400 cycles has been adopted as standard for precision work, the serviceman cannot do much better than follow the example of those who should know.

It will be quite readily appreciated that a flock of gadgets, such as modulation percentage controls and modulation frequency switches, only lead to confusion and also, in a lot of cases, subsequent variation of calibration characteristics.

Output Required

The next consideration is that of the output required. This is rather a problem, as the maximum output is, to a large extent, dependent on the amount of high-tension supply fed to the oscillator valve. The amount of high tension supply is in turn limited by the demands of portability, as very few servicemen would find it practicable to have two oscillators, one for "inside" work and the other for "outside" jobs. The problem is simplified somewhat in cases where a supply of A.C. is available wherever work is being done, but the construction of an A.C. oscillator calls for somewhat different treatment and will be dealt with separately. In any case, a maximum output of more than a tenth of a volt will seldom be required outside the laboratory, and this figure is readily attainable in a battery operated oscillator using about 60 volts of high tension.

The minimum output required is regulated by the type of receiver to be tested and also by the accuracy required. Receiver sensitivities nowadays range as high as one microvolt absolute, and the minimum output of the oscillator must be fairly close to this figure if comparative tests are to be made. Reduction of the maximum output to this figure means an attenuation ratio of 100,000—1, which is quite a difficult proposition, especially on the higher frequencies. However, a figure of about 5 microvolts is low enough for all normal purposes, and by careful shielding and control design, can be fairly easily obtained. These figures are given as the maximum and minimum outputs required, but no exact calibration will be necessary. The main essential is that the output control be continuously variable between these limits, at all frequencies developed by the oscillator.

General

The frequency coverage may be arranged by switching or by plug-in coils. A frequency ratio of 3—1 on each band is easily attainable with this class of instrument, and, as a result, the entire band will be covered in five steps. It is preferable that the tuning dial used be fairly large and easily readable, otherwise difficulty will be experienced in ascertaining the exact frequency at which the oscillator is set.

The modulation is preferably effected by means of a separate oscillator. This is the only practicable means of ensuring that a constant percentage and frequency of modulation is obtained.

Output control may be by means of a continuously variable and shielded potentiometer, which should be of the constant impedance type.

The containing case is really a matter for the individual constructor and may be made in any way that is particularly convenient. The only essential in this regard is that the entire oscillator assembly, with the exception of the control spindles, of course, be completely encased in aluminium or copper to ensure as complete shielding as possible.

The Construction of an All-Wave Battery-Operated Service Oscillator

The circuit arrangement of a battery operated oscillator is shown in fig. 1.

It will be seen that two valves are used, both 30 type 2 volt triodes, thus necessitating an "A" supply of 2 volts or, what is more convenient, two dry cells in series, giving 3 volts and thus allowing some latitude in the setting of the rheostat.

The constants indicated in the circuit diagram are as follows:—

C1—Tuning Condenser. C2—0.0001 microfarad moulded mica. C3—0.001 microfarad moulded mica. C4—0.0002 microfarad moulded mica. C5—0.01 microfarad moulded mica. C6—0.001 microfarad moulded mica. C7—1 microfarad paper block condenser.

R1—50,000 ohms carbon resistance. R2—3,000 ohms carbon resistance. R3—60,000 ohms carbon resistance. R4—20 ohms rheostat. R5—100,000 ohms carbon resistance. R6—400 ohms potentiometer.

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ALL-WAVE BATTERY OSCILLATOR—
(Continued)—

L1—Secondary tuning inductance. L2—Output coupling coil. L3—Reaction coupling coil. L4—R.F. Choke. L5—Dummy inductance.

S1, S2, S3—Ganged switches for L1, L2, L3. S4—Meter "A" and "B" Switch. S5—On-off switch.

A.F.T.—Push-pull A.F. Transformer—Ratio 1—2. M—0—1 mA. D.C. Meter.

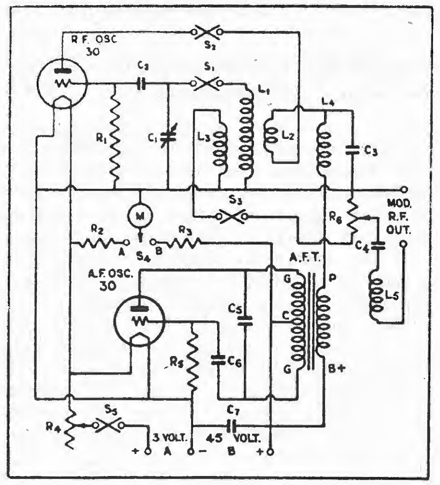

Fig 1

The resistors R2 and R3 are merely intended as multipliers to enable an ordinary 1 mA. D.C. meter to be used as battery supply indicator. These values are only intended as a guide, as the sensitivity of the meter is not critical, and should a 5 mA. meter, for instance, be on hand, it will serve the purpose quite as well.

In this case it will be necessary to reduce the value of the resistors to a fifth of the stated value. If these instructions are followed out the meter will give full scale deflections on 3 volts and 60 volts and thus enable an accurate check to be made of the voltages actually supplied to the tubes.

With relation to the switching. S1, S2 and S3 are ganged together to enable simultaneous changing of L1, L2 and L3 to be effected.

This is necessary, as it will be remembered that five bands were necessary to cover the frequency range required. Thus it will be seen that the three switches named have five positions each. It is only necessary to arrange the switching of one end of the respective coils. The remaining ends of L1 and L3 are earthed and the remaining ends of L2 connected to the junction of the R.F. choke and C3.

The designations of the coils in this case apply to each group of five coils necessary to cover the entire range.

Suitable coil constants for frequency coverage are:—

1st Short Wave Band

L3—1 turn 22 gauge S.W.G. enamelled; L1—6 turns 22 gauge S.W.G. enamelled; L2—5 turns 32 gauge S.W.G. enamelled. Wound on one inch former in order shown and all in same direction.

2nd Short Wave Band

L3—2 turns 26 gauge S.W.G. enamelled; L1—14 turns 26 gauge S.W.G. enamelled; L2—8 turns 32 gauge S.W.G. enamelled. Wound on one inch former in order shown and all in same direction.

Broadcast Band

L3—5 turns 26 gauge S.W.G. enamelled; L1—110 turns 32 gauge S.W.G. enamelled; L2—20 turns 32 gauge S.W.G. enamelled. Wound on one inch former in order shown and all in same direction.

465 kc/sec. I.F. Band

L3—15 turns pile wound 26 gauge S.W.G. enamelled; L1—300 turns Honeycomb bobbin from I.F. Transformer; L2—50 turns 32 gauge S.W.G. enamelled pile wound. Wound on ½-inch former in order shown and all in same direction.

175 kc/sec. I.F. Band

L3—35 turns 26 gauge S.W.G. enamelled pile wound; L1—600 turns Honeycomb bobbin from I.F. Transformer; L2—150 turns Honeycomb bobbin from I.F. Transformer. Wound on ½-inch former in order shown and all in same direction.

The order of coil connection is as follows: Start of L3 to earth, finish of L3 to S3, start of L1 to earth, finish of L1 to S1, start of L2 to S2, finish of L2 to L4 and C3. The coils should be wound about 3/16 inch apart, or as close to that figure as is possible.

The honeycomb coils for the 465 kc/sec. band and 175 kc/sec. band may be obtained from a spare I.F. transformer of the frequency required. It is a fairly easy matter to find out the exact number of turns on the I.F. transformer used, and as ½-inch is about the standard former size for I.F. transformers the spare coil may be wound off and the necessary coils for the oscillator wound on in its place.

The attenuator potentiometer, R6, should be totally enclosed in a metal case and leads from it to S3 and C4 should be shielded with copper braiding.

C4 and L5 form a built-in dummy antenna to match the oscillator to the aerial input of the receiver. A suitable value for L5 is obtained by winding about 50 turns of 32 gauge S.W.G. enamelled wire on a ⅜-inch former.

Apart from these points the construction of the job is quite straightforward and no difficulty should be experienced in getting the job operating satisfactorily.

Calibration Procedure

The circuit details and constants of the battery driven modulated R.F. Oscillator already given should enable the moderately technical dealer or serviceman to proceed with the construction of such an instrument.

However, the story does not end there, as unless the completed instrument is frequency calibrated in some manner, its full potentialities cannot be realised.

It is possible that quite a few men have oscillators of some kind which are not calibrated accurately, and it is felt that their interests, as well as the interests of those constructing the instrument detailed, will be served by a perusal of the following data. The procedure outlined is one which has been tried and proved in practice, and moreover, one which may be followed by anyone who is the possessor of a dual-wave receiver of any description.

It is desirable that the completed oscillator be fitted with a fairly large diameter dial in order to enable accurate frequency determinations to be obtained.

The calibration graphs should be made on fairly large squared paper, as it is obviously useless making graphs which cannot be read to at least the same degree of accuracy as the tuning dial. A suitable size for each graph will be 100 divisions of one tenth of an inch each long each side. This will enable each division to correspond to a dial degree (assuming a hundred dial divisions) on the tuning side of the graph, and each division to correspond to 10 kc/sec. for frequency calibration on the broadcast band. The latter figure will be proportionately increased or reduced according to the band in use at the time, but as the most accurate calibration is usually required on the broadcast band, this figure will form a useful basis for the commencement of operations.

Band Coverage

The usual 400 micro-microfarads tuning condenser used in conjunction with the coils specified for the oscillator, will result in a frequency coverage of approximately 3—1 on each band, and, under these conditions, the band coverages, commencing from the low I.F. end, will be somewhere in the neighbourhood of 150 kc/sec.—400 kc/sec., 250 kc/sec.—700 kc/sec., 500 kc/sec.—1,500 kc/sec., 3,000 kc/sec.—9,000 kc/sec. and 6,000 kc/sec.—18,000 kc./sec. Translated into terms of metres on the short wave bands, this means that the coverage will be complete between 16 metres and 100 metres. A gap exists

(Continued on page 252)

ALL-WAVE BATTERY OSCILLATOR—
(Continued)—

between 100 metres and 200 metres, but, as this band is only covered by very few receivers in use to-day, no useful purpose is served by its coverage, as harmonics from the broadcast band may be used if an alignment signal is required.

Having obtained the necessary graph paper, the next step is to mark it in dial degrees along one axis and hundredths of the frequency coverage along the other. In the case of the low I.F. band, which will cover approximately 150 kc/sec.—400 kc/sec. it is just as well to mark the frequency axis as covering from 150 kc/sec.—450 kc/sec., as this will give 300 kc/sec. coverage, and thus enable each division to equal 3 kc/sec. The same procedure may be followed for each of the other bands, taking care in each case that each division equals a full number of kilocycles. This is necessary in order to simplify the reading of the completed calibration curves.

These preparations and precautions having been made and taken, the next step is the provision of some method of obtaining accurate frequency readings to set the calibration check points.

Naturally, this can be done most accurately by means of a reliable frequency standard of some kind, but, as standards of this nature are not generally available to everybody, we shall have to fall back on more or less indirect means of obtaining the desired result.

The only essentials for calibration under these conditions are a dual-wave receiver, preferably of the "465 kc/sec." type, and a standard log card. The 465 kc/sec. super is preferable on two counts, one of which is the elimination of any possibility of error due to image responses, and the second is that I.F. band calibration is simplified considerably by the use of a receiver of this nature.

It will usually be found that six check points in each band will be sufficient to ensure reasonable calibration accuracy, although, of course, more can be taken if time and circumstances permit.

Broadcast Band Calibration

The first step is to connect up the receiver to a length of aerial sufficient to enable it to pick up all local stations at reasonable volume, **with the volume control well up.** A short length of wire (about two feet long) is then connected additionally to the aerial terminal, and a similar piece of wire is then twisted around it and connected to the R.F. output terminal of the oscillator which is "live" (the terminal which goes to L5 on the circuit of fig. 1). The remaining output terminal of the oscillator is then earthed to the earth terminal of the receiver. This done, a modulated signal will be heard on the receiver when the oscillator wave band switch is on "Broadcast" or either of the two I.F. bands, the position at which it is tuned in being dependent on the dial settings.

It will be found that a considerably stronger signal will be heard on the receiver when the oscillator is tuned over the "broadcast" band position, and it will be necessary to reduce this signal very considerably by means of the attenuator potentiometer (R6 in fig. 1).

Reference to a station log card will soon show the frequencies of at least six stations which are distributed fairly evenly throughout the broadcast band. and these frequencies should be carefully noted.

Each of them is then tuned in and the oscillator dial setting altered until the modulated signal from the oscillator coincides with the station carrier. This point is easily recognisable, as a double-humped whistle will be heard in addition to the modulation note of the signal as the oscillator is tuned through the station. The centre of the two humps is known as "zero-beat" position, and exactly coincides with the station frequency.

The oscillator dial settings for each of the stations tuned in, together with the frequency, must then be noted as a spot on the graph paper, the position of the spot being located by straight lines taken from the frequency and dial degrees axes. Inspection of the six spots after plotting will show that they follow the shape of a definite curve. A tentative line can then be drawn connecting the six points and this will form our preliminary calibration graph for the broadcast band.

However, this curve will, in most cases, only extend over portion of the broadcast band, and leave a gap at each end. There are two ways of filling these gaps, which can be used separately, or both together and thus ensure greater calibration accuracy.

The first of these is waiting until a number of stations are receivable at both ends of the tuning range, and to plot their frequencies against dial degrees in a similar manner to that employed before. By this means a number of extra check points will be obtained and from these a complete calibration curve may be drawn covering the entire scale.

Use of Harmonics

The second method of filling in the band makes use of the calibrations already obtained, together with the harmonic output of the oscillator. By reference to the calibration curve already made it will be possible to determine the oscillator dial setting for 750 kc/sec. and, on rotation of the receiver dial, it will be found that this signal can be tuned in, as well as another near the bottom of the dial. This second signal is a harmonic of the 750 kc/sec. signal developed by the oscillator, and, as it is the first harmonic found, is at 1500 kc/sec. This gives us the receiver dial setting for 1,500 kc/sec. and, by retuning the oscillator, the signal output may be brought into resonance at this point. The received signal will be considerably stronger when the fundamental output of the oscillator is being received instead of the harmonic, and from this, as well as the relative dial settings, it is easily possible to make sure whether the harmonic or fundamental is tuned in.

Having located the 1500 kc/sec. fundamental by this means, the oscillator dial position may be plotted, and the procedure repeated until a sufficient number of check points are obtained to complete the calibration at the bottom of the dial.

To fill in the gap at the top, the reverse procedure is followed, that is, the receiver is tuned to the oscillator at about 1100 kc/sec., and the oscillator retuned towards the lower frequency end of the scale until the signal is heard again. Providing the frequency of the original position is accurately known, this new position will be at **half** the original frequency, or, in the example quoted, 550 kc/sec., and may be plotted as such.

By the careful application of these two systems it is easily possible to completely calibrate the broadcast band in a very accurate manner, as it will readily be seen that if one or two marker stations are located at the top of the band, a cross check may be made on the calibrations at the centre of the band, and so on.

Short Wave and I.F. Band Calibration

THE "465 kc/sec." dual-wave super, is still necessary for the remainder of the calibration procedure, and the first step is to connect it up with the oscillator, as before, and switch both the set and the oscillator on.

As most of the calibration on the bands in question will have to be done with the aid of harmonics, it will be as well to choose a fairly quiet time of the day or evening for the operation, and to make sure that the receiver and oscillator are effectually earthed.

Having done this, it will be necessary to ascertain the exact intermediate frequency used in the receiver. If this is already known, the procedure will be simplified considerably and it will only be necessary to couple the output of the oscillator direct to the grid of the first detector in the super and rotate the oscillator dial until the oscillator signal comes in at its strongest point, making sure, of course, that the oscillator band switch is on the "465 kc/sec." position. A point worthy of note is that a resistance of about 500,000 ohms should be connected across the oscillator output terminals when the connection is made to the first detector grid, otherwise the grid will be open circuited, and, even if the valve does not choke up, lots of other noises will be heard as well as the signal.

If the I.F. of the receiver is known accurately the resonance point so found may be plotted on the graph as such. If the frequency is not known exactly, it will be necessary to make a note of the dial position (not on the graph) for future reference.

High I.F. Band

Having obtained this point, the grid connection is then replaced on the first detector and the oscillator coupled back to the aerial, as before. With the oscillator left tuned to the I.F. position found, and the attenuator and radio receiver vol-

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ALL-WAVE BATTERY OSCILLATOR—
(Continued)—

ume controls well up it will now be possible to tune in the oscillator signal at all positions of the receiver dial. This will indicate that the oscillator is tuned exactly to the intermediate frequency. Should this not be possible, the coupling must be made tighter and it may be necessary to connect the oscillator output direct to the aerial terminal of the receiver. Turning the attenuator or the volume control down slightly will eliminate this untuned response, and result in only two signals being heard on the broadcast band. These two will be on the second and third harmonics of the I.F. signal and will be in the middle and lower parts of the dial respectively. For an I.F. of 465 kc/sec. these two points will be located at 930 kc/sec. and 1395 kc/sec. on the broadcast band, or, in other words, at twice and three times the intermediate frequency. The converse applies, and if the harmonics are tuned in at the above frequencies, the intermediate level may be ascertained by simple division.

From this it will be seen that the calibration of the high intermediate band is quite a simple procedure, as a calibration has already been made for the broadcast band, and it is only a matter of locating the harmonics as the oscillator dial is turned and dividing by the approximate number. Three or more harmonics will be found when the dial is at the low-frequency end of the I.F. band, but, as they will be progressively lower in strength, their exact harmonic relation may be easily deduced. Naturally, each point is plotted on the graph as soon as it is identified, and, as a result, sufficient points will be located to draw a complete calibration curve for this band.

Low I.F. Band

The procedure is then repeated for the low I.F. band, but in this case it will be first necessary to feed the oscillator signal direct to the grid of the first detector, and then, instead of rotating the receiver dial to locate the harmonics, rotating the oscillator dial while the switch is on the low I.F. band and noting the position at which signals are heard. This will give plotting points at 232.5 kc/sec. and 155 kc/sec. if the receiver has a 465 kc/sec. I.F. amplifier. It will quite readily be seen that 465 kc/sec. is the second and third harmonic respectively of these two frequencies, and, since the receiver I.F. is fixed, these two frequencies will be the only ones heard. (The same reasoning applies to any other I.F. as, for example, 450 kc/sec. The points will then be 225 kc/sec. and 150 kc/sec.).

Having located these two check points, the oscillator output is again coupled to the aerial terminal of the receiver. Several other plotting points may then be located by reference to harmonics on the broadcast band. The exact harmonic relation may easily be ascertained if the dial positions originally located and lower parts of the dial respectively. For an I.F. of 465 with 175 kc/sec. intermediates is available, and it should not be difficult to obtain a reasonably accurate low I.F. band calibration from the points so obtained.

Short Wave Bands

Short wave calibration on the highest frequency band may be carried out in the same manner as the broadcast band calibration, and, as the other short wave band is an exact first sub-multiple of this band, second harmonic calibration may be employed in this case.

The calibration graphs so obtained for all these bands will be accurate enough to enable working determinations of frequency to be made on any of the bands covered, and from time to time it will be found possible to locate additional plotting points, and so revise the curves originally obtained.

An A.C.-Operated Oscillator

The construction of an A.C. operated instrument will now be dealt with, and the details presented should be of value to those who wish to build an instrument suitable for semi-permanent installation in the workshop.

Circuit Requirements

The circuit diagram for the oscillator modulator and power supply are given in fig. 2 and it will be seen that with the exception of tubes and power supply the arrangement is very similar to that employed for the battery-operated instrument. Full details of the battery driven oscillator and the coil data necessary to ensure complete frequency coverage have already been given and are equally applicable to the construction of the instrument (with the exceptions noted above). The calibration procedure required is identical so that it is only necessary to detail the alterations necessary to tubes and constants which will enable A.C. operation to be achieved.

(Continued on page 254)

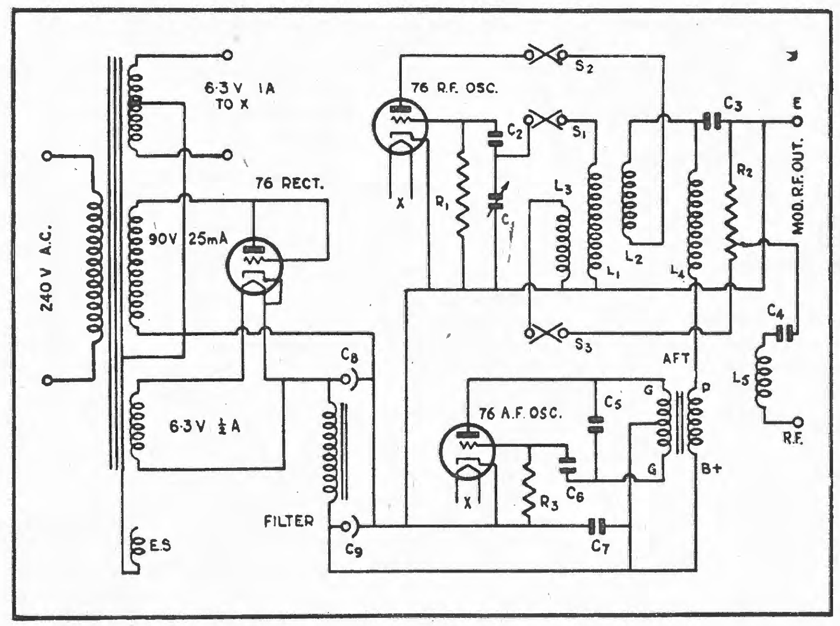

Fig. 2.—A.C.-Operated All-Wave Test Oscillator

A.C. OSCILLATOR—(Continued)—

Several detail alterations to the constants employed are necessary to enable satisfactory operation of the A.C. instrument, and the complete list of constants is as follows:—

C1—Tuning Condenser, C2—Osc. Grid. Con. 0.0001 mfd., C3—Plate circuit R.F. Bypass 0.001 mfd., C4—0.0002 mfd., C5—A.F. tuning Cond. 0.01 mfd., C6—Mod. Grid. Cond., 0.0005 mfd., C7—0.5 mfd. Tubular Paper. R1—Osc. grid lead, 50,000 ohms carbon, R2—400 ohms potentiometer for output control, R3—Mod. grid lead, 100,000 ohms carbon. Modulation is effected by means of A.F.T. which is a receiving type of push-pull transformer with a turns ratio of 1—2 overall. S1, S2 and S3 are the switch sections associated with L1, L2 and L3, and serve to select the various frequency bands on which it is desired to operate. As mentioned before, the winding data for the various coils is the same as that employed for the battery-powered oscillator and need not be repeated. L4 is a radio-frequency choke, and must have sufficient inductance to prevent R.F. leakage through the primary winding of the modulation transformer. L5 is a small inductance which serves, with C4, as a built-in dummy antenna.

Power supply is from the transformer shown at the left of the circuit diagram. A 76 with grid and plate tied together, and cathode returned to one side of the heater, serves as a rectifier, and filtration is by means of C8 and C9 and an iron-cored choke with an inductance of about 30 henrys at 10 mA. The primary of an old A.F. transformer will serve admirably in this position. C8 and C9 are ordinary 8 mfd. electrolytic condensers.

Constructional Requirements

Great care is necessary in shielding and wiring if satisfactory results are required from an instrument of this description as attentuation is quite a big problem on the higher frequency bands.

A good plan is to build the R.F. oscillator valve and associated circuit components into a separate shielded box inside the main case holding the complete instrument.

All wiring should be carried out independently of any nearby earthing points, and the main earth bus-bar grounded to the frame at a point close to the output terminals of the instrument. This procedure will eliminate any possibility of small circulating currents being set up in the shields and allowing direct radiation to take place.

An Attenuator for the Battery and A.C. Operated Instruments

The attenuator to be described is of the "T"—pad type and has a reasonably constant input and output impedance of 40 ohms.

This, in itself, is quite an advantage, as variation of the output control will not affect the tuning of either oscillator or receiver appreciably.

The assembly is quite small in size, being built up around a single bank of the well known "Yaxley" all-wave switch. This switch should be obtained complete with the special location plate so as to enable accurate settings to be maintained.

Circuit

The method of wiring and the electrical circuit are shown in fig. 3, and it will be seen that eight resistors are necessary besides the switch and a shielding case for the completed attenuator.

The external connections shown (S3, earth bus and dummy) are those which will be used if the attenuator is used to replace the potentiometer in the oscillator previously detailed.

Care should be exercised when assembling and wiring the attenuator to see that the circuit is only earthed at the point where the output lead comes from the case. This is shown clearly in the diagram and is most important, otherwise small circulating currents will be set up in the box and prevent complete attenuation from being effected.

The eight resistors used should each have a resistance of 10 ohms, **and must be non-inductive.** It is advisable that they be made as small as possible, otherwise excessive capacity coupling between the various units will exist, with a resultant reduction of the effective attenuation.

Resistors

Non-inductive resistors of the required type may be obtained from several of the manufacturers making wire-wound components, or, if desired, they may be made by the constructor himself.

The wire used should be 36g to 40g S.W.G. enamelled Eureka or Advance. A flat strip former must be used, as solenoidal windings on a round former will have an appreciable self-inductance. Quarter inch wide strips of mica, between five and ten thousandths of an inch thick, are the most suitable formers, and, as no lugs are necessary for termination, the wire can be threaded through a hole in the mica and taken direct to the solder lug on the switch.

Assembly

No connection is made to the rotating contact of the switch, the two contact strips on the "Yaxley" bank being merely bridged together and forming the floating arm of the "T" pad.

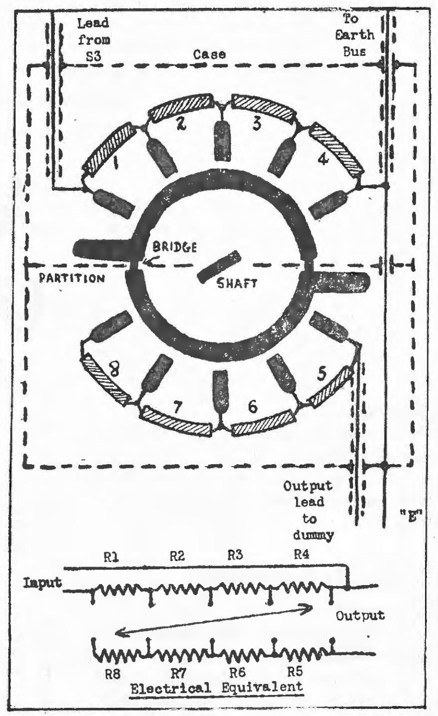

Fig. 3—Construction and wiring of five-step attenuator for modulated R.F. oscillator.

It will be necessary to attach a pigtail to the rotating shaft of the switch assembly and to earth this pigtail to the earthing point of the attenuator box. Otherwise, it will be found that appreciable signal leakage will occur at this point.

The partition shown in the diagram is arranged to separate the two banks of four resistors and thus avoid any stray coupling at this point.

Carefully made, the control afforded by this attenuator will be found fairly constant at all frequencies, and, as a result, the performance and usefulness of any oscillator, to which it is fitted improved.

Alignment Procedure for Modern Receivers

The first essential is an accurately calibrated signal generator or modulated oscillator of some type, and following this, an output meter capable of accurate indications at very low signal levels. In the treatment of receivers equipped with A.V.C. the output meter may be dispensed with, and a milliammeter with a full scale deflection of about 10 mA. connected as a "tuning meter," used instead.

Too much emphasis cannot be laid on the necessity of accurate I.F. alignment, for it will readily be seen that, unless the I.F. tuning circuits are adjusted exactly to the frequency which the receiver was designed to use, accurate tracking of the radio frequency and oscillator circuits is impossible.

Bearing this in mind, then, first ascertain the I.F. that the receiver was designed for, and adjust the I.F. Transformers to this frequency. The modulated oscillator output should be fed into the grid of the first detector valve for this operation, and the tuning gang must be turned to a position where no heterodyning takes place with either the modulated oscillator or a broadcasting station which happens to be on the air at the time. Failing this the oscillator section of the gang should be shorted out. In the case of an A.V.C. set, use the milliammeter connected in the plate circuit of one of the controlled valves as an indication of resonance, or, if this is impracticable, use the lowest possible range on the output meter, so that "lining-up" can be carried out at a signal level lower than that at which the A.V.C. takes charge.

A useful "don't" to bear in mind when lining-up is "Don't reduce volume by means of the receiver volume control." Always use the attenuator on the modulated oscillator if the output meter needle tends to wrap itself round the stop. If the attenuator has not got sufficient range to do this, then the receiver control may be retarded **slightly**, but in all other cases, keep it hard on.

Having accurately adjusted the I.F. transformers in the receiver, the next step is to adjust the signal frequency trimmers on the gang or coils associated with it. A number of operators go to a lot of trouble determining "tie-in" points with the super turned into a T.R.F. by feeding the R.F. output into the second detector. This may be quite in order when doing developmental work, but is totally unnecessary, and, in some cases, even misleading, to say the least, in a completed receiver.

Procedure

The correct procedure is to first set the modulated oscillator to a frequency around 1450 kc. The output of the oscillator is then connected to the aerial and earth terminals of the receiver, preferably through a "dummy" which has characteristics approximating those of the aerial which the receiver is to be used on. The receiver dial is then turned until maximum output is obtained, still bearing in mind the rules set out for lining the I.F. amplifier. Where the receiver has a frequency or wave length calibrated dial, the control should be set to a point corresponding to the frequency developed by the modulated oscillator. In this case, no signal may be heard if the receiver is right out of alignment and the next step is to adjust the oscillator trimmer, or the position of the dial on the condenser shaft until the receiver calibration coincides with the modulated oscillator setting.

This having been done, the aerial and R.F. stage trimmers are adjusted for maximum output and lining is complete at the high frequency end of the tuning range.

The modulated oscillator is then set to approximately 600 k.c. and the receiver dial rotated until resonance is obtained. The oscillator padding trimmer must then be adjusted to ensure correct tracking, but it is of no earthly use adjusting the padder unless the receiver dial is adjusted accordingly. The correct procedure is to **increase** the dial reading slightly if the padder capacity is **reduced**, and vice versa. If either of these **simultaneous** adjustments results in an increased output reading, then continue on in the same direction until a slight drop is noticed. The procedure is then reversed until maximum indication is again obtained. The gang or coil trimmers must not be touched whilst making this adjustment. Having obtained the correct padder setting, the tuning is then returned to 1450 k.c. and a check is made again. If the padder did not have to be shifted, or was only moved very slightly at the 600 k.c. setting, no re-adjustment of the trimmers will be necessary at 1450 k.c., but if the padder was shifted to any extent, the **aerial** and **R.F.** trimmers will have to be adjusted slightly to obtain maximum response at this frequency. The oscillator coil trimmer must on no account be touched after the **initial** adjustment at 1450 kc/sec.

Correcting Tracking Faults

In the preceding paragraphs we dealt with the general procedure to be adopted in servicing, or "lining-up" production model receivers where the coils and associated gear were designed correctly.

This latter is not always the case, however, and we will now deal with the correct method of ensuring accurate tracking.

Even though a receiver lines up properly at the bottom of the band, and "pads" nicely at the top, it does not always follow that the various circuits are keeping in line throughout the intervening frequencies. Turning the super into a T.R.F. provides one means of checking the tracking approximately, but, as this method is liable to be misleading if practised by any but a highly skilled technician, we will not enter into details here.

Recommended Procedure

The first step in determining whether the tracking is correct throughout the band is to **accurately** line the receiver at both ends of the dial, as previously detailed. After re-checking at 1,450 kc/sec. shift the modulated oscillator frequency to round about 1,000 kc/sec. The exact frequency used will depend on local conditions (nearby station), as it is not desirable to have broadcast signals "chipping in" whilst making tests of this nature.

Tune the receiver on to the oscillator signal for maximum deflection on the output meter, remembering to keep the oscillator attenuator well **down** and the receiver volume control well **up.** Having done this, check the trimmers on the **aerial** and **R.F.** coils. If everything is O.K., any movement of these will give a decided drop in output. In that case, return to 1,450 kc/sec. and re-check. It may be found that one trimmer will be O.K. and the other gives an increase in output when it is shifted. Should this occur, look at the moving plates of the gang on the section associated with the trimmer which is out, as the trouble in this case will be almost invariably due to the gang itself tracking incorrectly. Sectors are provided on the moving plates of the gang to take care of contingencies such as this. Providing the rotor itself is centred correctly between the fixed plates; then should the trimmer have to be screwed **in** to increase the output, it follows that more capacity is needed in that section. If this is so, the sectors up to that point (working from the low capacity and of the rotor) must be bent inwards carefully until any movement of the trimmer results in decreased output. The reverse applies if the trimmer has to come out.

Sometimes it will be found that both aerial and R.F. trimmers will increase the output even if moved in **opposite** directions (for example, the aerial trimmer may have to be screwed in and the R.F. trimmer out). The gang is usually at fault in this case, and the above procedure is again followed being careful to adjust only one section at a time, until maximum output is obtained at the original 1,450 kc/sec. trimmer settings.

Having done this, the tuning is taken back to 1,450 kc/sec. again, and the trimmers rechecked. After making an adjustment to the gang of this nature, it is advisable to check the padding again, or at least, the alignment, at the top of the band. Having tuned to 600 kc/sec. the first step is to check the padding in the manner previously specified. The next step is to check the aerial and R.F. trimmers at this frequency.

(Continued on page 256)

ALIGNMENT OF MODERN RECEIVERS—(Continued)—

If much alteration to the gang was required at 1,000 kc/sec. it will be found that some movement of these trimmers will be necessary in order to obtain maximum output. In this case the same procedure is adopted as at 1,000 kc/sec. making sure that the trimmers are returned to their original setting and that the rotor sectors are only bent from the 1,000 kc/sec. setting on, that is, the sectors which were bent at 1,000 kc/sec. must not be touched again. Any adjustment at the top of the band should be made with the remaining sectors. The tuning is then returned to 1,450 kc/sec. and the trimmers re-checked.

Obtaining Correct Oscillator Ratio

There still remains the condition at 1,000 kc/sec. to consider where **both** trimmers have to be shifted in the **same** direction in order to obtain maximum output. This condition is an indication that the oscillator coil is not matched to the aerial and R.F. coils for the particular intermediate frequency used. Should both aerial and R.F. trimmers have to be screwed **in** it is an indication that the oscillator coil is too big or conversely, the aerial and R.F. coils are too small. As the oscillator coil is usually more accessible, it is better to regard it as being the culprit, and to take turns off it until movement of the trimmers results in decreased output. The reverse treatment applies if the aerial and R.F. trimmers have to come **out** to bring the output up to maximum.

Experience shows that a quarter-turn on the trimmers necessitates an alteration of one turn on the oscillator coil to correct matters. This is approximate only, as a great deal depends on the capacity of the trimmers themselves, but it is a useful "Rule of Thumb."

Great care is necessary in carrying out this operation, and, it is advisable to recheck at top and bottom continually whilst making any adjustment to the oscillator coil to ensure that the correct padder and trimmer positions are maintained. In this connection it must be remembered that a **reduction** in the oscillator coil will necessitate an **increase** in the padder setting, and vice versa.

It may be found that the original coil in the receiver was so far out, that the original padder will not have sufficient range to take care of tracking at the top of the band with the new coil. In this case the padder should be changed before finalising any adjustments.

After some alterations have been made to the oscillator coil, it may be found that one trimmer becomes normal, while the other one is still out. If this occurs, do not make any more adjustments to the coil, but proceed then to adjust the gang in accordance with the instructions already given.

The procedure in a receiver which does not incorporate an R.F. stage, but only has an aerial and oscillator coil, is identical with that outlined above, with the exception that if the aerial section gang sectors have to be bent much at 1,000 kc/sec. to obtain correct tracking it is safe to regard it as an indication that the oscillator coil is at fault and to proceed accordingly.

Extending Wave-Band Coverage

The following notes will prove useful in cases where an existing receiver, or even one in the process of development, does not cover any required band satisfactorily. The notes refer particularly to the broadcast band, but are equally applicable to the treatment of any other frequency range.

Correct Tracking Essential

The first step in extending the wave-band coverage in an existing receiver is to make certain that it is tracking correctly throughout the band already covered. The procedure for doing this has already been outlined, and attention in this respect is likely to have astounding results. One receiver, inspected by the writer recently, appeared to be tracking quite nicely, as far as indications by reception only showed, but the actual coverage was only from 1,450 kc/sec. to 560 kc/sec. A check was then made on the tracking throughout the band, and revealed that it was far from correct. A little alteration to the padder and oscillator coil increased the coverage by nearly 100 kc/sec. and enabled several more stations to be tuned in quite comfortably.

However, the results obtained from tracking the receiver correctly will not always be so gratifying, and the trouble must be sought elsewhere if it is found that everything is in order in this direction and the set still does not cover the band.

Usual Faults

It is only very rarely that a case will be found where the top **and** bottom of the band are cut off, and, should this be the case, quite extensive alterations will be necessary to the receiver. The cause of trouble of this nature will almost invariably be found to be the use of tuning coils which are too large, either in length or diameter for the shielding cans employed.

Replacement of the coils with others better proportioned for the size of the cans employed will usually have the desired effect.

The usual complaint will be that the stations either come in too high or too low. In other words, either the top or the bottom of the band is cut off.

Procedure

In the first case, screwing the gang trimmers down may make sufficient difference to the tuning to enable the extra coverage to be obtained. These may be already hard down, though, and some alteration to the coils will be necessary. Some idea of the extent of the alteration required may be gained by noting the position of the existing stations on the dial. To enable 2CR (Cumnock) to be tuned in properly, 2CO should come in between 94 and 96. If 2CO now tunes at 99, it is quite obvious that a four degree drop in their tuning position is required. A handy guide to the coil changes necessary may be gained from this, as in practice it is usually found that a turn added to the aerial and R.F. coils will drop the tuning a degree. Therefore in this case, four turns should be added to the aerial and R.F. coils, taking care that approximately the same gauge of wire is used for the added turns as is already wound on the existing coil.

This applies only to the aerial and R.F. coils, as a different set of conditions apply for the oscillator coil. In this case it must be remembered that the oscillator coil is wound with a definite turns ratio to the aerial and R.F. coils and, when making any changes, the alteration to the oscillator must preserve this ratio.

The oscillator coil winding in a receiver using an intermediate frequency of 460 kc/sec. is somewhere between 60% and 65% of that used on the aerial and R.F. coils, and therefore, in the above example, where four turns were added to the other coils, 60% of four, or two and one-half turns must be added to the oscillator coil. The percentage in a receiver employing 175 kc/sec. I.F. transformers, is approximately 80% and alterations to the oscillator coil should be in this ratio.

The reverse procedure to this applies where the stations tune in too low, and in this case, turns must be taken off the coils. The reduction on the oscillator coil in this case is in the same proportion as when adding turns, that is, if four turns are taken off the aerial and R.F. coils in a 460 kc/sec. super two and one-half turns must be taken off the oscillator coil.

Before taking turns off coils, however, it is as well to be sure that the gang trimmers are out as far as they will go, and that the radio frequency wiring of the receiver is so arranged that no undue capacity exists between grid leads and chassis, or earth. A little attention to this latter detail will sometimes have quite a decided effect on shifting the tuning positions of the various stations on the dial.

Choosing the Correct Intermediate Frequency

Quite a lot of divergent opinions exist as to the relative advantages of the various intermediate frequencies used in radio receivers to-day, and it is often very difficult for the dealer to decide which is the better of two receivers, each of similar valve power but using different intermediate frequencies.

Nowadays, receivers fall into two fairly well defined classes: those using an intermediate frequency of somewhere in the neighbourhood of 465 kc/sec. and those using an intermediate frequency of 175 kc/sec. or thereabouts.

Before endeavouring to draw any comparisons between the two systems, it will be as well to probe a little into the theory of super-heterodyne receiver operation and thus clear the way for what comes after.

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CHOOSING THE CORRECT INTERMEDIATE FREQUENCY—(Continued)—

Super-Het Theory

It is well-known that any type of superhet receiver incorporates some means of developing radio frequency oscillations, the frequency of which oscillations is controllable by means of the receiver tuning dial. The means for generating these oscillations takes several forms, and we have to-day receivers employing self-oscillating devices such as autodynes and pentagrids and other receivers employing a separate oscillator valve.

Whatever the means employed, the function of the oscillator is to provide a frequency which may be mixed with the incoming signal frequency and so produce a beat-frequency which is usually known as the intermediate frequency. This frequency is governed, in normal receiver design, by the difference between the oscillator frequency and that of the incoming signal, and tracking considerations rule that the oscillator frequency shall be equal to the signal frequency plus the intermediate frequency chosen. For example, if we are to receive a station on 1,000 kc/sec. and our intermediate frequency is 465 kc/sec., then the oscillator must be tuned to 1,465 kc/sec.

It will also be seen that the beat frequency of 465 kc/sec. will also be developed if the oscillator is tuned to 535 kc/sec. and this phenomenon is one that has to be considered in the choice of the intermediate frequency for use in a receiver.

From the above it will be seen that a normal super-heterodyne receiver must incorporate some means of tuning in any desired radio frequency signal, together with a local oscillator having its tuning ganged to the signal frequency tuner in such a way as to produce a fixed frequency beat note or difference-frequency.

Some means must then be provided for amplifying this difference frequency, and it is here that our original problem of 465 kc/sec. versus 175 kc/sec. comes in.

Advantages of 175 Kc/Sec.

It is fairly well-known that greater amplification, together with higher stability, may be obtained from a valve amplifier when it is operating at low-frequencies.

On this count, then a difference-frequency of 175 kc/sec. is to be preferred, especially when it is considered that the higher stability obtainable at the lower frequency means considerably greater permanency of characteristics in the final I.F. amplifier.

However, there is another point to consider, that of the difference frequency being also developed when the oscillator is tuned to a frequency **below** that of the signal.

This effect is not always apparent in a single dial control receiver, as the signal frequency tuning is altered at the same time as the oscillator tuning, and a shift of double the intermediate frequency on the part of the oscillator results in the receiver being detuned to the same extent from the original signal being received. This results in the receiver being detuned 350 kc/sec. when an I.F. of 175 kc/sec. is used and 930 kc/sec., when an I.F. of 465 kc/sec. is used.

When receiving distant stations, de-tuning to a point of 350 kc/sec. away from the signal is quite adequate to prevent any signal coming in from the station and allowing a double-response or "second-spot" to be set up, as obviously, no difference frequency can be developed unless there is a sufficient amount of the signal available to mix with the oscillator frequency.

Image Response

However, this state of affairs does not always obtain, and where powerful locals are operating, sufficient signal will leak through to the mixer valve to allow mixing to take place, with a resultant "second-spot" response on the station concerned. This effect may be overcome by providing a sufficient number of tuned circuits in front of the mixer valve to prevent any signal reaching it, other than that to which the receiver is actually tuned at the time. The provision of these circuits is made by inserting one or more radio-frequency amplifying stages between the aerial and the mixer valve or, if extra sensitivity is not required, by the provision of one or more tuned circuits in cascade, known as a "pre-selector."

While precautions of this nature result in "image-free" reception being obtained with a receiver using an I.F. of 175 kc/sec., it is not always possible either economically or practically, to realise the conditions set out. Firstly, the provision of extra tuned circuits between the aerial and mixer valve requires extra components such as tuning coils and extra gang sections, and this factor alone may prohibit the use of a low intermediate frequency. Again, extra components mean extra space requirements, and in some of the models being produced nowadays, space is at a premium. The provision of a sufficient number of tuned circuits in front of the mixer valve is not quite so easy as it sounds, from a technical and production point of view, and unless the design of the completed receiver is carried out very carefully serious complication of wiring and construction can very easily arise.

These factors, then, will sometimes combine to make the use of a low intermediate frequency impracticable and some other alternative becomes necessary.

Advantages of 465 Kc/Sec.

This is found in the use of a high frequency, such as 465 kc/sec., or thereabouts. Whereas, in a receiver using an I.F. of 175 kc/sec., the "second-spot" is only 350 kc/sec. away from the signal frequency, the use of an I.F. of 465 kc/sec. shifts this spot to a point over 900 kc/sec. away. This simplifies matters enormously, as it is quite possible to make a single tuned circuit which will successfully reject signals 900 kc/sec. off resonance. Another point which must be considered is that, even if the signal is not rejected, the second-spot will in most cases be at a point right off the dial, especially when tuning a band such as our present broadcast spectrum, which is only 950 kc/sec. wide. A word of warning must be sounded here, however, as second spot interference is not the only trouble which has to be contended with.

Adjacent channel selectivity is still a factor, even though with normal components very little difficulty will be experienced in this direction.

Final Considerations

Summing up, then, we can see that, providing adequate pre-selection can be incorporated, the use of a low intermediate frequency is preferable, as much greater gain may be obtained from the same number of valves. The high degree of pre-selection necessary will have an additional advantage in that the adjacent channel selectivity will be greater than that of a 465 kc/sec. I.F. receiver designed to give the same degree of image-rejection, with a consequent reduction in the amount of cross-modulation and whistles encountered in the operation of the receiver.

Against this, however, we have a definite saving in cost and space when the high intermediate frequency is used, together with a definite simplification of design and construction, at the expense of some amplification. This latter is not particularly important with modern tubes, unless the receiver is designed for operation on a dual wave-band. If this is the case, the problem is one for the individual designer to consider with relation to the price-field he is catering for.

A point that is worth mentioning with regard to adjacent channel selectivity, is that alhough a 465 kc/sec. I.F. receiver can be designed to give the same results in this respect as the receiver using the lower I.F. the cost will be the same in each case, and if this is so, the designer only has to consider whether the extra gain inherent in the use of the 175 kc/sec. I.F. is required or not.

In this discussion the writer has endeavoured to present the case for both high and low intermediate frequencies in as non-technical a manner as possible, in order to make a general basis for comparison of the two systems. While it is realised that there is much more to be said for both sides, it must be conceded that the points raised are those which directly concern the man whose interests are centred mainly on the commercial end of the business. Any further discussion must of necessity be theoretical in its scope, and, as such, is beyond the province of these pages.

Radio Service Notes

THE efficient servicing of radio receivers is very largely a matter of experience and a knowledge of the fundamentals of circuit design.

Service notes dealing with the location and cure of some of the less obvious faults are presented in the following pages and, in many cases, a study of the "cures" necessary will show how preventive measures can be taken. Application of the latter while one job is being done will often eliminate "callbacks" and will certainly result in more satisfied customers.

In the presentation of these notes, it is assumed that the obvious steps, such as checking of valves and external connections, have been taken and that the difficulty being experienced is one that cannot be located by seeing if all of the voltages are where they should be, approximately, at any rate.

General Hints

THE following are a few summarised notes which will often assist in the location of troubles and, at any rate, give the serviceman some idea where the trouble might be.

Noisy Operation. Loose valve or coil cans. Corrosion at terminals or lugs.

Breakdown of high voltage leads, which should be replaced with fryed wire.

Check bonding of shielded leads to chassis.

Clean volume controls thoroughly with benzine or preferably pure alcohol.

Remove dust or metallic particles from between variable condenser plates by means of pipe cleaner. If necessary, wash with benzine or alcohol. May be desirable to add flexible pigtails to wiping contacts.

On short-wave bands: check contacts between metal surfaces, even if not portion of the S.W. circuit. Check soldered joints. Check metal-to-metal contacts around house, such as clothes-lines or guys in contact with iron roof or one another, etc.

Hum. Shorted bias or C.T. resistor in output stage (using 45, 47, etc.) reduces "B" supply voltage and produces hum.

Corroded connections in filter system.

Insufficient by-pass or de-coupling of detector screen and/or plate circuit.

Poor contacts or shorts in pick-up connections and/or switch.

Shorted field coil, with weak distorted output.

Check matching of output valves if in push-pull.

If an 80 or other vacuum type rectifier is used with a choke input filter, the addition of a 1 mfd. condenser from rectifier filament to ground will increase output with reduction in hum.

The centre tap on filament windings is often beneficially replaced by a C.T. resistor.

Oscillation and/or **Motor Boating.** Defective R.F. and I.F. by-pass condensers.

Check suppressor to cathode connections on R.F. and I.F. pentode valves.

Sometimes due to bad contact between rotor of tuning condenser and frame, or frame and chassis. Each section should have its wiper-spring bonded direct to chassis as near the coils as possible. Fit flexible pig-tail if necessary.

While using analyser touch a finger on the grid cap of the valve under test.

Check de-coupling circuit of A.V.C. voltage.

Intermittent Operation. Defective chokes in R.F. plate circuits.

Check speaker plug and socket, also all valve bases and sockets from output back through set.

Defective local-distance switch.

Defective coupling condenser in pre-selector (band-pass) unit sometimes causes this, with possible inselectivity and faltering of signals.

If volume changes suddenly and at random, check R.F. and I.F. cathode by-passes.

Check for dirty trimmer or padder, fluff or dirt in tuning condenser, or poor coil contacts.

Shorted or leaky trimmers in R.F. or I.F. stages.

Weak Volume, Poor Quality. Shorted field coil.

If associated with positive bias on first audio valve, check coupling condenser from detector plate circuit.

Check alignment of gang condenser, especially if old set.

Check output stage bias.

Check matching of output valves if in push-pull.

Low screen voltages.

Fractured speaker cone.

General Hints. Air cell batteries produce corrosive fumes and should be kept clear of the receiver.

Short circuits in radio-gramophones may be caused by gramophone needles.

To cure a howl which occurs during the warming-up process, try another detector valve.

Soldering flux may be melted from dirty contact surfaces with a hot iron. Alcohol or benzine will remove grease or oil.

General Notes

The following are some complete service notes of general interest which will be of assistance when unusual problems are encountered.

A Battery Set Tip

It will sometimes be found, when servicing a battery receiver, that the "B" batteries are giving rise to a fair amount of noise, even though their voltage is still sufficient to operate the set satisfactorily. This is due to polarisation of one or more cells in the blocks. The trouble sometimes takes the form of a high pitched squeal in the reproduction from the receiver, especially when the volume is turned fairly well on.

A temporary cure can often be effected by shunting a fixed condenser of one or two microfarads across the maximum "B" voltage tapping and "B" negative, and replacement can be avoided until the customer has had a little more value for his money.

Modulation Hum

Modulation hum, or "station" hum, as it is sometimes called, is probably one of the most prevalent troubles in A.C. receivers.

In cases where the hum is only associated with one station and all the others are O.K. nothing can be done except write to the station and tell them about it. When the trouble is impartial, and affects all stations the receiver is probably at fault. "Probably," because occasionally it will be found that the mains from which the receiver is run are the cause of the trouble, and some method of power factor correction, or extensive R.F. filtration, is necessary.

Usually, though, the trouble can be corrected in the receiver itself, and the following notes will be of assistance in locating and curing the fault.

One common cause of modulation hum is a cathode to heater short in an indirectly heated valve. Replacement of the faulty valve is indicated if this is the case.

(Continued on next page)

RADIO SERVICE HINTS—

Another fruitful source of trouble is the centre tap on the heater winding for the valves preceding the second detector. If this tapping is not **electrically** central with relation to the heater terminals of the valves themselves, a modulation hum will sometimes be developed especially on weak stations.

The remedy in this case is to make an artificial centre tap by means of a low resistance, centre-tapped and connected directly across the heater terminals of one of the valves concerned. The centre tap is, of course, earthed. A total resistance of 20 ohms for 2.5 volt valves, and 60 ohms for 6.3 volt valves, is in order. In some power transformers, the heater winding centre tap is brought out by means of a very light flexible lead. A momentary short circuit to earth of one of the heater leads is sufficient to fuse this wire, and, as a result, the winding is left "floating" and a very pronounced modulation hum will be set up. The use of a centre tapped resistance, as detailed above, will rectify the trouble.

A potential source of modulation hum is found in the high-tension secondary of the power transformer. It will sometimes be found that the full-wave secondary becomes unbalanced. This is caused by a few turns partially short-circuiting on one side of the secondary, due to faulty design or workmanship originally, and intensified by the operation of the transformer over a period of time. The trouble can be located by means of an A.C. Voltmeter, or, if one is not available, by connecting a resistance of about 25,000 ohms across each side of the secondary in turn. The extra load thus placed on the transformer will intensify the hum on the faulty side and alleviate it slightly when placed on the good side. A temporary cure can be effected in this way, but the only satisfactory method is to replace the transformer.

Modulation hum can also be set up by an ineffective electrostatic shield on the power transformer. The remedy in this case is to bridge a pair of high voltage mica condensers of 0.01 microfarad capacity, across the two sides of the high tension secondary and earth.

An alternative method is to filter the input to the transformer by means of a 2 x 0.1 microfarad line filter condenser connected across the mains. The centre tap of this condenser is earthed. This latter is usually quite effective in preventing "man-made" static interference from entering the set via the mains.

Periodic Fading

This is one of the most annoying faults to be found in modern receivers, and one which can take quite a while to locate. The fault will occasionally be evidenced by the set operating quite satisfactorily for a few minutes after switching on, but will then gradually fade out and come on again equally slowly. The trouble in this case is nearly always due to an open circuit heater in one of the valves and replacement is the only cure. Location of the offending valve can be accomplished by watching the spot of light at the top of the cathode, or, if this does not show up, replacement of each of the valves in turn.

One experience the writer had recently in this connection was due to a badly soldered joint at the power transformer terminal board. In this case the connection was making sufficient contact to allow the valves to heat up, but the passage of current set up a slight arc which broke the circuit after a while. On cooling, the joint was remade, and the cycle was repeated.

Most periodic fading faults are due to something of this nature, and it is as well to carefully check over **all** joints carrying any appreciable amount of current when a fault like this is experienced.

Likely offenders are voltage divider clips, valve socket contacts, all transformer terminal board connections, and bias resistors on power tubes.

"Back-Biassing" Faults

Every now and then the serviceman comes across a receiver which works quite well in all respects except tone.

If the set checks O.K. for resistance readings, etc., when cold, and valves check up to standard, have a look at the bias system employed on the output valve. If this is of the "back-bias" or bleed type, check the washers insulating the can of the first electrolytic from the chassis, carefully.

It will often be found that one of the washers is sufficiently out of place to allow the bias resistor to be partially short-circuited, when the bias voltage is developed across it.

This may seem a very obvious procedure but the writer has seen a surprising number of receivers lately in which this fault existed and which failed to be located by routine checking methods.

Polarity of Dry Electrolytic Condensers

Judging by a recent census of service troubles, quite a number of servicemen and even manufacturers do not seem to realise that high-capacity low-voltage "dry" electrolytic condensers have definite plus and minus terminals. Even though these condensers are usually clearly marked, their similarity to ordinary pigtail type tubular condensers appears to be misleading.

Always make sure that the marked polarity is observed when using these condensers, and, in addition, be very sure that the marked **working** voltage is not exceeded, otherwise the noise level in the completed receiver will be pretty high, and distortion will, in most cases, result, especially if the condenser is usd to by-pass an A.F. bias resistor.

Pigtail Tubular Condensers

The almost universal use of small pigtail type tubular condensers calls for a word of warning as to their correct use.

Most brands are marked in some way, such as "outside foil" or "earth this end" on one end of the label.

This is not put on for the sake of filling up the label, as some people appear to think, but is there to indicate that the outside layer of foil is connected to that end. If freedom from instability and hum troubles is desired, this end must be earthed or connected to the low potential side of the circuit.

Non-observance of this precaution will almost invariably result in a form of R.F. or I.F. instability which is particularly difficult to trace and rectify.

Valves With Spray Shields

Now and then one comes across a case where a receiver, using valves which are shielded by a sprayed coating, exhibits traces of almost uncontrollable instability.

This sometimes is due to unevenness in the sprayed coating setting up a high resistance to earth and not allowing the shield to operate as it should.

The remedy is to clamp a thin metal band around the largest diameter portion of the valve and earthing this band by a piece of stranded hook-up wire to the main earth bus-bar.

This treatment has been known to cure cases of instability which defied all other attempts at control, and, in one or two cases, has proved very efficacious in cutting out traces of cross-modulation and apparent broadness of tuning in receivers located near a powerful local.

Connecting An Extra Loud Speaker

It is occasionally necessary to connect a loud-speaker extension to a receiver to enable a separate speaker from that in the set to be used in another room or at a distance.

For this purpose it is best to use a per-magnetic speaker or one which has its own field energisation, if a moving coil speaker must be used, as it is next to impossible to arrange extra field energisation from the one set.

Actually, the audio frequency impulses should be conveyed by a low-impedance line of some kind if no loss of highs is tolerable, but this procedure is not always practicable and is not necessary for temporary use.

The simplest procedure is to connect one side of a 1 microfarad high voltage (400 volts) fixed condenser to the plate of

(Continued on next page)

RADIO SERVICE HINTS—(Continued)—

the output valve, and run a lead from the other side of the condenser to one of the input transformer leads of the extension speaker. The other lead from the extension speaker may then be connected to earth, and providing the receiver is earthed, the circuit will be complete. Should it be impossible to earth either the speaker lead or the set, it will be necessary to run an extra lead from the set earth terminal to the extension speaker.

It is, of course, necessary that the speaker at the receiver be left plugged in and in operation.

The advantage of this method is that in most cases only one lead is necessary to link the receiver and the speaker, the return path being through the earth.

Another advantage, and one that is quite important, is that no high voltage exists in either lead and there is no danger of an accidental shock being experienced.

"Dead Spots" on Short Waves

When building up a dual-wave set, or any receiver, incorporating a short-wave band, it will quite frequently be found that the oscillation appears to cut out at one or more points on the dial.

This trouble takes several forms, and its treatment may be fairly easily localised by the position on the dial at which the trouble occurs.

Should the receiver operate satisfactorily up to about 70° or 80° on the dial it would usually be found that the trouble is due to insufficient reaction being applied. This may be overcome by slightly increasing the oscillator plate voltage, or, if this fails to have the desired effect, by increasing the value of the grid leak or condenser. Care must be taken that the value of the grid condenser is not increased by too great an extent, as the wave-band coverage will be restricted if this is too large. An alternative method is to increase the reaction winding on the oscillator coil slightly, but this will not be necessary, except in an extreme case, as, with factory-made coils, this winding is usually correctly proportioned.

The other usual case is where oscillation appears to fall off at the bottom of the band. This condition is usually caused by excessive damping being placed on the oscillator circuit through faulty wiring or components. The trouble may, in some cases, be overcome by slightly increasing the oscillator feedback, as detailed before, but it is advisable to check over all components very carefully before making any adjustments of this nature. The trouble may also be caused by too much reaction coupling, and the procedure in this case is to reduce the coupling turns on the oscillator coil slightly. A fair amount of experimentation is called for in this case, but the above details should give a guide to the probable causes of trouble of this nature.

The final condition is one where oscillation appears normal at the top and bottom of the band, but "dead spots" or falls off over a few degrees in the centre of the tuning range. With pentagrid or octode converters this may be due to a phenomenon known as "interlocking" and is caused by either too much reaction feed-back or the incorrect voltages being applied to the valve. Careful attention to these points is indicated if trouble of this nature is experienced.

Another cause of this fault, which may be experienced with either converter valves or separate oscillators, is stray coupling between the oscillator coil or wiring and other portions of the receiver wiring. This trouble is particularly prevalent in receivers using coil switching for wave-band changes, and the only method of overcoming the trouble is to carefully space out all oscillator circuit wiring and components.

Induced Hum

This is a very common complaint in A.C. operated receivers, and one which is, in most cases, very easily cured.

Hum of this nature is caused by stray magnetic fields from the power transformer or A.C. wiring.

Induced hum is readily distinguishable from that due to insufficient filtration in that its pitch sounds higher, and thinner than the deep, drumming hum due to the lack of sufficient "mikes" or "hens" in the filter.

The precautions to observe to ensure freedom from trouble of this nature are quite simple, and care should be taken when wiring up a new receiver, or servicing an old one, that the A.C. flex from the mains to the power transformer is kept clear away from the rest of the wiring.

Other leads to watch are pick-up leads and volume control leads going to the front of the chassis. These should always be shielded, or if this is impracticable, twisted and kept well away from any A.C. leads at all.

A rather elusive hum of this nature that the writer came across recently was due to a "floating" spindle on a volume control. Most controls of the high-resistance variety nowadays have their spindles insulated from the moving arm, and, in some cases, even the cover is insulated from the rest of the frame. These two items, if isolated from earth in any way, appear to act as quite efficient collectors of any stray magnetic fields, and, as a result, give rise to quite an appreciable amount of hum in the audio-frequency output. Earthing the offending spindle or cover will usually rectify the trouble.

A badly placed filter choke in a receiver can give rise to quite a lot of hum as this component often has a greater leakage flux than a power transformer. It is a good idea to remove the filter choke from the chassis if the hum keeps eradicating in any other way. Leave the choke connected up and move it around at different angles noting carefully the amount of hum in each position. Quite often it will be found that shifting the angle of a filter choke only a few degrees will cure a hum case that has given the radio doctor a few grey hairs.

Coupling Condenser Faults

Quite a common cause of trouble in receivers using R.C. Coupling, is the breakdown, partial or complete, of the audio frequency coupling condenser between the plate of one valve and the grid of the next. A number of receivers built in the past were fitted with tubular paper condensers of very uncertain vintage, with the result that quite a high leakage current is often present. The effect of this is to neutralise the bias on the driven valve, and the life of this valve is shortened accordingly.

While this leakage is low, the only noticeable effect is on the quality of reproduction, but when it increases, the gain of the stage decreases rapidly and the hum level increases to a marked degree. Complete breakdown is usually indicated by a loud hum in the speaker and no signal. A good tip, when coming across any doubtful coupling condensers at all, is to replace them by either a mica condenser or a high-quality tubular about which no doubt is felt.

R.F. Volume Controls

The importance of a low minimum value of resistance in a wire-wound volume control is not always realised, but a little thought will soon show that this minimum resistance, if much above zero, will have the effect of increasing the minimum bias on the controlled valves to such an extent that sensitivity will be seriously impaired.

Although it is usual to check this type of control for minimum resistance before building it into a set, and to arrange the series cathode "limit" resistors to suit, the value may quite easily vary after use, and another service problem is presented.

The trouble is quite easily checked by means of a high resistance voltmeter connected between the cathode of one of the controlled valves and earth, making sure, of course, that the control is full on. Reference to the data charts for the valves under consideration will show the correct value of minimum bias and adjustments may be made accordingly.

The above procedure is quite a good one to follow whenever a set fitted with an R.F. type volume control seems to have lost its "pep" and some surprising defects may be unearthed at times.

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RADIO SERVICE HINTS—(Continued)—

High Noise Level

Trouble of this nature may be due to a number of things, and quite a lot of notes the size of this would be required to give adequate treatment to the subject.

We can leave out the noise caused by radio-inductive interference, as this subject is being covered fairly exhaustively in a complete paper on radio inductive interference, of a very constructive nature, delivered before the I.R.E. by Mr. H. K. Burbury, and printed in another section of this Annual.

This leaves us with noise originating in the receiver, and which is heard whether the aerial is connected or not.

Several classifications of noise such as this exist, and, by bearing a few points in mind, much time may be saved in the location of the fault or faults causing the trouble.

The first of these is noise heard whether a station is tuned in or not, and with the volume control turned off. In this case, the trouble is nearly always due to a fault in the A.F. end of the receiver, and, after checking the rectifier and output valves to make sure that they are O.K. the next step is to test the voltages delivered at the plates of the various valves in the A.F. channel.

Trouble such as this may be caused by a defective input transformer on the loud-speaker, and in this case the fault will usually be evidenced by a fluctuating voltage at the plate of the output valve.

Another fruitful source of trouble, in the A.F. end, is the plate load resistor for the detector valve, or the R.F. choke which is usually in series with it. Shorting out the R.F. choke will soon indicate whether any trouble exists there, although the writer has struck several instances where a high resistance leak to earth was found in the assembly of the choke. This would cause loss of plate voltage, as well as a high noise level and is readily located. A faulty grid blocking condenser will also set up a high noise level, besides reducing the bias on the following valve, and, as it also causes loss of plate voltage the plate voltage reading will give a lead to the trouble.

In circuits where the screen voltage for the detector or an A.F. valve is obtained from a variable clip on the voltage divider, quite a lot of noise can be set up by a loose or dirty contact at this point. In this connection, it is well to go over all clip connections of any kind in the receiver when high noise level is experienced, as connections of this nature probably give rise to more noise than all the other sources in the set put together.

A.F. transformer primaries are very prone to become noisy after a while, and they should be among the first things checked when a set incorporating a transformer becomes noisy.

When the noise experienced only becomes evident with the volume control well up, but no station is being received, the trouble is usually due to a faulty I.F. transformer primary coil or trimmer. In a receiver equipped with A.V.C. the diode load resistor may be the culprit, or failing that, the R.F. choke associated with it and used for filtration.

Several receivers the writer has inspected lately had a noisy crackle which cut out if the receiver was bumped. Trouble of this nature is often due to a loose contact of some kind or a dry soldered joint. Failing this, a check of all pigtail condensers is indicated, as in quite a few instances, the pigtails have been found to be making imperfect contact with the condenser element itself. This trouble may usually be located by moving each condenser a little in turn. The faulty component will soon be spotted.

One or two instances have been encountered where a badly soldered end-cap to a carbon resistor gave rise to a fair amount of noise. This can be located by moving each resistor in turn until the offending specimen is found.

One of the most difficult cases of noise to locate is that where everything is O.K. until a station is tuned in. This may be caused by faulty receiver design, and, if so, there is nothing much that can be done about it, except by the manufacturer.

Loose coil or valve shields are a quite common cause of this type of noise, and care should be taken to see that every shield is bolted or fitted firmly into place.

Quite a number of the older receivers, and even some of the newer ones, rely on solder lugs, held by component mounting screws, for earthing leads to the chassis. This practice is probably the most fruitful source of noise on stations, and even high inherent set noise level. When coming across a set wired in this way, it is well worth any dealer's or serviceman's time, to obtain a few feet of tinned copper wire and efficiently bond all earthed points together. The writer has had quite a number of experiences of this nature, and in the majority of cases the improvement in the receiver has been sufficient to warrant an extra 50% on the bill.

CHARGING OF ACCUMULATORS—

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moved through the filling vent, but not, of course, any larger pieces which may have become detached and are forming a short between plates.

To proceed further it is necessary to remove the plates from the cell by cutting the supporting compound top around its edge. Plates should be cleaned and smoothed and the container thoroughly cleaned. Slightly buckled plates may be pressed flat, but if badly buckled or sulphated the plates or the whole cell should be scraped.

Special Care Necessary

No apparatus should be placed near the cells during charging on account of the corrosive fumes. For the same reason it is dangerous to approach the cells with a naked light as portion of the fumes (hydrogen and oxygen) form a highly explosive mixture. Always switch off the charging current when disconnecting cells, as it is quite possible that a spark on breaking circuit will ignite the fumes. Any acid which burns on skin should be immediately neutralised by an alkali, ammonia being very convenient. Even if washed under a tap drops of acid on clothes will continue to rot and darken the cloth. Again ammonia is indicated (immediately) before washing.

It is to be noted that the S.A.A. rules for the installation of battery chargers not exceeding 1200 volt-amps input rating are identical with those for radio sets.

BRAND LINE RECEIVERS

THE following tabulated list includes the vast majority of brand lines available to the Australian radio market. The information contained herein should prove of material value to all sections of the industry. It is, we believe, the most complete tabulation ever produced in Australia. The various manufacturers concerned (who are regular advertisers in "Radio Retailer") have co-operated in the compilation of the details in order to make these data as informative as possible.

When analysing the contents of the various columns the following interpretations should be used:—
CABINET, either console (con.), mantel (man.), midget (mid.), Combination (comb.) automobile (car) . . . POWER, A.C. operated (●), Battery operated (+), AC-DC (=) . . . COVERAGE, Broadcast (B) Dual wave (D), All wave or triple wave (T) . . . BAND PASS, is band pass filter used, Yes (Y) or no (N) . . . SPEAKER diameter and resistance . . . DIAL LAMP, voltage or type given . . . CONTROLS number of . . . TUNING either single (S) or dual (D) . . . DIAL shape expressed in degrees when circular or semi-circular. Size given below. octagonal (Oct.), oblong (O), square (S) . . . SEN. CON. is sensitivity control fitted, yes or no . . . TUN. INDIC. is tuning indicator fitted, yes or no . . . PHONO Sw. is phonograph or pick-up switching provided for . . . LAMP Sw. are means provided for switching off dial lamp on battery models . . .
A, gives voltage, capacity and drain of A battery . . . B, gives B battery voltage . . . C, gives C battery voltage or (A) indicates automatic.

ASTOR

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
77	Con.	+	5	B	456	1C6, 2/1C4, 1B5, 22A.	N	N	8" P.M.	Y	6	3	Y	S	4½" 180°	N	N	N	N	Y	Y	6/100 1.1A	Vib	A	31/10/-
77DW	Con.	+	5	D	456	1C6, 2/1C4, 1B5, 22A.	N	N	8" P.M.	Y	6	3	Y	S	4½" 180°	N	N	N	N	Y	Y	6/100 1.1A	Vib	A	36/15/-
Mickey Mouse	Mid.	●	4/5	B	456	6A7, 6D6, 6B7S, 41, 80.	N	N	5" 1350	—	4.5	2	N	S	180°	N	N	N	N	—	N	—	—	—	——
Mickey Grand	Man.	●	4/5	B	456	6A7, 6D6, 75, 42, 80.	N	N	6" 1350	—	4.5	2	N	S	180°	N	N	N	N	—	Y	—	—	—	——
220	Car	+	5/6	B	173	2/78, 6A7, 6B7S, 41, 84.	N	Y	6" 4	Y	6	2	Y†	S	**	N	N	N	N	—	Y	6V 6.5A	Vib	A	——
55DB	Con.	●	3/4	B	456	6A8, 6B7, 6F6, 5Z4.	N	N	7" 1900	Y	4.5	3	Y	S	4½" 180°	Y	Y	N	N	N	N	—	—	—	15/15/-
66S	Con.	●	4/5	D	472.5	6A8, 6K7, 6Q7, 6F6, 5Z4.	N	N	7" 1900	Y	4.5	3	Y	S	4½" Oct.	Y	N	N	N	N	N	—	—	—	23/15/-
88	Con.	=	4/5	B	472.5	CK1, CF2, CBC1, CL2, CY2, C1.	N	N	7" 1500	Y	4.5	3	Y	S	4½" Oct.	Y	N	N	N	N	Y	—	—	—	25/4/-
190	Con.	●	6/7	D	456	3/6D6, 6A7, 75, 42, 80.	N	Y	7" 1550	Y	4.5	4	Y	S	4½" Oct.	N	N	N	N	N	Y	—	—	—	34/13/-
30	Con.	+	5	B	456	2A7, 2/34, 19, 33.	N	N	8" P.M.	Y	—	4	Y	S	4½" 180°	N	N	N	N	N	Y	6/100 1.25A	135	22.5	*23/10/-

* Batteries extra.
† Tone control on speaker.
** Special control heads available for all types of car

AIRMASTER

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
D32	Con.	●	4/5	D	455	6A7, 6D6, 75, 42, 1867.	Y	N	10" 2000	—	6	4	Y	D	360° 4½"	N	N	N	N	—	Y	—	—	—	27/10/-
D36	Con.	●	5/6	D	455	6D6, 6A7, 6B7S, 75, 42, 1867.	Y	Y	12" 2000	—	6	5	Y	D	360° 7½"	N	Y	Y	Y	—	Y	—	—	—	37/10/-
C36	Con.	●	4/5	B	158	6A7, 6B7S, 55, 42, 1867.	Y	N	12" 2000	—	6	5	Y	D	360° 7½"	N	Y	Y	Y	—	Y	—	—	—	32/10/-
B33*	*	+	4	B	455	1C6, 1C4, 1B5, C243N.	Y	N	8" P.M.	—	2.5	3	N	S	360° 4½"	N	N	N	N	Y	Y	2/100 0.5A	135	A	*

* This model when released will be available in both mantel and console cabinets.
The dial used on Models D36 and C36 has 6E5 tuning indicator built-in.

AIRZONE

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
556	Con	●	4/5	B	456	6A8, 6K7, 6J7, 6F6, 5Z4.	N	N	8"	Y	6.3	4	Y	S	O 8"x2"	Y	N	N	N	—	N	—	—	—	21/-/-
552A	Man.	●	4/5	B	456	6A7, 6D6, 6C6, 42, 80.	N	N	6"	—	6.3	4	Y	S	360° 5"	Y	N	N	N	—	N	—	—	—	17/12/6
553	Mid.	●	4/5	B	—	6F7, 6D6, 6C6, 41, 80.	N	N	5" 1500	N	6.3	2	N	S	360° 3"	N	N	N	N	—	N	—	—	—	14/14/-
554	Man.	●	4/5	B	—	6A8, 6K7, 6Q7, 6F6, 5Y3.	N	N	8" 2500	Y	6.3	2	N	S	360° 3"	N	N	N	N	—	Y	—	—	—	16/16/-
561	Con.	=	4/5	B	—	6F7, 6D6, 75, 43, 25Y5.	N	N	8"	—	6.3	3	Y	S	360° 5"	N	Y	N	N	—	N	—	—	—	26/19/6
565	Con.	●	4/5	D	—	6A8, 6K7, 6Q7, 6F6, 5Y3.	N	N	8"	Y	6.3	4	Y	S	O 8"x2"	N	Y	N	N	—	Y	—	—	—	28/15/-
582	Man.	●	4/5	D	456	6D6, 6A7, 6B7, 42, 80.	N	Y	6"	N	6.3	5	Y	S	360° 3½"	Y	N	N	N	—	Y	—	—	—	24/17/6
583	Con.	●	4/5	D	456	6D6, 6A7, 6B7, 42, 80.	N	Y	6"	N	6.3	5	Y	S	360° 3½"	Y	N	N	N	—	Y	—	—	—	27/19/6
584	Con.	●	4/5	B	175	6D6, 6A7, 6B7S, 42, 80.	N	Y	8"	N	6.3	4	Y	S	360° 5"	Y	N	N	N	—	Y	—	—	—	23/17/6
635	Con.	=	5/6	B	175	6D6, 6A7, 6D6, 85, 43, 1V.	N	Y	10"	N	6.3	4	Y	S	180° 5"	Y	N	N	N	—	Y	—	—	—	31/15/-
652	Man.	●	5/6	D	456	6D6, 6A7, 6D6, 75, 42, 80.	N	Y	6"	N	6.3	5	Y	S	360° 5"	Y	N	N	N	—	Y	—	—	—	26/17/6
658	Con.	●	5/6	D	456	6D6, 6A7, 6D6, 75, 42, 80.	N	Y	8"	N	6.3	5	Y	S	360° 5"	Y	N	N	N	—	Y	—	—	—	31/-/-
660	Con.	●	5/6	D	456	6K7, 6A8, 6K7, 6Q7, 6F6, 5Z4.	N	Y	12"	Y	6.3	5	Y	D*	360° 6½"	Y	Y	N	Y	—	Y	—	—	—	39/18/-
563	Con.	+	5	B	175	1A4, 1C6, 1A4, 1B5, 22A.	N	N	8"	N	2	3	Y	S	360° 4½"	N	N	N	N	Y	Y	2/120	135	4.5	28/19/6
651B	Con.	+	6	B	175	34, 1C6, 34, 25s, 30, 19.	N	Y	8" P.M.	N	2	4	Y	S	360° 5"	N	N	N	N	Y	Y	2/120	135	9	33/17/6
653	Con.	+	6	D	456	VP2, 1C6, VP2, 1B5, 30, 19.	N	Y	8" P.M.	N	2	5	Y	S	360° 6"	N	N	N	N	Y	Y	2/120	135	9	42/10/-

NOTE.—* Band spread needle pointer.

BANDMASTER

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
M656E	Man.	●	4/5	B	175	6D6, 6A7, 6B7, 42, 80.	N	Y	5" 1600	N	6.3	3	N	S	S 3"	Y	N	N	N	—	Y	—	—	—	15/15/-
D556E	Man.	●	4/5	D	460	6D6, 6A7, 6B7, 42, 80.	N	N	5" 1600	N	6.3	4	N	D	S 3¾"	Y	N	N	N	—	Y	—	—	—	19/19/-
M356E	Con.	●	4/5	B	175	6D6, 6A7, 6B7, 42, 80.	N	Y	8" 2000	N	6.3	4	Y	S	O 7¼"x 2¼"	Y	N	N	N	—	Y	—	—	—	24/3/-
D356E	Con.	●	4/5	D	460	6A7, 6D6, 6B7, 42, 80.	N	N	8" 2000	N	6.3	5	Y	D	O 7¼"x 2¼"	Y	N	N	N	—	Y	—	—	—	27/6/-
M276E	Con.	●	6/7	B	175	6K7, 6A8, 6K7, 6H6, 6F5, 6F6, 80.	N	Y	10" 2000	N	6.3	4	Y	S	O 7¼"x 2¼"	Y	N	N	Y	—	Y	—	—	—	32/11/-
D276E	Con.	●	6/7	D	460	6K7, 6A8, 6K7, 6H6, 6F5, 6F6, 80.	N	Y	10" 2000	N	6.3	5	Y	D	O 7¼"x 2¼"	Y	N	N	Y	—	Y	—	—	—	36/15/-
D186E	Con.	●	7/8	D	460	6K7, 6A8, 6K7, 6H6, 6F5, 2-6F6, 80.	N	Y	10" 1000	N	6.3	5	Y	D	O 7¼"x 2¼"	Y	Y	N	Y	—	Y	—	—	—	44/2/-
M546B	Man.	+	4	B	460	1C6, 1C4, 1B5, 1D4.	N	N	5" P.M.	N	2.5	4	Y	S	S 3"	N	N	N	N	Y	Y	2/100 0.54A	120	4.5	19/19/-
M346B	Con.	+	4	B	175	1C4, 1C6, 6B7, 1D4.	N	Y	8" P.M.	N	6.3	4	Y	S	O 7¼"x 2¼"	N	N	N	N	Y	Y	6/100 0.54A	135	A	28/7/-
M256B	Con.	+	5	B	175	1C4, 1C6, 1C4, 1B5, 1D4.	N	Y	8" P.M.	N	2.5	4	Y	S	O 7¼"x 2¼"	N	N	N	N	Y	Y	2/100 0.66A	135	4.5	30/9/-
D266B	Con.	+	6	D	460	1C4, 1C6, 2-1C4, 1B5, 1D4.	N	Y	8" P.M.	N	2.5	5	Y	D	O 7¼"x 2¼"	N	N	N	N	Y	Y	2/120 0.78A	135	13.5	35/14/-

NOTE.—All models with the designation O are fitted with slide-rule type dials.
All models shown with dual-ratio tuning are equipped with automatic vernier tuning mechanisms.

BREVILLE

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
67	Con.	●	4/5	B	446	6C6, 6K7, 6C6, 6F6 & 80.	N	N	8" 2000	N	6	3	Y	S	360° 5"	N	N	N	N	—	N	—	—	—	A 19/19/- B 21/5/-
69	Con.	●	4/5	B	446	AK2, 6K7, E444N, 6F6 & 80.	N	N	10" 2000	Y	6	3	Y	S	360° 5"	N	N	N	N	—	Y	—	—	—	A 23/5/- B 24/10/- C 25/10/-
76	Con.	●	4/5	D	446	AK2, 6K7, E444N, 6F6 & 80.	N	N	8" 2000	N	6	4	Y	S	360° 5"	N	N	N	N	—	N	—	—	—	A 23/5/- B 24/10/- C 25/10/-
70	Con.	●	4/5	D	446	AK2, 6K7, E444N, 6F6 & 80.	N	N	10" 2000	Y	6	4	Y	S	360° 5"	N	N	N	N	—	Y	—	—	—	B 26/5/- C 27/5/- D 28/5/- E 36/5/-

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
71	Con.	●	5/6	D	446	6K7, 6A8, 6K7, 75, 42 & 80.	N	Y	10" 2000	Y	6	4	Y	S	360° 5"	N	N	N	N	—	Y	—	—	—	C 31/15/- D 32/15/- E 40/15/-
72*	Con.	●	6/7	D	446	6K7, 6A8, 6K7, 6B7, 79, 6F6 & 80.	N	Y	10" 1000	Y	6	4	Y	S	360° 5"	N	N	N	N	—	Y	—	—	—	C 38/10/- D 39/10/- E 47/10/-
74	Con.	+	4	B	446	1C6, 1C4, 1B5, 1D4.	N	N	8" P.M.	Y	2	3	N	S	360° 5"	N	N	N	N	Y	Y	2/100 0.54A	135	Auto	A 24/10/- B 25/15/-
80	Con.	+	5	B	446	1C4, 1C6. 1C4, 19, 19.	N	Y	8" P.M.	Y	2	3	N	S	360° 5"	N	N	N	N	Y	Y	2/100 0.88A	135	4.5	A 28/10/- B 29/15/- C 30/15/- D 31/15/- E 39/15/-
75	Con.	+	5	D	446	1C4, 1C6, 1C4, 1B5, 1D4.	N	Y	8" P.M.	Y	2	4	Y	S	360° 5"	N	N	N	N	Y	Y	2/100 0.66A	135	4.5	B 32/5/- C 33/5/- D 34/5/- E 42/5/-
79	Con.	+	6	D	446	1C4, 1C6, 1C4, 1B5, B217, 19.	N	Y	8" P.M.	Y	2	4	Y	S	360° 5"	N	N	N	N	Y	Y	2/100 0.78A	135	4.5	B 35/15/- C 36/15/- D 37/15/- E 45/15/-
48	Mid.	●	4/5	B	446	6C6, 6D6, 6C6, 42 & 80.	N	N	6" 2000	N	6	3	Y	S	360° 5"	N	N	N	N	—	N	—	—	—	F 16/19/6
49	Mid.	=	4/5	B	446	6C6, 6D6, 6C6, 43 & 25Y5.	N	N	6" 1250	N	6	3	Y	S	360° 5"	N	N	N	N	—	N	—	—	—	F 17/19/6

Last Col.: A, Richmond; B, York; C, Devon; D, New Beale; E, Edward; F, Clyde.
* This model has variable selectivity, compensated tone control, push-pull output.
All prices shown for Battery models are complete with accumulator, C battery and triple capacity B batteries.

BRITON

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
4MD	Man.	●	4/5	D	470	EK2, EF5, EBC3, EL3, EZ3.	N	N	6"	N	6	4	Y	S	S 3"	N	N	N	Y	—	Y	—	—	—	18/18/-
4AA	Con.	●	4/5	B	470	AF7, AF3, ABC1, AL2, 1561.	N	N	8"	N	6	3	Y	S	360° 5"	N	N	N	N	—	N	—	—	—	18/18/-
4AD	Con.	●	4/5	D	470	EK2, EF5, EBC3, EL3, EZ3.	N	N	8"	N	6	4	Y	S	360° 5"	N	Y	Y	Y	—	Y	—	—	—	25/4/-
6CDM	Con.	●	5/6	D	470	EK2, 6K7, 6H6, 6J7, 6F6, 5Y3.	Y	N	10"	N	6	4	Y	S	360° 5"	N	Y	Y	Y	—	Y	—	—	—	34/13/-
84	Con.	●	7/8	D	470	AK2, 2-AF3, ABC1, AC2, 2-E406N, 1561.	Y	N	10"	N	6	4	Y	S	360° 5"	N	Y	Y	Y	—	Y	—	—	—	47/5/-
94C	Comb.	●	7/8	D	470	AF3, AK2, 2-AF3 ABC1 AC2, 2-E406N, 1561.	Y	Y	10"	N	6	4	Y	S	360° 5"	N	Y	Y	Y	—	Y	—	—	—	68/5/-
94CS	Comb.	●	7/8	D	470	———	Y	Y	12"	N	6	4	Y	S	360° 5"	N	Y	Y	Y	—	Y	—	—	—	110/5/-
94CH*	Comb.	●	7/8	D	470	———	Y	Y	†	N	6	4	Y	S	360° 5"	N	Y	Y	Y	—	Y	—	—	—	157/10/-
5B	Con.	+	5	B	178.5	2-1C4, KK2, 1B5, 1D4.	N	Y	8" P.M.	N	2.5	3	N	S	360° 5"	N	N	N	N	Y	Y	2/100	135	A	24/10/-
6B	Con.	+	6	B	178.5	2-1C4, KK2, 1B5, B217, B240.	N	Y	8" P.M.	N	2.5	3	N	S	360° 5"	N	N	N	N	Y	Y	2/100	135	4.5	28/10/-
12	Con.	=	6	B	178.5	CK1, CF2, CBC1, CL2, C1, CY2.	Y	N	8"	N	4	3	Y	S	360° 5"	N	N	N	N	N	N	—	—	—	25/10/-

* Automatic record changer. Marconiphone pick-up.
† High fidelity speaker.

CALSTAN

SS1	Con.	●	4/5	B	450	2-6C6, 6D6, 42, 80.	N	N	8" 2500	Y	6.3	3	Y	S	360° 5"	N	N	N	N	N	N	—	—	—	18/5/-
SS1V	Con.	●	4/5	B	450	6C6, 6D6, 75, 42, 80.	N	N	8" 2500	Y	6.3	3	Y	S	360° 5"	N	*	N	N	N	Y	—	—	—	19/5/-
SS1U	Con.	=	4/5	B	450	6C6, 6D6, 75, 43, 25Y5,	N	N	8" 2500	Y	6.3	3	Y	S	360° 5"	N	*	N	N	N	Y	—	—	—	19/5/-
D5A	Con.	●	4/5	D	450	AK2, AF3, ABC1, AL2, 1561.	N	N	8" 2500	N	4	4	Y	S	360° 5"	Y	N	N	N	N	N	—	—	—	19/5/-
D5AV	Con.	●	4/5	D	450	AK2, AF3, ABC1, AL2, 1561.	N	N	8" 2500	N	4	4	Y	S	360° 5"	Y	*	N	N	N	Y	—	—	—	24/10/-
D5AVU	Con.	=	4/5	D	450	CK1, CF2, CBC1, CL2, CY2, C1.	N	N	8" 7500	N	4	4	Y	S	360° 5"	Y	*	N	N	N	Y	—	—	—	24/10/-
D5M†	Con.	●	4/5	D	450	MG, 6A8, 6K7, 6B6, 6F6, 5Z4.	N	N	8" 2500	Y	6.3	4	Y	S	360° 5"	Y	*	N	N	N	Y	—	—	—	25/-/-
D6A	Con.	●	5/6	D	450	6D6, 6A7, 6B7, 75, 42, 80.	N	Y	8" 2500	Y	6.3	4	Y	S	360° 5"	N	*	N	N	N	Y	—	—	—	32/10/-
D6S	Con.	●	6/7	D	450	6D6, 6A7, 6B7, 75, 6C6, 42, 80.	N	Y	8" 2500	Y	6.3	5	Y	S	360° 5"	N	*	Y	N	N	Y	—	—	—	35/10/-
D6B	Con.	+	6	D	450	2-KF2, 1C6, 1B5, B217, B240.	N	Y	8" P.M.	Y	2	5	Y	S	360° 5"	N	N	N	N	N	Y	2/60 0.96A	135	4.5	33/10/-

NOTE.—SS1 and D6 models may be obtained with M.G. valve equipment.
* Tuning indicator (6E5) may be fitted at small extra cost.
† These models have band spread Edgelit dials.
Muting is provided in model D6S by means of special automatic noise suppression circuit.

GENALEX

BC310	Con.	+	5	D	470	EK1, 75, PM12M, 2-19.	N	N	8" P.M.	Y	6.3	4	Y	S	360° 5"	N	N	N	N	N	Y	6 0.96A	135	A	35/10/-
BC315	Car	+	5/6	B	—	6D6, 6A7, 6D6, 75, 42, 84.	N	Y	6" 6	N	—	2	Y	§	§	N	N	N	—	—	Y	—	G	A	29/15/-
BC320	Man.	●	4/5	B	470	EK1, 75, 42, 6D6, 80.	N	N	6"	N	6.3	2	N	S	360° 5"	N	N	N	N	—	Y	—	—	—	16/16/-
BC325	Con.	●	5/6	D	470	2-6D6, 42, 75, 6A7, 80.	N	Y	10" 1650	Y	6.3	4	Y	S	360° 5"	Y	N	N	N	—	Y	—	—	—	37/10/-
BC330	Con.	=	6/7	D	470	2-CF2, CK1, CBC1, CL2, CY2, C1.	N	Y	10" 1650	Y	—	4	Y	S	360° 5"	N	N	N	N	—	Y	—	—	—	39/10/-
BC335	Con.	+	6	D	405	2-1C4, 1C6, 1B5, 2-19.	N	Y	10"	Y	2	4	Y	S	360° 5"	N	N	N	N	N	Y	2/150 0.9A	135	4.5	43/10/-
BC350**	Con.	●	4/5	B	470	EK1, 6D6, 75, 42, 80.	N	N	8"	Y	6.3	4	Y	S	360° 5"	Y	N	N	N	—	Y	—	—	—	31/15/-
BC360§§	Con.	●	4/5	B	470	EK1, 6D6, 75, 42, 80.	N	N	8"	Y	6.3	3	Y	S	360° 5"	N	N	N	N	—	Y	—	—	—	21/17/6
BC365†	Con.	●	4/5	D	470	6A7, 6D6, 75, 42, 80.	N	N	8"	Y	6.3	4	Y	S	360° 5"	Y	N	N	N	—	Y	—	—	—	29/15/-
BC370††	Con.	=	5/6	B	470	CK1, CF2, CBC1, CL2, CY2, C1.	N	N	8"	Y	—	3	Y	S	360° 5"	N	N	N	N	—	Y	—	—	—	23/17/6
BC375	Con.	+	4	B	470	1C6, C4, B5, D4.	N	N	8" P.M.	Y	2	3	Y	S	360° 5"	N	N	N	N	N	Y	2/100 0.54A	135	4.5	
BC380*	Comb.	●	7/8	D	470	2-6D6, 6A7, 75, 6A6, 2-42, 80.	N	Y	12"	Y	6.3	5	Y	S	360° 5"	Y	Y	N	Y	—	Y	—	—	—	98/10/-

NOTE.—All dial drives are of the counter-balanced band spread type, except those fitted to models BC315 and BC320.
§ Remote control automobile flex. cables either dash-board or steering column type.
* Any A.C., AC/DC or Battery chassis with either Automatic Record Changer (A.C. only), Electric Motor and Pickup or (in the case of Battery receivers) Spring type motor with pickup, can be obtained in this cabinet. Price on application.
** This model is available in table type cabinet at 26/15/-.
§§ Available also in table type cabinet at 19/19/-. † Available also in table type cabinet at 25/15/-. †† Available also in table type cabinet at 21/17/6.

HIS MASTER'S VOICE

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
121	Con.	●	5/6	B	460	2-6D6, 6A7, 6B7, 42 & 80.	N	Y	6½" 1250	N	6.3	3	Y	S	360° 5½"	N	N	N	Y	—	Y	—	—	—	28/7/-
719	Con.	●	5/6	T	460	2-6D6, 6A7, 6B7, 42 & 80.	N	Y	6½" 1250	N	6.3	5	Y	D	360° 4"	Y	Y	—	Y	—	Y	—	—	—	38/17/-
718	Man.	●	5/6	T	460	2-6D6, 6A7, 6B7, 42 & 80.	N	Y	6½" 1250	N	6.3	5	Y	D	360° 4"	Y	Y	—	Y	—	Y	—	—	—	30/9/-
720	Com.	●	5/6	T	460	2-6D6, 6A7, 6B7, 42 & 80.	N	Y	6½" 1250	N	6.3	5	Y	D	360° 4"	Y	Y	—	Y	—	Y	—	—	—	51/9/-

NOTE.—Models 718 and 719 have band spread dials. Wave bands are 175-560, 55-175 and 16.5-55 metres.

LEKMEK

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
406	Mid.	●	3/4	B	458	6A7, 6B7S, 6F6, 80.	N	N	5" 2500	N	6.3	2	N	S	360°	N	N	N	N	—	N	—	—	—	11/11/-
513	Man.	●	4/5	B	458	AK2, 6K7, 6B7S, 42, 80.	N	N	8" 2500	N	6.3	3	Y	S	360° 4¾"	N	N	N	N	—	Y	—	—	—	18/18/-
513C*	Con.	●	4/5	B	458	AK2, 6K7, 6B7S, 42, 80.	N	N	8" 2500	N	6.3	3	Y	S	360° 4¾"	N	N	N	N	—	Y	—	—	—	19/19/-
514	Man.	●	4/5	D	458	AK2, 6K7, 6B7S, 42, 80.	N	N	8" 2500	N	6.3	4	Y	S	360° 4½"	N	N	N	N	—	Y	—	—	—	19/19/-
514C†	Con.	●	4/5	D	458	AK2, 6K7, 6B7S, 42, 80.	N	N	8" 2500	N	6.3	4	Y	S	360° 4½"	N	N	N	N	—	Y	—	—	—	24/3/-
516	Con.	+	5	B	458	KK2, 1C4, 1C4, 25S, C243N.	N	N	8" P.M.	N	2.5	4	Y	S	360° 4½"	N	N	N	N	N	Y	2/100	135	9	30/19/-
518	Con.	+	5	D	458	KK2, 1C4, 1C4, 25S, C243N.	N	N	8" P.M.	N	2.5	5	Y	S	360° 4½"	N	N	N	N	N	Y	2/100	135	9	32/11/-
614	Con.	+	6	B	458	1C4, KK2, 1C4, 1C4, 25S, C243N.	N	Y	10" P.M.	N	2.5	4	Y	S	360° 4¾"	N	N	N	N	N	Y	2/100	135	9	37/16/-
710**	Con.	●	6/7	D	458	AK2, 6K7, 75, 75, 42, 42, 80.	N	N	10" 750	N	6.3	5	Y	D	360° 4½"	Y	N	Y	N	N	Y	—	—	—	35/14/-

* Available also in Venus cabinet with 10" Speaker at 22 gns.
† Available also in Venus cabinet with 10" Speaker at 25 gns.
** Available in Special Arcturus cabinet and fitted with magic eye at 37 guineas.

KRIESLER

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
170	Man.	●	4/5	D	458	6A8, 6K7, 6Q7, 6F6, & 5Y3.	N	N	8"	N	6.3	3	N	S	360° 5"	N	N	N	N	—	Y	—	—	—	17/17/-
150	Man.	●	4/5	D	458	6A7, 6D6, 75, 42, 80.	N	N	8"	N	6.3	3	N	S	360° 5"	N	N	N	N	—	Y	—	—	—	15/15/-
210*	Con.	●	4/5	D	175	6A7, 6D6, 75, 42, 80.	Y	N	8"	N	6.3	4	Y	S	360° 5"	N	N	Y	N	—	Y	—	—	—	19/19/-
220†	Con.	●	4/5	D	175	6A8, 6K7, 6Q7, 6F6G, 5Y3.	Y	N	8"	N	6.3	4	Y	S	360° 5"	N	N	Y	N	—	Y	—	—	—	26/10/-
240**	Con.	●	5/6	D	458	2-6K7, 6A8, 6Q7, 6F6G, 5Y3.	N	Y	8"	N	6.3	4	Y	S	360° 5"	N	N	Y	N	—	Y	—	—	—	30/10/-
260††	Con.	●	6/7	D	458	3-6K7, 6A8, 6Q7, 6F6G. 5Y3.	N	Y	8"	N	6.3	4	Y	S	360° 5"	N	N	Y	N	—	Y	—	—	—	33/15/-

(Continued on page 271)

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
KRIESLER—(Continued)—																									
280§	Con.	●	9/10	D	458	3-6K7, 6A8, 6Q7, 6F5, 2-6F6, 5Y3.	N	Y	10"	N	6.3	4	Y	S	360° 5"	N	Y	Y	N	—	Y	—	—	—	39/19/6
400§§	Man.	+	4	B	458	1C6, 1C4, 2-19.	N	N	8" P.M.	N	2	3	N	S	360° 5"	N	N	N	N	Y	N	2/100	150	4.5	22/10/-
410‡	Con.	+	5	B	175	2-1C4, 1C6, 1B5, 1D4.	N	Y	8" P.M.	N	2	4	Y	S	360° 5"	—	—	—	—	—	—	2/100	135	4.5	30/10/-
420‡‡	Con.	+	5	D	458	2-1C4, 1C6, 1B5, 1D4.	N	Y	8" P.M.	N	2	4	Y	S	360° 5"	N	N	N	N	Y	Y	2/100	135	4.5	32/10/-
430‖	Con.	+	7	D	458	4-1C4, 1C6, 1B5, 19.	N	Y	8" P.M.	N	2	4	Y	S	360° 5"	N	N	N	N	Y	Y	2/100	135	1.5	37/10/-
440‖‖	Con.	=	4/5	B	175	6A7, 6D6, 75, 43, 25Y5.	Y	N	8"	N	6.3	4	Y	S	360° 5"	N	N	N	N	—	Y	—	—	—	——
450	Con.	=	4/5	D	175	6A7, 6D6, 75, 43, 25Y5.	Y	N	8"	N	6.3	4	Y	S	360° 5"	N	N	N	N	—	Y	—	—	—	——

* Available in cabinet type 44 at 22/10/-.
† Available in cabinet type 44 at 28/15/-; type 55 at 29/15/-; and type 66 at 32/15/-.
** Available in cabinet type 44 at 32/15/-; type 55 at 33/19/-; and type 66 at 36/19/-.
†† Available in cabinet type 44 at 36/-/-; type 55 at 37/5/-; and type 66 at 40/5/-.
§ Available in cabinet type 44 at 42/5/-; type 55 at 43/10/-; and type 66 at 46/10/-.
§§ Available in cabinet type 33 at 25/10/-; type 44 at 27/15/-.
‡ Available in cabinet type 44 at 32/15/-; type 55 at 34/-/-; and type 66 at 37/-/-.
‡‡ Available in cabinet type 44 at 34/15/-; type 55 at 36/-/-; and type 66 at 39/-/-.
‖ Available in cabinet type 44 at 39/15/-; type 55 at 41/-/-; and type 66 at 44/-/-.
‖‖ Available in cabinet type 44 at 26/15/-; type 55 at 28/-/-.

MULLARD

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
Mark I.	*	+	7	B	450	VP2, SP2, 2-VP2, TDD2, PM2DX, PM2B.	N	Y	8" P.M.	N	N	3	N	S	S 3½"	Y	N	N	N	N	Y	6/120 0.48A	135†	Auto	28/10/-

* This unit may be fitted to any type of cabinet or used without cabinet as a self-contained unit.
† Battery reserve switch fitted to back of chassis.

NICHOLSON

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
A45 Mozart	Con.	●	3/4	B	456	6A7, 6B7, AL3, 80.	N	N	8"	N	6	—	—	S	O	N	N	N	N	—	N	—	—	—	17/17/-
B56 Beethoven	Con.	●	4/5	B	456	6A8, 6K7, 6Q7, 6F6, 5Z4.	N	N	8"	N	6	—	—	S	O	N	N	N	N	—	Y	—	—	—	22/1/-
B565 Schubert	Con.	●	4/5	B	456	6A8, 6K7, 6Q7, 6F6, 5Z4.	N	N	8"	N	6	—	—	S	O	N	N	N	N	—	Y	—	—	—	24/3/-
CD566 Liszt	Con.	●	4/5	D	456	6A8, 6K7, 6Q7, 6F6, 5Z4.	N	N	8"	N	6	—	—	S	O	Y	N	N	N	—	Y	—	—	—	25/4/-
CDS56 Bach	Con.	●	4/5	D	456	6A8, 6K7, 6Q7, 6F6, 5Z4.	N	N	8"	N	6	—	—	S	O	Y	N	N	N	—	Y	—	—	—	28/7/-
D65 Chopin	Con.	●	5/6	D	456	6A8, 6K7, 6Q7, 6J7, 6F6, 5Z4.	N	Y	8"	N	6	—	—	S	O	Y	N	N	N	—	Y	—	—	—	34/13/-
DS656 Strauss	Con.	●	5/6	D	456	6A8, 6K7, 6F6, 6J7, 6Q7, 5Z4.	N	Y	8"	N	6.3	4	Y	S	O	Y	N	N	N	—	Y	—	—	—	38/17/-

PHILCO

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
654D	Con.	●	4/5	B	—	———	Y	N	10"	N	6.3	3	Y	S	360° 5"	N	Y	N	N	—	Y	—	—	—	30/9/-
65U	Con.	=	4/5	B	—	———	N	N	8"	N	—	3	Y	S	360° 5"	N	N	N	N	—	Y	—	—	—	30/9/-
653	Con.	●	4/5	B	—	———	N	N	8"	N	6.3	3	Y	S	360° 5"	N	N	N	N	—	Y	—	—	—	26/5/-
654	Con.	●	4/5	B	—	———	Y	N	8"	N	6.3	3	Y	S	360° 5"	N	N	N	N	—	Y	—	—	—	28/7/-
651	Man.	●	4/5	B	—	———	N	N	6"	N	6.3	2	N	S	360° 5"	N	N	N	N	—	N	—	—	—	17/17/-
652	Con.	●	4/5	B	—	———	N	N	8"	N	6.3	3	Y	S	360° 5"	N	N	N	N	—	N	—	—	—	22/1/-
64B	Con.	+	4	B	—	———	N	N	8" P.M.	N	2	3	Y	S	360° 5"	N	N	N	N	Y	N	2	135	—	28/7/-
68B	Con.	+	8	T	—	———	N	Y	10" P.M.	N	2	4	Y	D	360° 5"	Y	N	N	N	Y	Y	2	180	A	54/12/-
66X	Con.	+	6	D	—	———	N	N	10" P.M.	N	2	4	Y	D	360° 5"	N	N	N	N	Y	Y	2	135	—	44/2/-
66B	Con.	+	6	B	—	———	N	Y	8" P.M.	N	2	4	Y	S	360° 5"	N	N	N	N	Y	Y	2	135	—	38/17/-
688	Con.	●	7/8	D	—	———	N	Y	12"	N	6.3	4	Y	D	360° 5"	Y	Y	N	N	—	Y	—	—	—	50/8/-
667	Con.	●	5/6	D	—	———	N	Y	10"	N	6.3	4	Y	D	360° 5"	Y	Y	N	N	—	Y	—	—	—	39/18/-
656	Con.	●	4/5	D	—	———	N	Y	10"	N	6.3	4	Y	D	360° 5"	Y	Y	N	N	—	Y	—	—	—	32/11/-
655	Con.	●	4/5	D	—	———	N	N	8"	N	6.3	4	Y	D	360° 5"	Y	N	N	N	—	Y	—	—	—	31/10/-
609*	Con.	●	9/10	T	—	———	N	Y	12"	N	6.3	4	Y	D	†	Y	Y	N	N	—	Y	—	—	—	68/5/-

NOTE.—In triple wave models the coverage is complete from 18 megacycles to 530 k.c. (16—560 m.). Dual wave models 16-53 and 190-560 m.
* This model has variable selectivity, also two-in-one high fidelity speaker.
† Special type dial with shadowgraph tuning.

RADIOLA

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
31/32	Man.*	●	4/5	B	175	6D6, 6A7, 6B7, 42, 80.	N	Y	5" 1600	N	6.3	3	N	S	S 3"	Y	N	N	N	—	Y	—	—	—	15/15/-
33	Man.†	●	4/5	D	460	6D6, 6A7, 6B7, 42, 80.	N	N	5" 1600	N	6.3	4	N	D	S 3¼"	Y	N	N	N	—	Y	—	—	—	19/19/-
155	Con.	●	4/5	B	175	6D6, 6A7, 6B7, 42, 80.	N	Y	8" 2000	N	6.3	4	Y	S	O 7¼"x 2¼"	Y	N	N	N	—	Y	—	—	—	24/3/-
248	Con.	●	4/5	D	460	6A7, 6D6, 6B7, 42, 80.	N	N	8" 2000	N	6.3	5	Y	D	O 7¼"x 2¼"	Y	N	N	N	—	Y	—	—	—	27/6/-

(Continued on page 273)

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
RADIOLA—(Continued)—																									
158	Con.	●	6/7	B	175	6K7, 6A8, 6K7, 6H6, 6F5, 6F6, 80.	N	Y	10" 2000	N	6.3	4	Y	S	O 7¼"x 2¼"	Y	N	N	Y	—	Y	—	—	—	32/11/-
249	Con.	●	6/7	D	460	6K7, 6A8, 6K7, 6H6, 6F5, 6F6, 80.	N	Y	10" 2000	N	6.3	5	Y	D	O 7¼"x 2¼"	Y	N	N	Y	—	Y	—	—	—	36/15/-
251	Con.	●	7/8	D	460	6K7, 6A8, 6K7, 6H6, 6F5, 2-6F6, 80.	N	Y	10" 1000	N	6.3	5	Y	D	O 7¼"x 2¼"	Y	Y	N	Y	—	Y	—	—	—	44/2/-
35	Man.†	+	4	B	460	1C6, 1C4, 1B5, 1D4.	N	N	5" P.M.	N	2.5	4	Y	S	S 3"	N	N	N	N	Y	Y	2/100 0.54A	120	4.5	19/19/-
156	Con.	+	4	B	175	1C4, 1C6, 6B7, 1D4.	N	Y	8" P.M.	N	6.3	4	Y	S	O 7¼"x 2¼"	N	N	N	N	Y	Y	6/100 0.54A	135	A	28/7/-
157	Con.	+	5	B	175	1C4, 1C6, 1C4, 1B5, 1D4.	N	Y	8" P.M.	N	2.5	4	Y	S	O 7¼"x 2¼"	N	N	N	N	Y	Y	2/100 0.66A	135	4.5	30/9/-
250	Con.	+	6	D	460	1C4, 1C6, 2-1C4, 1B5, 1D4.	N	Y	8" P.M.	N	2.5	5	Y	D	O 7¼"x 2¼"	N	N	N	N	Y	Y	2/120 0.78A	135	13.5	35/14/-

* Moulded Radelec cabinets. Model 31 in black, Model 32 in ivory.
† Moulded Radelec cabinet, black finish relieved with green fr et and base.
All models designated O are fitted with straight line tuning slide rule type dials.
All models shown with dual ratio tuning are equipped with automatic vernier tuning mechanisms

RADIOPLAYER

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
6506	Man	●	4/5	B	462	AK2, AF3, ABC1, AL2, EZ3.	N	N	5" 1000	Y	4.5	2	N	S	S 2¾"	N	N	N	N	—	Y	—	—	—	15/15/-
6507	Con.	●	4/5	B	462	do.	N	N	8" 1000	Y	4.5	2	N	S	S 2¾"	N	N	N	N	—	Y	—	—	—	19/19/-
6608	Con.	●	5/6	D	462	AK2, AF3, AB2, AC2, AL2, EZ3.	N	N	8" 1000	Y	6811	3	Y	S	S 6"	N	Y	N	Y	—	Y	—	—	—	28/7/-
6709	Con.	●	6/7	D	462	2-AF3, AK2, AB2, AC2, AL2, EZ3.	N	Y	10" 1000	Y	6811	3	Y	S	S 6"	N	Y	N	Y	—	Y	—	—	—	35/14/-

SANDEL

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
5G36	Man.	●	4/5	B	460	6C6, 6D6, 6C6, 42, 80.	N	N	8" 2000	N	6.3	3	Y	S	360° 4¼"	Y	N	N	N	—	N*	—	—	—	**14/14/-
5M36	Man.	●	4/5	B	460	6J7, 6K7, 6J7, 6F6, 5Z4.	N	N	8" 2000	N	6.3	3	Y	S	360° 4¼"	Y	N	N	N	—	N*	—	—	—	†18/18/-
6G36	Con.	●	5/6	B	460	6D6, 6A7, 6D6, 75, 42, 80.	N	Y	8" 2000	N	6.3	3	Y	S	360° 4¼"	N	N	N	N	—	Y	—	—	—	††22/10/-
5DW36	Con.	●	4/5	D	460	6A7, 6D6, 75, 42, 80.	N	N	8" 2000	N	6.3	4	Y	S	360° 4¼"	N	N	N	N	—	Y	—	—	—	§19/19/-
6DW36	Con.	●	5/6	D	460	6D6, 6A7, 6D6, 75, 42, 80.	N	Y	8" 2000	N	6.3	4	Y	S	360° 4¼"	N	N	N	N	—	Y	—	—	—	§§27/10/-
636B	Con.	+	6	B	460	1C4, 1C6, 1C4, 1B5S, 1C4, 1D4.	N	Y	8" P.M.	N	2.5	4	Y	S	360° 4 ¼"	N	N	N	N	Y	Y	2/100 0.78A	135	9	§§27/10/-
736B	Con.	+	7	B	460	1C4, 1C6, 1C4, 1B5S, 30, 2-1D4.	N	Y	10" P.M.	N	2.5	4	Y	S	3 60° 4 ¼"	N	N	N	N	Y	Y	2/100 0.96A	139	9	§§29/15/-

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
636BDW	Con.	+	6	D	460	1C4, 1C6, 1C4, 1B5S, 1C4, 1D4.	N	Y	8" P.M.	N	6.3	5	Y	S	350° 4¼"	N	N	N	N	Y	Y	2/100 0.78A	135	9	§§34/10/-
736BDW	Con.	+	7	D	460	1C4, 1C6, 1C4, 1B5S, 30, 2-1D4.	N	Y	10" 2000	N	2.5	5	Y	S	360° 4¼"	N	N	N	N	Y	Y	2/100 0.96A	135	9	§§37/10/-

NOTE.—All Battery receivers also A.C. dual-wave models are available with Edgelit dials at same price. A.C. Broadcast models fitted with Edgelit dial at 21/- extra.
* These models are fitted with A.V.C. if desired.
** In York console; also available in Milton or Lytton at 16/16/- or Chaucer console at 17/17/-.
† In Milton or Lytton consoles; also available in Chaucer console at 19/19/-.
†† Same price in either Milton, Lytton or Chaucer consoles.
§ In Milton or Lytton consoles; also available in Chaucer console at 21/10/-.
§§ In Milton or Lytton consoles; also available in Chaucer console at 20/- extra.

STROMBERG-CARLSON

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
496	Man.	●	3/4	B	465	6C6, 6A7, AL3, 80.	N	N	7"	N	6	2	N	S	S	N	N	N	N	—	N	—	—	—	14 gns.
55B	Man.	=	4/5	B	465	CBC1, C1, CY2, CL2, CF1, CK1.	N	N	8"	N	240	4	Y	S	S	Y	N	N	N	—	Y	—	—	—	18 gns.
566	Con.	=	4/5	B	465	CBC1, C1, CY2, CL2, CF1, CK2.	N	N	8"	N	240	4	Y	S	O	Y	N	N	N	—	Y	—	—	—	24 gns.
556	Con.	●	4/5	B	250	6A7, 6F7, 6B7, AL3, 80.	N	Y	8"	N	6	3	Y	S	O	N	N	N	N	—	Y	—	—	—	27 gns.
536	Con.	●	4/5	D	250	6A7, 6F7, 6B7, AL3, 80.	N	Y	8"	N	6	4	Y	D	O	N	N	N	Y	—	Y	—	—	—	31 gns.
736	Con.	●	6/7	D	392	6D6, 6A7, 6B7, 79, 80, 2-42.	N	Y	8"	N	6	4	Y	D	O	N	Y	N	Y	—	Y	—	—	—	39 gns.
836	Con.	=	7/8	D	392	C1, CY2, CB1, 2-CF2, 2-CL2, CK1, CF1.	N	Y	8"	N	240	4	Y	D	O	N	Y	N	Y	—	Y	—	—	—	43 gns.
466	Con.	+	4	B	465	KF1, KK2, 25S, C243N.	N	N	8"	N	2	3	N	S	O	N	N	N	N	Y	Y	2/100	135	A	25 gns.
506	Con.	+	5	B	175	KK2, 25S, C243N, 2-1C4.	N	Y	8"	N	2	3	N	S	O	N	N	N	N	Y	Y	2/100	135	A	29 gns.
666	Con.	+	6	D	392	1C6, 25S, C243N, 3-1C4.	N	Y	8"	N	2	4	N	D	O	N	N	N	N	Y	Y	2/100	135	A	37 gns.
888	Con.	+	8	D	392	25S, KK2, 2-30, 4-1C4.	N	Y	8"	N	2	4	N	D	O	N	N	N	N	Y	Y	2/100	135	A	45 gns.

S.T.C.

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
514	Man.	●	4/5	B	450	6A7, 6D6, 6C6, 42, 80.	N	N	8"	N	6.3	—	N	S	§	N	N	N	N	—	N	—	—	—	16/16/-
511	Con.	●	4/5	B	450	6A7, 6D6, 6C6, 42, 80.	N	N	8" 2000	N	6.3	—	N	S	§	N	N	N	N	—	N	—	—	—	19/19/-
580	Con.	●	4/5	B	450	6A8, 6K7, 6J7, 6F6, 5Y3.	N	N	8" 2500	N	6.3	—	Y	S	§	Y	N	N	N	—	N	—	—	—	24/3/-
530	Con.	●	4/5	D	450	6A8, 6K7, 6Q7, 6F6, 5Y3.	N	N	8" 2000	Y	6.3	—	Y	D	§	Y	N	N	N	—	Y	—	—	—	29/8/-
577D	Con.	=	4/5	B	450	2-6C6, 6D6, 43, 12Z3.	N	Y	8"	N	6.3	—	N	S	§	N	N	N	N	—	N	—	—	—	26/10/-
613	Con.	●	5/6	B	175	2-6K7, 6A8, 6Q7, 6F6, 5Y3.	N	Y	8" 2500	Y	6.3	—	Y	S	§	N	Y	N	N	—	Y	—	—	—	30/9/-
623	Con.	●	5/6	D	450	2-6K7, 6A8, 6Q7, 6F6, 5Y3.	N	Y	10" 2500	Y	6.3	—	Y	D	§	Y	Y	N	N	—	Y	—	—	—	35/14/-
452B	Con.	+	4	B	450	1C6, 30, 33, 34.	N	N	8" P.M.	N	6.3	—	N	S	§	N	N	N	N	Y	N	6/100 0.5A	135	A	23/10/-
510B	Con.	+	5	B	175	2-1C4, 1C6, 1B5/25S, 1D4.	N	Y	8" P.M.	N	2	—	N	S	§	N	N	N	N	Y	Y	2/90	135	A	29/8/-
520B	Con.	+	5	D	450	2-1C4, 1C6, 1B5/25S, 1D4.	N	Y	8" P.M.	Y	2	—	N	D	§	Y	N	N	N	Y	Y	2/90 0.6A	135	A	34/13/-
677B	Con.	+	6	B	450	19, 6A7, 2-34, 2-30.	N	Y	8" P.M.	N	6	—	N	S	§	N	N	N	N	Y	Y	6/140 0.55A	135	9	38/15/-
780B	Con.	+	7	D	450	3-1C4, 1C6, 1B5/25S, 30, 19.	N	Y	8" P.M.	Y	2	—	N	D	§	Y	N	N	N	Y	Y	2/140 0.9A	135	9	40/19/-

§ Special ovaloid spotlight tuning dial.

TASMA

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
305	Con.	●	4/5	B	175	EK1, 6D6, 75, 42, 80.	Y	N	8"	Y	6.3	3	Y	S	360° 5"	N	N	N	N	—	Y	—	—	—	25/19/6
310*	Con.	+	5	D	470	EK1, 75, PM12M, 2-19.	N	N	8" P.M.	Y	6.3	4	Y	S	360° 5"	N	N	N	N	N	Y	6 0.96A	135	A	35/10/-
315	Car	+	5/6	B	—	6D6, 6A7, 6D6, 75, 42, 84.	N	Y	6" 6	N	—	2	Y	§	§	N	N	N	—	—	Y	—	G	A	29/15/-
320	Man.	●	4/5	B	470	EK1, 75, 42, 6D6, 80.	N	N	6"	N	6.3	2	N	S	360° 5"	N	N	N	N	—	Y	—	—	—	16/16/-
325	Con.	●	5/6	D	470	2-6D6, 42, 75, 6A7, 80.	N	Y	10" 1650	Y	6.3	4	Y	S	360° 5"	Y	N	N	N	—	Y	—	—	—	37/10/-
330	Con.	=	6/7	D	470	2-CF2, CK1, CBC1, CL2, CY2, C1.	N	Y	10" 1650	Y	—	4	Y	S	360° 5"	N	N	N	N	—	Y	—	—	—	39/10/-
335	Con.	+	6	D	405	2-1C4, 1C6, 1B5, 2-19.	N	Y	10"	Y	2	4	Y	S	360° 5"	N	N	N	N	N	Y	2/150 0.9A	135	4.5	43/10/-
350	Con.	●	4/5	B	470	EK1, 6D6, 75, 42, 80.	N	N	8"	Y	6.3	4	Y	S	360° 5"	Y	N	N	N	—	Y	—	—	—	31/15/-
360	Con.	●	4/5	B	470	EK1, 6D6, 75, 42, 80.	N	N	8"	Y	6.3	3	Y	S	360° 5"	N	N	N	N	—	Y	—	—	—	21/17/6
365	Con.	●	4/5	D	470	6A7, 6D6, 75, 42, 80.	N	N	8"	Y	6.3	4	Y	S	360° 5"	Y	N	N	N	—	Y	—	—	—	29/15/-
370	Con.	=	5/6	B	470	CK1, CF2, CBC1, CL2, CY2, C1.	N	N	8"	Y	—	3	Y	S	360° 5"	N	N	N	N	—	Y	—	—	—	23/17/6
375	Con.	+	4	B	470	1C6, C4, B5, D4.	N	N	8" P.M.	Y	2	3	Y	S	360° 5"	N	N	N	N	N	Y	2/100 0.54A	135	4.5	27/10/-

NOTE.—All dial drives are of the counter-balanced band spread type, except those fitted to models 315 and 320.
* This model available in Gilbert console at 33/19/6.
§ Remote control automobile flex. cables.

VAN RUYTEN

Model	Cabinet	Power	No. Valves	Coverage	Int. Freq.	VALVES USED	Band Pass	R.F. Stage	Speaker	Iron Cores	Dial Lamp	Controls	Tone Con.	Tuning	Dial	Sen. Con.	Tun. Indic.	Muting	Phono. Sw.	Lamp Sw.	A.V.C.	A.	B.	C.	PRICE
D30	Man.	=	5/6	B	175	CK1, CB1, CF2, CF1, CL2, CY2, C1.	Y	N	8" 1500	—	4	3	Y	S	3½" Oct.	N	N	N	N	—	Y	—	—	—	22/19/6
D31	Con.	+	6	B	175	2/34, 1C6, 1B5, 30, 19.	N	Y	8" P.M.	—	6	4	Y	S	4½" 360°	N	N	N	N	Y	Y	6/100 1.25A	Vib	A	38/15/-
D33	Con.	+	4	B	175	1A6, 1C4, 1B5, 1D4.	Y	N	8" P.M.	—	2	3	N	S	4" Oct.	N	N	N	N	N	Y	2/100 0.53A	135	A	23/15/6
D34	Con.	+	5	B	175	2/1C4, 1C6, 1B5, 1D4.	N	Y	8" P.M.	—	2	3	N	S	4" Oct.	N	N	N	N	Y	Y	2/100 0.66A	135	A	29/10/-
D35	Con.	●	4/5	B	456	6A7, 6D6, 75, 42, 80.	N	N	8" 1500	—	6	3	Y	S	4" Oct.	N	N	N	N	—	Y	—	—	—	19/19/-
D36	Man.	●	3/4	B	456	6A7, 6F7, 42, 80.	N	N	8" 1500	—	6	3	Y	S	3½" Oct.	N	N	N	N	—	N	—	—	—	14/14/-


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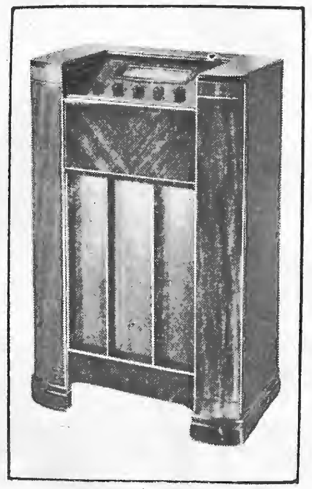
Airzone 660

EYE APPEAL

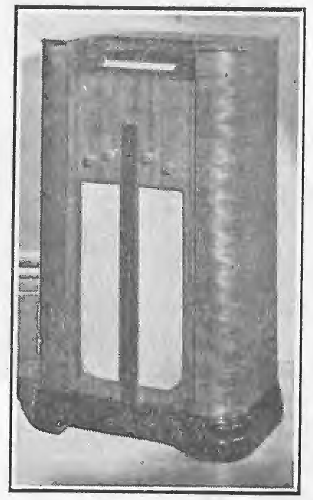
... in ...

1936 RADIO RECEIVERS

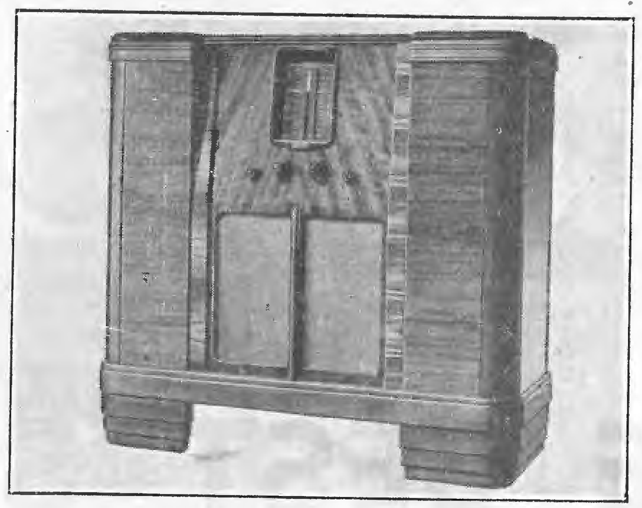
Pictured on the following pages are examples of cabinet designs in combination phono-radios, consoles, mantel models and midgets. The selection is representative of models by well known manufacturers and is not intended to be so embracing as the yearly "Pictorial Parade" published in "Radio Retailer."



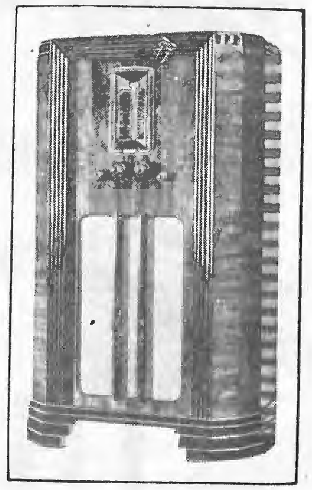
Radiola 158, 249, 250



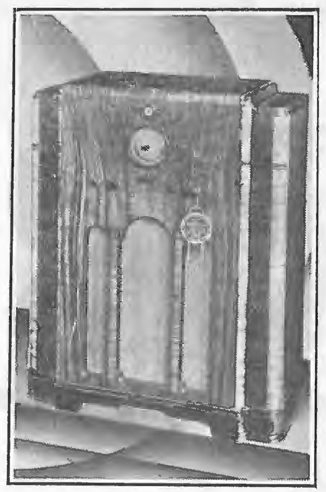
Airzone 556



Stromberg-Carlson 736, 836, 888

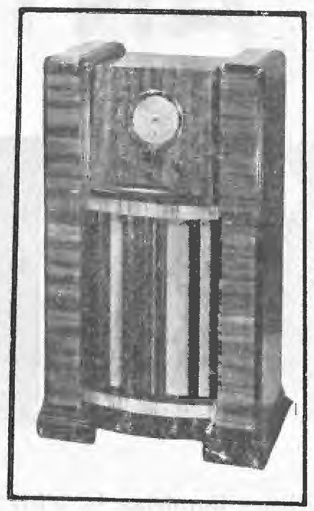


Stromberg-Carlson 666

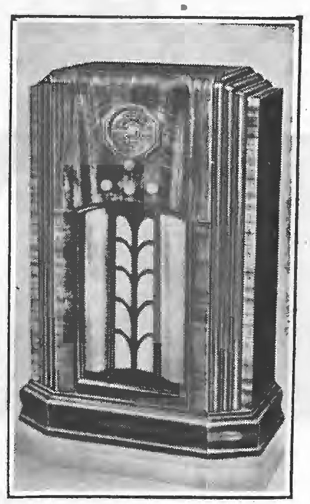


Kriesler 66 Airflow

Radioplayer 6709



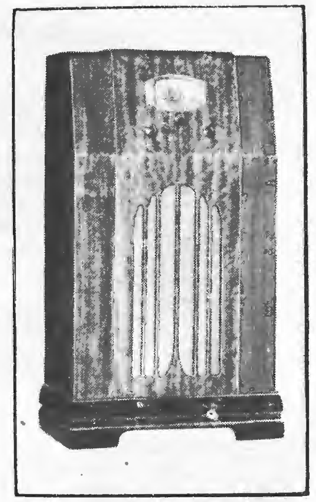
Tasma 305, 310, 365, 350



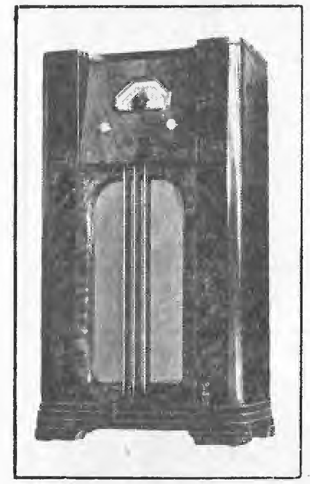
Breville Beale Edward

It will be obvious from a glance at this page that the dial plays no small part in to-day's radio. Circular dial scales tend to become larger, more artistically and evenly illuminated, and easier to read. Special dials, scales and escutcheons made their appearance, all with those objects in view. The cabinet work is decidedly better than previous years, some beautiful effects being obtained with richly grained veneers—all testimony to the present high standard of the cabinetmakers' craft. The lower right-hand model illustrated is carried out in moulded bakelite.

Bandmaster No. 3

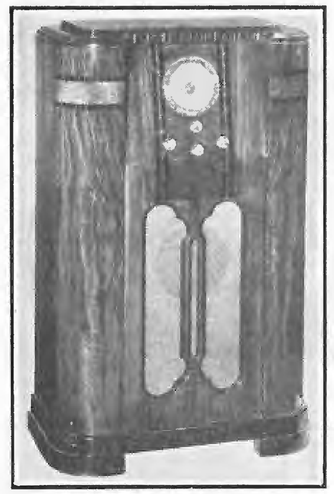


S.T.C. 580, 680



Astor 77, 88

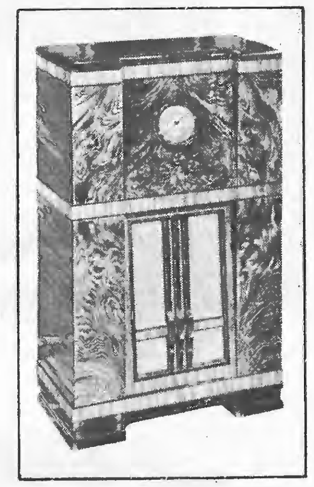
Airmaster D 36



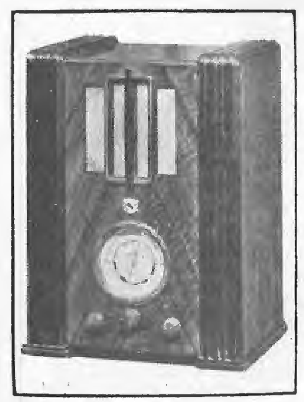
Calstan

Sandel 536

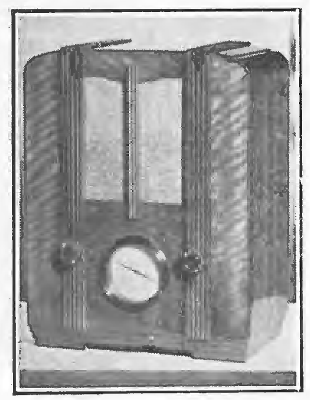
Genalex 350, 365, 310



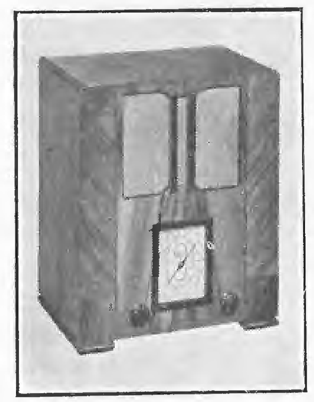
H.M.V. 719



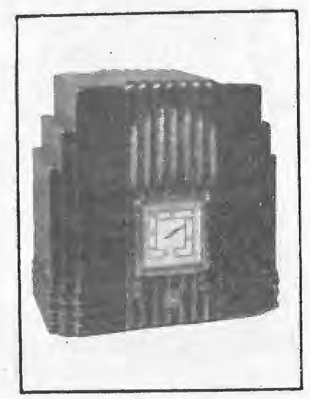
Lekmek 513, 514, 516



Airzone 554

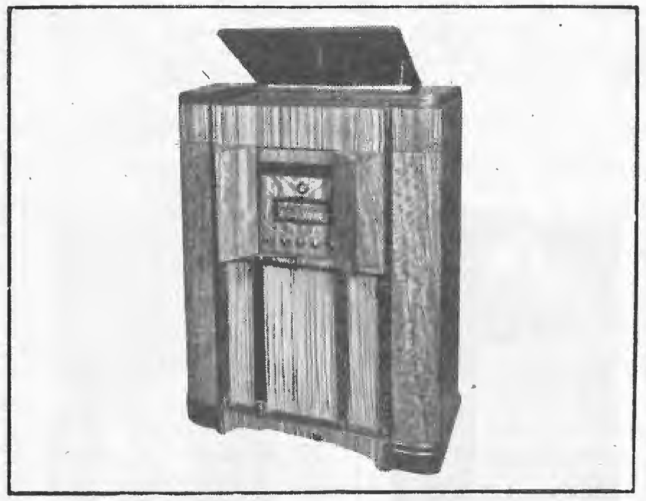


Genalex 320

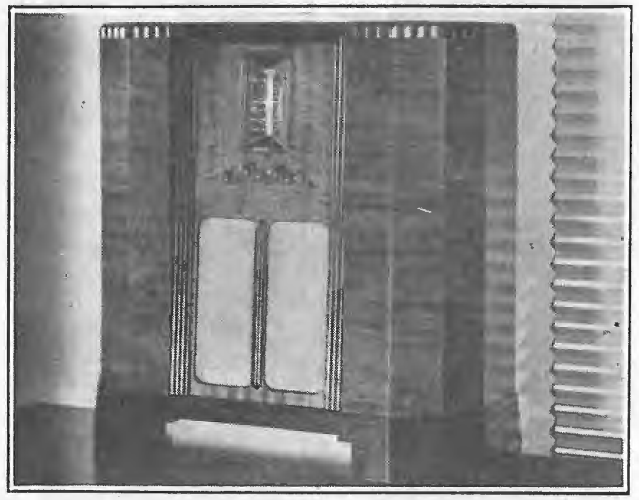


Radiolette 31

Many of the combination models shown here are either fitted or may be obtained with automatic record changers

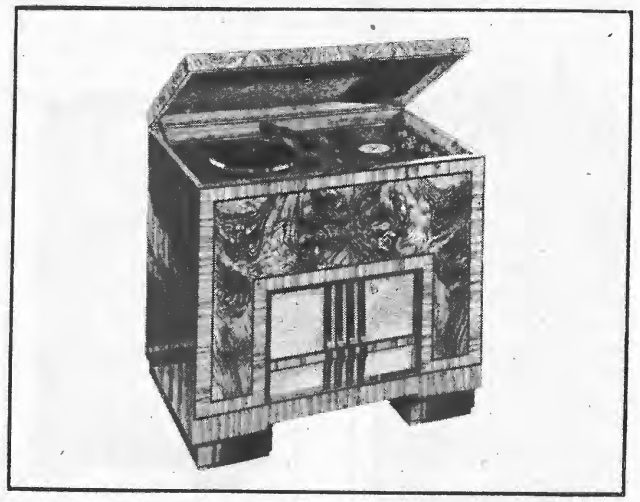


Radiola 302. Phono and world range combination

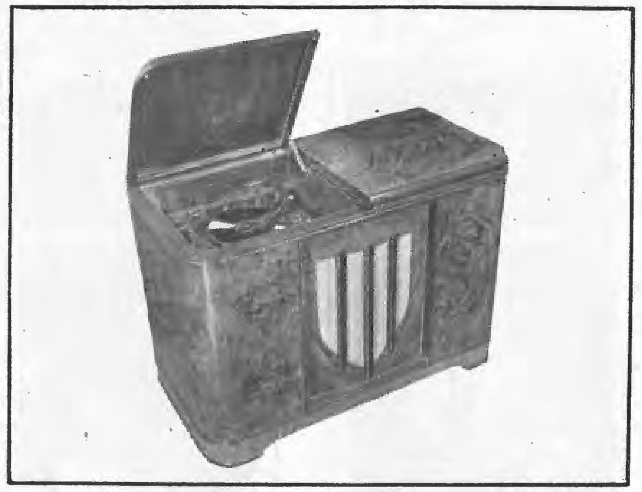


Stromberg-Carlson 536 B Radio only

Kriesler 10-valve Grand Combination with record compartments

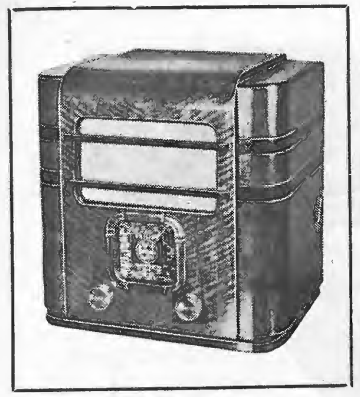


H.M.V. 720. Phono and All-Wave Combination



Briton Combination 94 CH

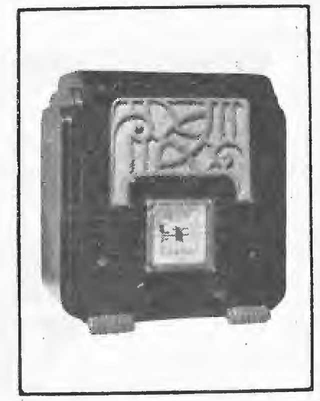
Genalex Combination with Auto Record Changer



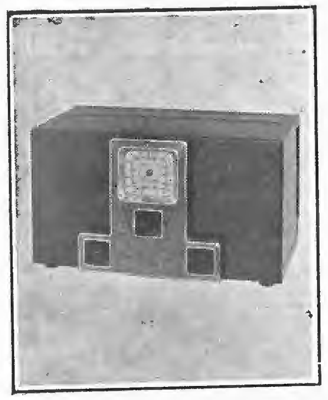
Radioplayer 6506

Stromberg-Carlson 55 B

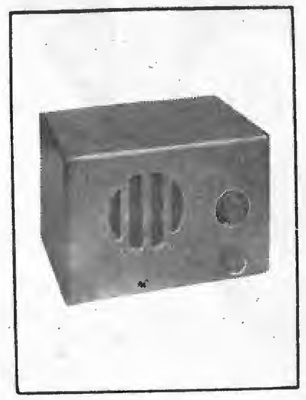
Kriesler 150



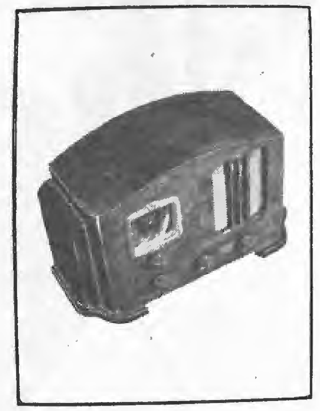
Radiolette 33, 35



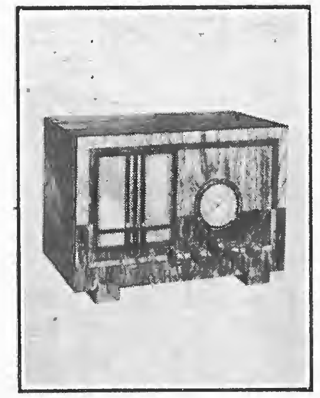
Mullard Master Unit



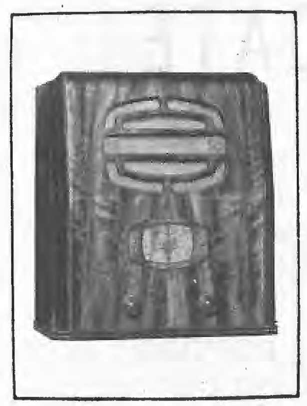
Lekmek Treasure Box



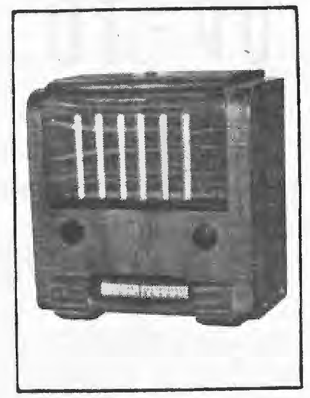
Briton Buccaneer



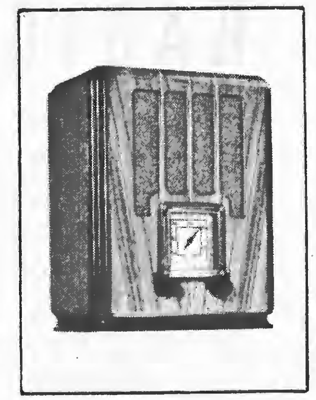
H.M.V. 718



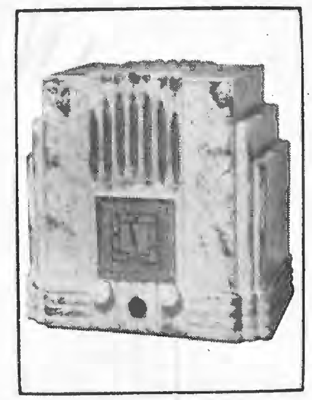
S.T.C. Mantel



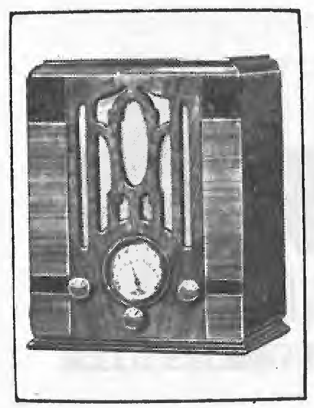
Astor Mickey Grand



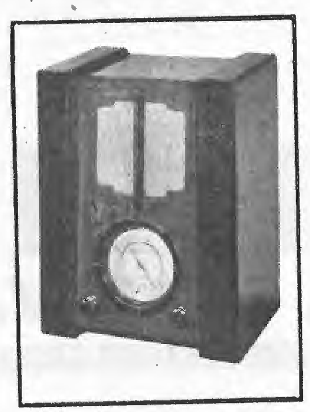
Bandmaster No. 6



Radiolette 32



Breville Mantel



Tasma 320

Genalex 360, 370

Van Ruyten D30

Valve Characteristics

IN the following pages will be found complete tabulations of the characteristics of the valve types in common use during 1935-1936.

It will be noted that all semi-obsolete types have been omitted from the lists, it being felt that no useful purpose would be served by their inclusion. Readers desirous of obtaining information on these older types are referred to previous editions of the "Radio Trade Annual" or to manufacturers' listings.

The space made available by the omission of these older types has been devoted to an extension of the data previously given to the listing of important or dual-purpose types under several sets of operating conditions.

Attention is drawn to the different system of classification which has been adopted whereby the old method of grouping the types listed by each manufacturer has been discontinued.

The tubes which come under each general classification (i.e. triodes, frequency changers, etc.), are now listed in order of filament voltage so that corresponding, or nearly corresponding, battery, A.C., or universal types may be readily compared.

Brands

The manufacturers of each type are now designated by their initials as follows:—

S.A. .... Standard American types, which are produced by Radiotron, Ken-Rad, National Union, Sylvania, Raytheon, Philips, Mullard and Osram.

In addition there are several "American" types which are produced exclusively by one or more of the above manufacturers. The make of these types is designated by the initial letter or portion of the brand, as follows:

Rad. or **R.** .... Radiotron.
N.U. or **N.** .... National Union.
Ken. or **K.** .... Ken-Rad.
Syl. or **S.** .... Sylvania.

Thus, a tube manufactured by National Union and Ken-Rad only is designated as "K.N."

Continental or English types, such as those manufactured by Philips, Mullard or Osram are designated by an abbreviation of the brand name, as follows:

Phil. .... Philips.
Mul. .... Mullard.
Osr. .... Osram.

Certain types which are common to both Philips and Mullard are designated "P.M."

Bases and Socket Connections

A column headed "Base Type" will be found in some of the type classifications in addition to the column headed "Symbol" or "Sym."

Under the "base type" heading will be found the actual base designation such as:

UX .... Standard American 4-pin.
UY .... " " 5-pin.
6 .... " " 6-pin.
7(S) .... " " Small 7-pin.
7(L) .... " " Medium 7-pin.
Eng. .... English Socket only.
Spec. .... Special base.
"P" .... Standard Philips side contact "P" base.
"V" .... Small Philips side contact "V" base.
Oct. .... Standard American octal base.

Under the "Symbol" heading will be found the index to the symbolic representation of the tube itself and its **under-socket** base connections. The Standard American R.M.A. method of representation and indexing is used for all American types. These are all designated by a numeral, followed by a hyphen and a letter (e.g., 4-C).

Octal-based types are designated by the letter "O," followed by a hyphen and a numeral (e.g., O-6).

Philips and Mullard "P" and "V" based types are indexed by a letter followed by a hyphen and a numeral (e.g., P-5 or V-2). These types are illustrated by the standard Philips method of representation.

English or Continental types which are fitted with "American" type bases are indexed by a numeral followed by a hyphen and a letter in the same way as standard American types. The Philips method of representation is used for the illustrations, however.

We are indebted to the Amalgamated Wireless Valve Co. Ltd. for the illustrations of all the standard American tube types and to Philips Lamps (A/sia) Ltd. for the illustrations of the English and Continental types.

Explanatory Notes Regarding Headings

The headings used for the remaining columns of the tabulated matter follow standard practice very closely, and are largely self-explanatory.

The system of abbreviations used for some of the columns follows standard practice also, but recapitulation is in order so that there will be no confusion.

Voltage Ratings

Va .... anode or plate voltage.
Vsg .... screen or auxiliary grid voltage.
Voa .... oscillator anode voltage.
Vcg .... control grid voltage or bias. The abbreviation "neg." means that the voltage is negative with relation to the cathode (in the case of an indirectly heated valve); the negative side of the filament (in the case of a battery operated (D.C.) valve) or the mid-point of the filament (in the case of directly-heated A.C. valves).

Current Ratings

Ia .... anode or plate current.
Isg .... screen or auxiliary grid current.
Ioa .... oscillator anode current.

The subscript "mA" indicates that the respective quantities are expressed in milli-amperes.

Other Headings

Mutual conductance (mut. cond.) or slope is given in **micromhos.** Those who prefer the **"milliamperes per volt"** expression may obtain it by shifting the decimal point three places to the left (e.g. 2000 micromhos is equal to 2 mA/V.).

Plate resistance (or impedance) is given in ohms except where specified as being in megohms.

The **load resistance** figures given for power tubes and in the "special application" section are in each case the optimum value specified by the tube manufacturer.

Power output is given in watts in each case as the number of tubes with outputs in excess of one watt considerably outnumbers those with outputs of under a watt.

Type of Bias. This column only appears in the output valve classifications and is inserted in the interests of valve life. It is fairly well recognised to-day that there is a maximum value of resistance which can be safely used between the grid and cathode of any tube. In the case of intermediate amplifier stage tubes the value of this resistance is usually of the order of megohms and is, in most cases, somewhat in excess of that which is likely to be employed in practice. For power tubes, however, the position is somewhat different and the maximum permissible value of resistance is usually less than most of us would like to use. This maximum value varies with the biassing system used and is invariably higher for self-biassed tubes. The letters "S" and "F" in the type of bias column indicate whether the maximum value of resistance (given in megohms in the last column) is for "self" or "fixed" bias.

An additional reason for this column will be found in the many push-pull output combinations listed and here it will be seen that the maximum power output obtainable from a pair of tubes is largely dependent on the type of bias which is used.

It should be noted that "fixed" bias can only be obtained from a separate bias source such as a battery or separate power

(Continued on next page)

VALVE CHARACTERISTICS—(Continued)—

supply. So-called "bleed" bias systems, where bias is obtained from the voltage drop across a resistor in the "B" return lead of a radio receiver (and is therefore largely a function of the plate current drawn by the power tube itself) are really "semi-fixed" biassing systems, and, under these circumstances, a grid resistance value about mid-way between the limits tabulated may be used with safety.

Variable-mu tubes are rated with two alternative values of negative grid bias, one beneath the other. The value given in the same line as the remainder of the characteristics is the minimum value and is that recommended for normal operation. The mutual conductance figure given in the next column is the maximum obtainable from the valve under the conditions listed.

Immediately below the "normal" bias rating is given the bias rating for **effective** cut-off, and the mutual conductance at that bias figure (assuming all other voltages remain the same) is given alongside.

Suppressor Connection. In all tube types where a separate suppressor grid connection is brought out it is assumed that this is connected to the cathode at the socket.

The "cathode type" (cath. type) column merely indicates whether a valve is directly or indirectly heated; the abbreviations used being "dir." and "ind." respectively.

Any other points in connection with the headings are dealt with in the form of foot-notes under the various classifications.

OUTPUT TRIODES—Class "A" and "AB"

Make	Type	Class of Service	Symbol	Filament V.	Filament A.	Cath. type	Va	Ia mA	Vcg neg	Type bias	Mut. Cond. μ mhos	Amp. fact.	Opt. load ohms	Power Output W.	Total dist. %	Max. grid res. megs.
S.A.	31	Class "A"	4-D	2.0	0.13	dir.	135	8.0	22.5	F	925	3.8	7000	0.185	—	0.1
Mul.	PM2A	" "	4-D	2.0	0.2	dir.	150	6.0	7.0	F	3500	—	7000	0.15	—	0.1
"	PM202	" "	4-D	2.0	0.2	dir.	150	14.0	13.5	F	3500	—	3700	0.35	—	0.1
Osr.	P2	" "	4-D	2.0	0.2	dir.	150	19.0	10.5	F	3500	—	4500	0.3	—	0.1
S.A.	45	" "	4-D	2.5	1.5	dir.	250	34.0	50.0	S	2175	3.5	3900	1.6	—	1.0
		2 tubes "AB" (1)	—	—	—	—	275	—	68.0	F	—	—	3200	18.0	5.0	(A)
"	"	" "	—	—	—	—	275	—	775Ω	S	—	—	5000	12.0	5.0	(A)
"	46	as triode driver *	5-C	2.5	1.75	dir.	250	22.0	33.0	S	2350	5.6	13000	1.0	—	1.0
"	49	" " *	5-C	2.0	0.12	dir.	135	6.0	20.0	S	1125	4.7	22000	0.15	—	1.0
"	2A3	Class "A"	4-D	2.5	2.5	dir.	250	60.0	45.0	S	5250	4.2	2500	3.5	—	0.5
		" "	—	—	—	—	—	—	—	F	—	—	—	—	—	0.01†
		2 tubes "A" (2)	—	—	—	—	300	80.0	62.0	F	—	—	3000	15.0	2.5	Tran.
"	"	" "	—	—	—	—	300	80.0	62.0	S	—	—	5000	10.0	5.0	Tran.
Osr.	ML4	Class "A"	5-A	4.0	1.0	ind.	200	20.0	9.0	S	4200	—	7000	0.65	—	1.0
"	PX4	" "	4-D	4.0	1.0	dir.	250	48.0	34.0	S	6000	—	3200	2.5	—	1.0
"	PX25	" "	4-D	4.0	2.0	dir.	400	62.5	31.0	S	8000	—	3200	5.5	—	0.5
"	PX25A	" "	4-D	4.0	2.0	dir.	400	62.5	100.0	F	6900	4.0	4500	8.0	—	0.01†
		" "	—	—	—	—	300	50.0	75.0	F	—	—	—	5.0	—	—
"	"	2 tubes-low load (3)	—	—	—	—	440	—	117.0	F	—	—	2800	32.0	5.0	Tran.
"	DA30	Class "A"	4-D	4.0	2.0	dir.	500	60.0	134.0	F	3850	3.5	6000	10.0	—	0.01†
Mul.	AC044	" "	4-D	4.0	1.0	dir.	200	30.0	32.0	S	3500	—	2300	1.5	—	1.0
"	DO/26	" "	4-D	4.0	2.0	dir.	400	62.5	92.0	F	6300	—	4000	7.5	—	0.01†
Phil.	E406	" "	4-D	4.0	1.0	dir.	250	48.0	24.0	S	4000	6.0	2500	1.75	—	1.0
"	E406N	" "	P-13	4.0	1.0	dir.	250	48.0	22.0	S	3500	6.0	3500	1.6	5.0	0.6
		" "	—	—	—	—	—	—	—	F	—	—	—	—	—	0.2
Osr.	LS6A	" "	4-D	6.0	2.0	dir.	400	63.0	91.0	F	2300	—	3250	5.0	—	0.01†
S.A.	42	as triode driver	6-B	6.3	0.7	ind.	250	31.0	20.0	S	2300	6.2	10000	1.0	—	1.0
		(G2 to plate)*	—	—	—	—	—	—	—	—	—	—	(min)	av'r'ge	—	—
		2 tubes as triodes	"	"	"	"	350	—	38.0	F	—	—	8000	18.0	5.0	(B)
"	"	Class "AB" (4)	"	"	"	"	350	—	730Ω	S	—	—	8000	15.0	5.0	(C)
"	6F6	as triode driver*	O-8	6.3	0.7	ind.	(42)	—	(42)	—	2700	—	(42)	(42)	—	(42)
"	"	2 tubes "AB" (4)	"	"	"	"	350	—	38.0	F	—	—	6000	18.0	7.0	(D)
"		(as triodes)	"	"	"	"	350	—	730Ω	S	—	—	10000	14.0	7.0	(E)
"	6D5	M. output triodes (5)	O-1	6.3	0.7	ind.	275	31.0	40.0	S	2100	4.7	7200	1.4	—	1.0
"	"	2 tubes "A"	"	"	"	"	300	46.0	50.0	F	—	—	5300	5.0	—	Tran.
K.N.	6E6	Twin Triode "A"	7-B	6.3	0.6	ind.	250	36.0 tot.	27.5	S	1700 each	6.0 each	14000 P-P	1.6 tot.	—	0.5
K	6B5	Twin Triode (int. direct coupled) (6)	6-S	6.3	0.8	ind.	325	51.0	—	—	2400	58.0	7000	5.2	—	—
			—	—	—	—	325	9.0	—	—	—	—	—	—	—	—

* Screen or No. 2 grid connected direct to plate. Load rating given is for driver service. For output use half value stated.
† Impedance or Transformer coupling recommended.
(1) Grid current drawn at some part of input cycle. Values given are for two tubes. (2) Grid remains negative throughout input cycle. Values given are for two tubes. (3) and (4) See note (1). (5) This tube was announced in original listing of metal series, but is not at present available. (6) Duplicate plate voltage and current rating is for "input" plate.
(A) With 56 as driver (250 volts on plate) and 1-5 : 1 (each half) step-down input transformer. (B) With 42 (triode) driver and 1.6 : 1 (each half) input transformer. (C) With 42 (triode) driver and 1.14 : 1 (each half) input transformer.
(D) With 6F6 (triode) driver and 1.67 : 1 (each half) input transformer. (E) With 6F6 (triode) driver and 1.29 : 1 (each half) input transformer.
Load values for all two tube output combinations are plate-to-plate.
"Undistorted" (up to 5%) rating applies where distortion percentage is not stated.

CONVERTER AND MIXER VALVES

Make	Type	Application	Symb.	Filament V.	Filament A.	Cath. type	Va	Vsg	Voa	Ioa mA.	Vcg neg.	Conv. cond. μ mhos	Plate res. megs.	Total cath. mA.	Osc. grid leak-ohms & mA.	Peak osc. input*
S.A.	1A6	Pen. B/C.	6-L	2.0	0.06	dir.	135	67.5	135	2.3	3.0	275	0.4	5.9	50,000	13.0
				—	—	—	—	—	—	—	22.5	4	—	—	0.2	—
,,	1C6	Pen. A/W	6-L	2.0	0.12	dir.	135	67.5	135†	2.6	3.0	300	0.55	5.9	50,000	13.0
		see note (A)		—	—	—	—	—	—	—	14.0	4	—	—	0.2	—
,,	,,	B/C. only		2.0	0.12	dir.	135	45	135ϕ	1.25	zero	—	—	3.5	50,000	8.5
				—	—	—	—	—	—	—	9.0	—	—	—	0.12	—
P.M.	KK2	Oct. B/C.	7-F	2.0	0.13	dir.	135	45	135	2.1	zero	270	2.5	3.5	50,000	8.5
			P-8	—	—	—	—	—	—	—	12.0	2	—	—	0.12	—
,,	,,	S/W. only		2.0	0.13	dir.	135	60	135	2.3	1.5	275	1.7	4.3	50,000	6.0
				—	—	—	—	—	—	—	—	—	—	—	0.08	—
S.A.	2A7	Pen. A/W.	7-C	2.5	0.8	ind.	250	100	250†	4.0	3.0	520	0.36	9.7	50,000	50.0
		see note (A)		—	—	—	—	—	—	—	45.0	2	—	—	0.7	—
Osr.	MX40	Hept. A/W.	—	4.0	1.0	ind.	250	80	150	—	3.0	500	0.5	5.85	50,000	10.0
		see note (A)		—	—	—	—	—	—	—	30.0	2.5	—	—	0.15	—
,,	X41	Triode/Hexode.	—	4.0	1.2	ind.	250	70	100	—	1.5	550	2.0	7.6	50,000	10.0
		A/W.		—	—	—	—	—	—	—	—	—	—	—	0.15	—
Mul.	FC4	Oct. A/W.	7-G	4.0	0.65	ind.	250	70	70	1.6	1.5	600	1.5	5.4	50,000	12.0
		see note (A)		—	—	—	—	—	—	—	20.0	2	—	—	0.19	—
Phil.	AK1	Oct. A/W.	7-G	4.0	0.65	ind.	250	70	70	1.6	1.5	600	1.5	5.4	50,000	12.0
		see note (A)		—	—	—	—	—	—	—	20.0	2	—	—	0.19	—
,,	AK2	Oct. A/W.	P-9	4.0	0.65	ind.	250	70	90	2.0	1.5	600	1.6	7.2	50,000	12.0
		see note (A)		—	—	—	—	—	—	—	16.0	2	—	—	0.19	—
,,	EK1	Oct. A/W.	P-9	6.3	0.3	ind.	250	70	70	1.6	1.5	600	1.5	5.4	50,000	12.0
		see note (A)		—	—	—	—	—	—	—	20.0	2	—	—	0.19	—
P.M.	EK2	Oct. A/W.	P-9	6.3	0.2	ind.	250	50	200	2.5	2.0	550	2.0	4.3	50,000	—
S.A.	6A7	Pen. A/W.	7-C	6.3	0.3	ind.	250	100	250†	4.0	3.0	520	0.36	9.7	50,000	50.0
		see note (A)		—	—	—	—	—	—	—	45.0	2	—	—	0.7	—
,,	6A8	Met. Pen. A/W.	O-7	6.3	0.3	ind.	250	100	250†	4.0	3.0	500	—	10.5	50,000	35.0
		see note (A)		—	—	—	—	—	—	—	45.0	2	—	—	0.5	—
,,	6L7	Pen. mixer	O-6	6.3	0.3	ind.	250	150	—	—	6.0	350	1.0	11.6	50,000	18.0
		(Sep. osc.)		—	—	—	—	—	—	—	45.0	5	—	—	—15v.+	(min.)
,,	6F7	Triode/pentode	7-E	6.3	0.3	ind.	100	100	100	2.4	10.0	300	2.0	5.8	100,000	7.0**
				—	—	—	—	—	—	—	35.0	—	—	—	0.15	—
,,	6D6	Pent. mixer	6-F	6.3	0.3	ind.	250	100	—	—	10.0	—	—	—	—	7.0**
		(Sep. osc.)		—	—	—	—	—	—	—	40.0	—	—	—	—	—
Mul.	FC13	Oct. A/W.	P-9	13.0	0.2	ind.	250	70	70	1.6	1.5	600	1.5	6.0	50,000	12.0
		see note (A)		—	—	—	—	—	—	—	20.0	2	—	—	0.19	—
Phil.	CK1	Oct. A/W.	P-9	13.0	0.2	ind.	250	70	70	1.6	1.5	600	1.5	6.0	50,000	12.0
		see note (A)		—	—	—	—	—	—	—	20.0	2	—	—	0.19	—
Osr.	X30/	Univ. heptodes	—	13.0	0.3	ind.	250	80	150	—	3.0	750	—	9.1	50,000	10.0
	X32	A/W.	—	—	—	—	—	—	—	—	30.0	20	—	—	0.15	—
,,	X31	Univ. triode/	—	13.0	0.3	ind.	200	70	100	—	1.5	550	—	7.6	50,000	10.0
		hexode A/W.	—	—	—	—	—	—	—	—	—	—	—	—	0.15	—

* Peak voltage developed by osc. section of pentagrid or injection voltage required for mixer.
† Applied through 20,000 ohm dropping resistor.
ϕ Applied through 50,000 ohm dropping resistor.
+ neg. bias applied to G3 through a 50,000 ohm resistor.
** External coupling means must be provided. 6A8 and 6L7 also in "G" and "MG" types.
(A) Application of A.V.C. not recommended on short waves.

DEMODULATOR DIODES

Make	Type	Description	Base	Symbol	Filament V.	Filament A.	Cathode Type	Max. applied volts	Max. D.C. Output	Load res. (ave.) M Ω
Philips	KB2	Duo-diode	V	V-1	2.0	0.95	ind.	125 (P)	0.5 mA	0.5
,,	AB2	,,	V	V-1	4.0	0.65	ind.	200 (P)	0.8 mA	0.5
P.M.	EB4	,,	P	P-3	6.3	0.2	ind.	200 (P)	0.8 mA	0.5
Philips	CB1	Universal D.D.	V	V-2	13.0	0.2	ind.	200 (P)	0.8 mA	0.5
Mullard	2D13	,, ,,	V	V-2	13.0	0.2	ind.	200 (P)	0.8 mA	0.5
Osram	D41	Duo-diode	Eng.	—	4.0	0.3	ind.	25 (r.m.s.)	0.13 mA	0.25
S.A.	6H6	Metal D.D.*	octal	O-3	6.3	0.3	ind.	100 (r.m.s.)	2.0 mA	0.5

* also in "G" and "MG" types.

DIODE-TRIODES AND PENTODES

Make	Type	Description	Base	Symb.	Filament		Cath. type	Va	Vsg	Ia mA	Isg mA	Vcg neg	Mutual Cond. μ mhos	Plate resist. ohms	Amp. factor
					V.	A.									
S.A.	1B5/25S	Duo-diode-triode †	6	6-M	2.0	0.06	dir.	135	—	0.8	—	3.0	575	35,000	20
P.M.	KBC1	" " †	P	P-4	2.0	0.1	dir.	135	—	2.5	—	4.5	1000	16,000	16
Mul.	TDD2	Also old KBC1 †	6	6-N	2.0	0.1	dir.	150	—	2.5	—	5.5	1400	12,000	16.5
S.A.	55	Duo-diode-triode	6	6-G	2.5	1.0	ind.	250	—	8.0	—	20.0	1100	7,500	8.3
"	2A6	D.D.-hi-mu triode	6	6-G	2.5	0.8	ind.	250	—	0.8	—	2.0	1100	91,000	100
"	2B7	D.D.-pentode	7 (S)	7-D	2.5	0.8	ind.	250	125	9.0	2.3	3.0	1125	0.65MΩ	730
Mul.	TDD4	Duo-diode triode	7 (L)	7-K	4.0	1.2	ind.	200	—	3.5	—	3.5	2000	15,000	30
Phil.	E454	" " "	7 (L)	7-K	4.0	1.2	ind.	250	—	3.5	—	3.5	1600	19,000	30
"	E444N	Single D.-tetrode	6	6-O	4.0	1.1	ind.	250	110	4.8	1.5	2.3	3000	2.5MΩ	1000
"	ABC1	Duo-diode-triode	P	P-5	4.0	0.65	ind.	250	—	4.0	—	7.0	2000	13,500	27
Osr.	WD40	D.D.-pentode with	Eng.	—	4.0	1.0	ind.	250	100	8.7	3.7	1.0	2600	0.7MΩ	1820
		"remote" cut-off			—	—	—	—	—	—	—	30.0	300	—	—
"	MHD4	Duo-diode-triode	7	—	4.0	1.0	ind.	200	—	3.0	—	3.0	2200	18,200	40
P.M.	EBC3	" " "	P	P-5	6.3	0.2	ind.	250	—	5.0	—	5.5	2000	15,000	30
P.M.	EBF1	D.D.-pentode	P	P-6	6.3	0.3	ind.	250	125	9.0	2.3	3.0	1125	0.65MΩ	730
S.A.	85	Duo-diode-triode	6	6-G	6.3	0.3	ind.	250	—	8.0	—	20.0	1100	7,500	8.3
"	75	D.D.-hi-mu triode	6	6-G	6.3	0.3	ind.	250	—	0.8	—	2.0	1100	91,000	100
"	6B7	D.D.-pentode	7 (S)	7-D	6.3	0.3	ind.	250	125	9.0	2.3	3.0	1125	0.65MΩ	730
Rad.	6B7S	6B7 with extended	7 (S)	7-D	6.3	0.3	ind.	250	100	6.0	1.5	3.0	1100	0.85MΩ	900
		grid control			—	—	—	—	—	—	—	35.0	10	—	—
S.A.	6R7	Metal D.D.-triode *	oct.	O-4	6.3	0.3	ind.	250	—	9.5	—	9.0	1900	8,500	16
"	6Q7	Metal D.D.-triode *	oct.	O-4	6.3	0.3	ind.	250	—	1.1	—	3.0	1200	58,000	70
P.M.	CBC1	Univ. D.D.-triode	P	P-5	13.0	0.2	ind.	200	—	4.0	—	5.0	2000	15,000	30
Osr.	DHD	" " "	Eng.	—	16.0	0.25	ind.	200	—	3.2	—	3.2	2200	18,200	40
"	DH30	" " "	Eng.	—	13.0	0.3	ind.	200	—	2.8	—	2.0	4500	18,000	80
"	WD30	Univ. D.D. pent.	Eng.	—	13.0	0.3	ind.	250	100	8.7	3.7	1.0	2600	0.7MΩ	1820
		with remote cut-off			—	—	—	—	—	—	—	30.0	300	—	—

* also in "G" and "MG" types. † diodes are at each end of filament so that action of one is delayed about 1.0 volt. All characteristics are for amplifier sections only and ratings are, in most cases, the maximums.

"STRAIGHT" R.F. TETRODES AND PENTODES

Make	Type	Description	Base	Symb.	Filament		Cath. type	Va	Vsg	Ia mA	Isg mA	Vcg neg	Mutual Cond. μ mhos	Plate resist. megohms	Amp. factor
					V.	A.									
K.N.S.	15	R.F. pentode	UY	5-E	2.0	0.22	ind.	135	67.5	1.85	0.25	1.5	750	0.8	600
S.A.	32	R.F. tetrode	UX	4-K	2.0	0.06	dir.	180	67.5	1.7	0.4	3.0	650	1.2	780
K.N.S.	1B4	" "	UX	4-K	2.0	0.06	dir.	180	67.5	1.7	0.4	3.0	650	1.2	780
Mul.	PM12A	" "	UX	4-R	2.0	0.18	dir.	150	90	2.8	0.5	2.0	1500	0.33	500
"	SP2	R.F. pentode	6	6-P	2.0	0.2*	dir.	150	150	2.6	0.7	0.5	1700	0.75	1300
Phil.	KF1	" "	6	6-P	2.0	0.2*	dir.	150	150	2.6	0.7	0.5	1700	0.75	1300
P.M.	KF4	" "	P	P-17	2.0	0.05	dir.	135	135	2.6	1.0	zero	800	1.0	800
Osr.	S21	R.F. tetrode	UX	4-R	2.0	0.1	dir.	150	70	2.0	1.5	1.0	1100	0.2	220
"	S23	" "	UX	4-R	2.0	0.1	dir.	150	70	1.4	0.8	2.0	1100	0.25	275
S.A.	57	R.F. pentode	6	6-F	2.5	1.0	ind.	250	100	2.0	0.5	3.0	1225	1.5	1500
Mul.	SP4	" "	7 (L)	7-H	4.0	1.1	ind.	200	100	3.0	1.1	2.0	2500	2.0	5000
Phil.	E446	" "	7 (L)	7-H	4.0	1.1	ind.	200	100	3.0	1.1	2.0	2500	2.0	5000
"	AF7	" "	P	P-7	4.0	0.65	ind.	250	100	3.0	1.1	2.0	2100	2.0	4200
Osr.	MS4B	Catkin R.F. pent.	UY	—	4.0	1.0	ind.	200	80	3.4	1.2	2.0	3200	0.35	1120
"	MSP4	R.F. pentode	Eng.	—	4.0	1.0	ind.	200	100	3.0	1.0	2.0	4000	0.75	3000
P.M.	EF6	" "	P	P-7	6.3	0.2	ind.	250	100	3.0	1.1	2.0	2000	2.5	5000
S.A.	77	" "	6	6-F	6.3	0.3	ind.	250	100	2.3	0.5	3.0	1250	1.5	1500
"	6C6	" "	6	6-F	6.3	0.3	ind.	250	100	2.0	0.5	3.0	1225	1.5	1500
"	6J7	Metal R.F. pent. †	oct.	O-5	6.3	0.3	ind.	250	100	2.0	0.5	3.0	1225	1.5	1500
Osr.	DSB	Univ. R.F. pent.	UY	—	16.0	0.25	ind.	200	80	3.4	1.2	2.0	3200	0.35	1120
Mul.	SP13	" " "	P	P-7	13.0	0.2	ind.	250	100	3.0	1.0	2.0	2200	1.3	3000
Phil.	CF1	" " "	P	P-7	13.0	0.2	ind.	250	100	3.0	1.0	2.0	2200	1.3	3000

* Original rating was 0.18 amp. † also available in "G" and "MG" types.

"VARIABLE-MU" R. F. TETRODES AND PENTODES

Make	Type	Description	Base	Symb.	Filament		Cath. type	Va	Vsg	Ia mA	Isg mA	Vcg neg	Mutual Cond. μ mhos	Plate resist. megohms	Amp. factor
					V.	A.									
S.A.	34	R.F. pentode	UX	4-M	2.0	0.06	dir.	135	67.5	2.8	1.0	3.0	600	0.6	360
			—		—	—	—	—	—	—	—	22.5	15	—	—
K.N.S.	1A4	R.F. tetrode	UX	4-K	2.0	0.06	dir.	180	67.5	2.3	0.7	3.0	750	0.96	720
		"short-base"	—		—	—	—	—	—	—	—	15.0	15	—	—
Rad.	1C4	R.F. pentode	UX	4-M	2.0	0.12	dir.	135	67.5	2.5	0.9	zero	1000	0.8	800
		"short-base"	—		—	—	—	—	—	—	—	16.0	4	—	—
Rad.	1C4	"Economy" rating	—		2.0	0.12	—	135	30.0*	0.65	0.25	zero	600	2.54	1525
			—		—	—	—	—	—	—	—	16.0	4	—	—
Mul.	PM12M	R.F. tetrode	UX	4-R	2.0	0.18	dir.	150	90	2.4	0.5	zero	1400	—	—
		"short-base"	—		—	—	—	—	—	—	—	9.0	14	—	—
"	VP2	R.F. pentode	6	6-P	2.0	0.2†	dir.	150	150	3.7	1.0	0.5	1700	0.5	900
			—		—	—	—	—	—	—	—	16.0	.5	—	—
Phil.	KF2	" "	6	6-P	2.0	0.2†	dir.	150	150	3.7	1.0	0.5	1700	0.5	900
			—		—	—	—	—	—	—	—	16.0	5	—	—
P.M.	KF3	" "	P	P-17	2.0	0.05	dir.	135	135	2.0	0.6	zero	650	1.3	850
		"short-base"	—		—	—	—	—	—	—	—	15.0	2	—	—
Osr.	VS24	" "	UX	4-R	2.0	0.15	dir.	150	75	4.4	0.3	zero	1500	—	—
			—		—	—	—	—	—	—	—	9.0	16	—	—
S.A.	58	" "	6	6-F	2.5	1.0	ind.	250	100	8.2	2.0	3.0	1600	0.8	1280
			—		—	—	—	—	—	—	—	40.0	10	—	—
Mul.	VP4	" "	7 (L)	7-H	4.0	1.1	ind.	200	100	4.5	1.8	2.0	2000	1.0	2000
			—		—	—	—	—	—	—	—	35.0	10	—	—
Phil.	E447	" "	7 (L)	7-H	4.0	1.1	ind.	250	100	4.5	1.8	2.0	2000	1.0	2000
		"long-base"			—	—	—	—	—	—	—	35.0	5	—	—
"	AF2	" "	7 (L)	7-H	4.0	1.1	ind.	250	100	4.25	1.5	2.0	2500	1.4	3500
		"short-base"	—		—	—	—	—	—	—	—	20.0	5	—	—
"	AF3	" "	P	P-7	4.0	0.65	ind.	250	100	8.0	2.6	3.0	1800	1.2	2200
			—		—	—	—	—	—	—	—	45.0	2	—	—
Osr.	VMP4G	" "	Eng.	—	4.0	1.0	ind.	250	100	8.0	5.0	2.0	2700	—	—
		"short-base"	—	—	—	—	—	—	—	—	—	20.0	10	—	—
"	VMS4	Catkin R.F. pent.	UY	—	4.0	1.0	ind.	200	80	10.0	2.0	1.0	2600	—	—
			—		—	—	—	—	—	—	—	30.0	30	—	—
P.M.	EF5	R.F. pentode	P	P-7	6.3	0.2	ind.	250	100	8.0	2.5	3.0	1700	1.2	2000
					—	—	—	—	—	—	—	50.0	2	—	—
S.A.	78	" "	6	6-F	6.3	0.3	ind.	250	100	7.0	1.7	3.0	1450	0.8	1160
			—		—	—	—	—	—	—	—	42.5	2	—	—
"	6D6	" "	6	6-F	6.3	0.3	ind.	250	100	8.2	2.0	3.0	1600	0.8	1280
			—		—	—	—	—	—	—	—	40.0	10	—	—
"	6K7	Metal R.F. pent. **	oct.	O-5	6.3	0.3	ind.	250	100	7.0	1.7	3.0	1450	0.8	1160
			—		—	—	—	—	—	—	—	42.5	2	—	—
"	6L7	Pentagrid Mixer**	oct.	O-6	6.3	0.3	ind.	250	100	5.3	5.5	3.0	1100	0.8	880
		as amplifier ††	—		—	—	—	—	—	—	—	15.0	5	—	—
"	6F7	Pentode section	7(S)	7-E	6.3	0.3	ind.	250	100	6.5	1.5	3.0	1100	0.85	900
		as R.F. amplifier			—	—	—	—	—	—	—	35.0	10	—	—
Mul.	VP13A	Univ. R.F. pentode	P	P-7	13.0	0.2	ind.	250	100	4.5	1.5	2.0	2200	1.0	2200
		"short-base"			—	—	—	—	—	—	—	20.0	5	—	—
Phil.	CF2	" "	P	P-7	13.0	0.2	ind.	250	100	4.5	1.5	2.0	2200	1.0	2200
					—	—	—	—	—	—	—	20.0	5	—	—
Osr.	VDS	Univ. R.F. pentode	UY	—	16.0	0.25	ind.	200	80	10.0	1.0	1.0	2400	—	—
					—	—	—	—	—	—	—	30.0	13	—	—
"	W30	Catkin Univ. R.F.	Eng.	—	13.0	0.3	ind.	250	250	12.3	6.0	1.0	4000	—	—
		pentode			—	—	—	—	—	—	—	30.0	1	—	—
"	W31	Univ. R.F. pentode	Eng.	—	13.0	0.3	ind.	250	100	8.0	5.0	2.0	2700	—	—
					—	—	—	—	—	—	—	20.0	10	—	—

* 67.5 volts through 150,000 ohm dropping resistor. † Originally rated at 0.18 ampere. ** Also in "G" and "MG" types.
†† Control voltage applied to G1 and G3.

OUTPUT PENTODES

Make	Type	Class of Service	Symbol	Filament V.	Filament A.	Cath type	Va	Vsg	Ia mA	Isg mA	Vcg neg.	Type bias	Mut. Cond. µmhos	Amp. fact.	Opt. load ohms	Power Output W.	Total dist. %	Max. grid res. megs.
S.A.	33	Class "A"	5-B	2.0	0.26	dir.	135	135	14.5	3.0	13.5	F	1450	70	7,000	0.7	7.0	0.5
				—	—	—	—	—	—	—	—	S	—	—	—	—	—	1.0
Rad.	1D4	,, ,,	5-B	2.0	0.24	dir.	135	135	6.0	1.5	4.5	F	2150	330	15,000	0.35	12.0	0.5
,,	,,	,, ,,		,,	,,	,,	157	157	9.0	2.2	4.5	F	2400	300	15,000	0.5	7.0	0.5
Syl.	1F4	,, ,,	5-B	2.0	0.12	dir.	135	135	8.0	2.6	4.5	F	1700	340	16,000	0.34	5.0	0.5
Ken.	950	Tentative	5-B	2.0	0.12	dir.	135	135	5.5	2.0	16.5	F	950	100	13,500	0.45	7.0	0.5
Osr.	PT2	Class "A"	5-B	2.0	0.2	dir.	150	150	6.5	1.9	4.5	F	—	—	17,000	0.5	—	0.5
Mul.	PM22	,, ,,	5-B	2.0	0.3	dir.	150	150	15.0	4.0	10.5	F	1300	—	8,000	0.6	—	0.5
,,	PM22A	,, ,,	5-B	2.0	0.2	dir.	135	135	7.5	1.5	4.5	F	2300	200	15,000	0.3	4.0	0.5
,,	,,	,, ,,	,,	,,	,,	,,	150	150	9.0	2.5	4.5	F	2500	180	15,000	0.45	4.0	0.5
Phil.	C243N	,, ,,	5-B	2.0	0.2	dir.	150	150	9.5	2.0	4.5	F	2400	180	15,000	0.58	—	0.5
P.M.	KL4	,, ,,	P-10	2.0	0.14	dir.	135	135	7.0	1.0	5.0	F	2100	200	19,000	0.44	—	0.5
S.A.	2A5	,, ,,	6-B	2.5	1.75	ind.	250	250	34.0	6.5	16.5	F	2200	220	7,000	3.0	7.0	0.1
				—	—	—	—	—	—	—	—	S	—	—	—	—	—	1.0
Mul.	P.4VA	,, ,,	7-J	4.0	1.35	ind.	250	250	36.0	3.2	22.0	S	2700	100	8,000	3.0	7.5	1.0
Phil.	E463	,, ,,	7-J	4.0	1.35	ind.	250	250	36.0	3.2	22.0	S	2700	100	8,000	3.0	7.5	1.0
,,	E443H	,, ,,	5-B	4.0	1.1	dir.	250	250	36.0	6.8	14.0	S	3000	130	7,000	3.0	7.5	1.0
,,	F443N	High-power	5-B	4.0	2.0	dir.	300	300	83.0	4.6	40.0	F	3900	80	3,500	12.9	10.0	0.1
		Class "A"		—	—	—	—	—	—	—	—	S	—	—	—	—	—	0.3
,,	,,	,, ,,		,,	,,	,,	550	200	45.0	1.4	30.0	F	3200	100	12,000	13.4	10.0	0.1
				—	—	—	—	—	—	—	—	S	—	—	—	—	—	0.3
,,	AL2	Class "A"	P-11	4.0	1.0	ind.	250	250	36.0	5.0	25.0	F	2600	100	7,000	4.5	11.0	0.3
				—	—	—	—	—	—	—	—	S	—	—	—	—	—	0.7
,,	AL3	High-mu	P-12	4.0	1.85	ind.	250	250	36.0	4.0	6.0	F	9500	—	7,000	4.5	10.0	0.4
		Class "A"		—	—	—	—	—	—	—	—	S	—	—	—	—	—	1.0
Osr.	MPT4	Catkin "A"	5-B	4.0	1.0	ind.	250	250	32.0	8.0	13.0	S	—	—	9,000	3.2	7.0	1.0
,,	PT16	Class "A"	5-B	4.0	1.0	dir.	300	300	53.0	10.0	15.0	S	—	—	5,000	6.3	7.0	0.5
,,	PT25H	High-power	5-B	4.0	2.0	dir.	400	400	62.5	12.5	16.0	S	6500	180	4,000	12.5	7.0	0.1
,,	,,	,,		,,	,,	,,	300	300	62.5	12.0	11.0	S	6500	180	3,500	9.5	7.0	0.1
,,	N41	High-mu	—	4.0	2.0	ind.	250	200	32.0	8.0	3.5	S	10000	210	7,800	4.0	7.0	0.5
,,	DN41	D.D. Pen.*	—	4.0	2.3	ind.	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
P.M.	EL2	Class "A"	P-11	6.3	0.2	ind.	250	250	32.0	5.0	18.0	S	2800	—	8,000	3.6	—	0.7
,,	EL3	High-mu	P-12	6.3	1.2	ind.	250	250	36.0	4.0	6.0	S	9,	—	7,000	4.4	—	1.0
,,	EL5	High-power	P-12	6.3	1.3	ind.	250	250	72.0	7.5	16.0	S	7000	—	3,500	7.7	—	0.5
S.A.	41	Class "A"	6-B	6.3	0.3	ind.	180	180	18.5	3.0	13.5	S	1850	150	9,000	1.5	10.0	1.0
,,	42	,, ,,	6-B	6.3	0.7	ind.	250	250	34.0	6.5	16.5	S	2200	220	7,000	3.0	7,0	1.0
,,	42	2 tubes "AB"	—	—	—	—	375	250	—	—	26.0	F	—	—	10,000	19.0	5.0	(A)
,,	,,	,, ,,		—	—	—	400	275	—	—	340Ω	S	—	—	10,000	19.0	5.0	(B)
,,	6A4/	"A" D.C. fil.†	5-B	6.3	0.3	dir.	180	180	22.0	3.9	12.0	S	2200	100	8,000	1.4	7.0	0.5
	LA	"A" A.C. fil.		,,	,,	,,	,,	,,	,,	,,	16.0	S	,,	,,	,,	,,	,,	,,
,,	6F6	Metal	O-8	6.3	0.7	ind.	315	315	42.0	8.0	22.0	S	2650	200	7,000	5.0	7.0	0.5
	,,			,,	,,	,,						F						0.05
	,,	,,		,,	,,	,,	250	250	34.0	6.5	16.5	S	2500	200	7,000	3.0	7.0	0.5
,,	6F6	2 tubes "AB"	—	—	—	—	**	**	**	**	**	**	**	**	**	**	**	**
Osr.	N30	Catkin uni.	—	13.0	0.3	ind.	250	250	32.0	8.0	15.0	S	3900	—	7,500	3.0	7.0	0.5
,,	N31	Universal	—	13.0	0.3	ind.	200	180	40.0	10.6	4.4	S	10000	—	5,500	4.0	7.0	0.5
,,	DPT	,,	—	16.0	0.25	ind.	200	200	40.0	6.5	10.0	S	—	—	8,000	2.0	7.0	0.5
Mul.	P.26	,,	P-11	24.0	0.2	ind.	250	100	40.0	5.0	19.0	S	3100	70	7,000	3.0	7.0	0.7
Phil.	CL2	,,	P-11	24.0	0.2	ind.	250	100	40.0	5.0	19.0	S	3100	70	7,000	3.0	7.0	0.7
,,	CL4	High-mu.	P-11	33.0	0.2	ind.	250	250	36.0	4.5	13.0	S	7500		7,000	4.0	10.0	1.0
,,	CL4	High-mu.	P-11	33.0	0.2	ind.	200	200	45.0	6.0	8.5	S	8000		4,500	4.0	10.0	1.0
S.A.	43	Universal	6-B	25.0	0.3	ind.	180	135	40.0	8.0	20.0	S	2400	96	5,000	2.75	10.0	0.3
,,	25A6	Metal uni.	O-8	25.0	0.3	ind.	180	135	40.0	8.0	20.0	S	2400	96	5,000	2.75	10.0	0.3

* Type DN41 is a pentode of the N41 type, but with two demodulator diodes incorporated in the assembly.
† Type 6A4/LA bias ratings depend on fil. supply. D.C. bias is to neg. end of fil. "A.C." rating is to C.T. of fil.
(A) With 42 triode driver and 3.32 : 1 step-down (each half) P.P. trans. (B) with 2.5 : 1 (each half) P.P. trans.
** Class "AB" ratings for 6F6 are same as for type 42.

CLASS "B" OUTPUT STAGES

Make	Type	Description	Symbol	Filament V.	Filament A.	Cath. type	Va	Ia zero signal mA	Ia max. signal mA	Vcg (fixed) neg	Load resist. P. to P. ohms	Driver power or tube	Power output W.
S.A.	19	Twin-triode	6-C	2.0	0.26	dir.	135	10.0	—	zero	10,000	170 mW	2.1
,,	,,	,, ,,	,,	,,	,,	,,	135	4.0	—	3.0	10,000	130 mW	1.9
,,	,,	,, ,,	,,	,,	,,	,,	135	1.0	—	6.0	10,000	95 mW	1.6
,,	,,	1 watt rating (1)	,,	,,	,,	,,	135	1.3	13.6	4.5	20,000	T.30 (A)	1.0
,,	30	two tubes (triodes)	4-D	2.0	0.12	dir.	157.5	1.0	—	15.0	8,000	T.30 (B)	2.1
,,	,,	1 watt rating (1)	—	—	—	—	135	1.6	15.4	12.0	20,000	T.30 (C)	1.0
,,	49	two tubes (grids of each tube together)	5-C	2.0	0.24	dir.	180	4.0	50	zero	12,000	T.49 (D)	3.5
,,	,,		,,	,,	,,	,,	135	2.6	—	zero	8,000	T.49 (D)	2.3
Mul.	PM2BA	Twin-triode	6-C	2.0	0.2	dir.	150	3.0	—	6.0	14,000	100 mW	1.45
,,	PM2B	,, ,,	6-C	2.0	0.2	dir.	150	3.0	—	zero	14,000	100 mW	1.45
Phil.	B240	,, ,,	6-C	2.0	0.2	dir.	150	3.0	21	zero	14,000	B217	1.9
,,	KDD1	,, ,,	P-16	2.0	0.22	dir.	135	3.0	40	zero	10,000	KC3*	2.0
Osr.	B21	,, ,,	6-C	2.0	0.2	dir.	150	2.2	—	6.0	12,000	100 mW	1.5
,,	QP21	Twin-pentode	—	2.0	0.4	dir.	150	4.3	30	10.5	24,000	—	1.0
S.A.	46	two tubes (grids of each tube together)	5-C	2.5	3.5	dir.	400	12.0	120	zero	5,800	T.46 (E)	20.0
,,	,,		—	—	—	—	300	8.0	—	zero	5,200	T.46 (F)	16.0
,,	53	Twin-triode	7-B	2.5	2.0	ind.	300	35.0	65	zero	10,000	53 (G)	10.0
,,	,,	,, ,,	,,	,,	,,	,,	250	28.0	—	zero	8,000	53 (G)	8.0
,,	6A6	Twin-triode	7-B	6.3	0.8	ind.	(53)	(53)	(53)	(53)	(53)	6A6 (G)	(53)

All values given are for two tubes, including filament current.
(1) Special operating conditions suggested by A.W.V. Co. Use of high load res. value limits useable power output to one watt, reduces peak plate current and eliminates low-volume distortion rise.
(A) With type 30 as driver (135V. "B"; 10.5 V. "C") and 2.2 : 1 (each half) transformer. (B) With type 30 as driver, (157.5 V. "B"; 11.3 V. "C") and 1.165 : 1 (each half) transformer. (C) With type 30 as driver (135 V. "B"; 9 V. "C") and 1.8 : 1 (each half) transformer. (D) With type 49 as triode driver or other tube capable of delivering 170 mW. (E) With type 46 as triode driver, or other tube capable of delivering 650 mW., and 2.2 : 1 (each half) input transformer. (F) With type 46 as triode driver or other tube capable of delivering 950 mW., and 2.2 : 1 (each half) transformer. (G) With type 53 or 6A6 as single-triode driver, or other tube capable of delivering 350 mW., and 5.0 : 1 (each half) transformer.
* Type KC3 is specially designed to act as driver for KDD1. Use of triode section of KBC1 as driver will result in reduction of power output to half.

SPECIAL TYPES AND APPLICATIONS

Make	Type	Description	Symbol	Filament V.	Filament A.	Cath. type	Va	Vsg	Ia mA	Isg mA	Vcg neg	Mut. Cond. µmhos	General
Rad.	864	Non-mic. amp. triode	4-D	1.1	0.25	dir.	135	—	4.5	—	9.0	645	Rp—12,700Ω A. Fact.—8.2
Osr.	A537	,, ,, ,, ,,	—	4.0	0.4	ind.	150	—	3.3	—	6.0	1550	Rp—10,000Ω A. Fact.—15.5
,,	"T"	Electrometer triode	—	1.0	0.1	dir.	6.0	—	—	—	2.0	80	Input cap. 1.6 mmfd.
,,	,,	,, ,,	—	—	—	—	4.0	—	—	—	2.0	40	Grid. ins. 10^{15} ohms
Rad.	955	U.H.F. "Acorn" triode	—	6.3	0.15	ind.	180	—	4.5	—	5.0	2000	Rp—20,000Ω A. Fact.—25
,,	954	U.H.F. "Acorn" pentode	—	6.3	0.15	ind.	250	100	2.0	0.7	3.0	1400	Rp—1.5 MΩ A. Fact.—2000
,,	6L6	"Beam" power tube	O-9	6.3	0.9	ind.	250	250	72.0	5.0	14.0	6000	Load—2500Ω. 6.5 watts*
,,	,,	2 tubes, Class "A"	—	—	—	—	250	250	120.0	10.0	16.0	—	Load—5000Ω. 14.5 watts*
S.A.	6E5	Cathode-ray tuning indicator	6-R	6.3	0.3	ind.	†	250	0.25	4.5	zero	—	Shadow angle, 90 deg.
			—	—	—	—	—	—	—	—	8.0	—	,, ,, 0 ,,
N.	6G5	6E5 with extended control range	6-R	6.3	0.3	ind.	†	250	0.25	4.5	zero	—	,, ,, 90 ,,
			—	—	—	—	—	—	—	—	22.0	—	,, ,, 0 ,,
Rad.	6B7S	as A.F. amp. (R.C.)	7-D	6.3	0.3	ind.	250	24	—	—	2.0	—	Stage gain 60. Note (1)
S.A.	6Q7	as A.F. amp. (R.C.)	O-4	6.3	0.2	ind.	250	—	0.35	—	1.9	—	,, ,, 45. Note (2)
,,	75	or 2A6, as A.F. amp (R.C.)	—	—	—	—	250	—	0.41	—	1.3	—	,, ,, 50. Note (3)
,,	1B5	as A.F. amp. (R.C.)	—	—	—	—	135	—	0.23	—	1.5	—	,, ,, 16.5. Note (4)

* Fixed bias operating conditions and ratings.
† From 250 volt plate supply through 1 meg resistor. Values in screen grid column are target ratings.
(1) Plate voltage given is actual supply voltage. Is applied through 0.25 meg. load resistor. Screen voltage is obtained from voltage divider using 1 megohm and 0.25 megohm resistors in series across max. "B" supply. Half of A.V.C. voltage is applied to grid through decoupling resistor. Bias resistance required is 2500 ohms. Grid res. of following valve should be 1 megohm.
(2) Plate supply of 250 volts applied through 0.25 meg. load resistance. Bias resistance, 5000 ohms. 0.5 meg. grid res. on following valve.
(3) Plate supply, 250 volts, applied through load resistance of 0.25 meg. Bias resistance, 3000 ohms. 0.25 grid res. on following valve.
(4) Plate supply, 135 volts, applied through load resistance of 0.25 meg. 1 megohm grid resistance on following valve.

RECTIFIERS

Make	Type	Application	Symbol	Filament V.	Filament A.	Cath. Type	Max. H. to C. Volts	Max. P.I. Volts	Max. R.M.S. Volts (plate)	D.C. output Volts	D.C. output mA.	Conditions
Osr.	U16	For Cath. ray power	—	2.0	0.25	dir.	—	—	5000	6800	2.0	H.W. condenser input
Rad.	878	” ” ” ”	4-P	2.5	5.0	dir.	—	20,000	7100	—	5.0	” ” ”
”	879	” ” ” ”	4-P	2.5	1.75	dir.	—	7500	2650	—	7.5	” ” ”
Osr.	U12	Full-wave vacuum	4-C	4.0	2.5	dir.	—	—	350	325	120	Condenser input
”	MU12	” ” ”	4-L	4.0	2.5	ind.	—*	—	350	—	120	” ”
”	U14	” ” ”	4-C	4.0	2.5	dir.	—	—	500	540	120	” ”
”	MU14	” ” ”	4-L	4.0	2.5	ind.	—*	—	500	—	120	” ”
Mul.	D4	” ” ”	4-C	4.0	2.0	dir.	—	—	500	500	120	” ”
Phil.	1561	” ” ”	4-C	4.0	2.0	dir.	—	—	500	500	120	” ”
Mul.	1W3	” ” ”	4-L	4.0	2.4	ind.	—*	—	350	350	120	” ”
Phil.	1867	” ” ”	4-L	4.0	2.4	ind.	—*	—	350	350	120	” ”
”	AZ3	” ” ”	P-14	4.0	1.85	ind.	—*	—	385	375	120	” ”
S.A.	80	” ” ”	4-C	5.0	2.0	dir.	—	—	350	330	125	” ”
”	”	” ” ”	”	”	”	”	”	”	400	390	110	” ”
”	”	” ” ”	”	”	”	”	”	”	500	460	100	1 mfd. max. cond.
”	”	” ” ”	”	”	”	”	”	”	400	280	125	20 H. Choke input
”	”	” ” ”	”	”	”	”	”	”	550	430	135	” ” ”
”	83	Full-wave mercury	4-C	5.0	3.0	”	—	1400	500	485	250	10 H. Choke input
”	83v	” ” vacuum	4-L	5.0	2.0	ind.	—*	—	400	470	200	8 mfd. max. cond.
”	”	” ” ”	”	”	”	”	”	”	500	430	250	10 H. Choke input
”	5Z2	” ” ”	4-C	5.0	3.0	dir.	—	—	500	475	250	Condenser input
”	”	” ” ”	”	”	”	”	”	”	500	360	250	10 H. Choke input
”	5Y3	F.W.V. “ G ” series	O-13	5.0	2.0	dir.	—	—	(80)	(80)	(80)	(80)
”	5Z4	F.W.V. metal	O-10	5.0	2.0	ind.	—*	1100	400	470	125	8 mfd. max. cond.
Phil.	EZ2	Full-wave vacuum	P-14	6.3	0.25	ind.	—*	—	350	350	60	condenser input
P.M.	EZ3	” ” ”	P-14	6.3	0.65	ind.	—*	—	350	350	100	” ”
P.M.	EZ4	” ” ”	P-14	6.3	0.9	ind.	—*	—	350	350	175	” ”
S.A.	IV	Half-wave vacuum	4-G	6.3	0.3	ind.	500	1000	350	380	50	4 mfd. condenser
”	”	” ” ”	”	”	”	”	”	”	250	250	50	” ”
”	84/	Types interchangeable	5-D	6.3	0.5	ind.	500	1000	200	225	50	” ”
”	6Z4	Full-wave vacuum							350	430	50	” ”
”	6X5	F.W.V. metal	O-11	6.3	0.6	ind.	500	1250	375	450	75	” ”
”	12Z3	Half-wave vacuum	4-G	12.6	0.3	ind.	350	700	250	270	60	8 mfd. condenser
”	25Z5	Half-wave vacuum†	6-E	25.0	0.3	ind.	—	350	125	100	100	16 mfd. condenser
”	”	Voltage doubler	—	—	—	—	—	—	125	180	100	2-16 mfd. condensers
”	25Z6	25Z5 in metal shell†	O.12	25.0	0.3	ind.	—	—	125	100	85	16 mfd. condenser
K.N.	25Y5	Half-wave vacuum†	6-E	25.0	0.2	ind.	—	—	250	270	85	8 mfd. condenser
Osr.	U30	” ” ”	—	26.0	0.3	ind.	—	—	250	220	120	” ”
Mul.	UR2	” ” ” †	P-15	30.0	0.2	ind.	350	—	250	270	120	Condenser input
Phil.	CY2	” ” ” †	P-15	30.0	0.2	ind.	350	—	250	270	120	” ”

* These tubes have the cathode connected either to the heater internally or direct at the socket.
† These tubes have independent twin cathodes and anodes and may be used as full-wave, half-wave or voltage doubler units.
H. to C.—heater to cathode P.I.—peak inverse.

AMPLIFIER TRIODES

Make	Type	Application	Base	Symbol	Filament V.	Filament A.	Cathode type	Va	Vcg neg	Ia mA	Mutual Cond. μ mhos	Plate resistance ohms	Amp. factor
Osram	H11	midget	spec.	—	1.0	0.1	dir.	60	2.0	0.6	500	30,000	15
”	L11	midget	spec.	—	1.0	0.1	dir.	60	7.5	1.3	400	12,500	5
S.A.	30	gen. purpose	UX	4-D	2.0	0.06	dir.	180	13.5	3.1	900	10,300	9.3
Mul.	PM1HL	”	UX	4-D	2.0	0.1	dir.	150	3.0	2.0	1400	20,000	28
”	PM2DX	”	UX	4-D	2.0	0.1	dir.	150	4.5	4.0	1500	12,000	18
Phil.	B217	”	UX	4-D	2.0	0.1	dir.	150	4.0	4.0	1300	13,000	17
P.M.	KC3	”	P	P-1	2.0	0.21	dir.	135	2.8	3.0	2500	12,000	30
Osram	HL2	”	UX	4-D	2.0	0.1	dir.	150	3.0	2.0	1500	18,000	27
”	L21	”	UX	4-D	2.0	0.1	dir.	150	6.0	2.2	1800	8,900	16
S.A.	56	”	UY	5-A	2.5	1.0	ind.	250	13.5	5.0	1450	9,500	13.8
”	53	as driver	7	7-B	2.5	2.0	ind.	294	6.0	7.0	3200	11,000	35
Phil.	E424	gen. purpose	UY	5-A	4.0	1.0	ind.	200	6.0	6.0	1800	13,000	24
”	AC2	”	P	P-2	4.0	0.65	ind.	250	5.5	6.0	2500	12,000	30
Mul.	164V	”	UY	5-A	4.0	1.0	ind.	200	8.5	8.5	3300	4,850	16
”	354V	”	UY	5-A	4.0	1.0	ind.	200	4.0	4.0	3500	10,000	35
Osram	MH4	” *	UY	5-A	4.0	1.0	ind.	200	3.0	4.5	3600	11,100	40
”	MHL4	”	UY	5-A	4.0	1.0	ind.	200	6.0	8.0	2500	8,000	20
”	MH41	high-mu	UY	5-A	4.0	1.0	ind.	200	1.5	5.0	6000	13,300	80
S.A.	76	gen. purpose	UY	5-A	6.3	0.3	ind.	250	13.5	5.0	1450	9,500	13.8
”	6A6	as driver	7	7-B	6.3	0.8	ind.	294	6.0	7.0	3200	11,000	35
”	6C5	metal G.P. **	octal	O-1	6.3	0.3	ind.	250	8.0	8.0	2000	10,000	20
”	6F5	metal hi-mu **	octal	O-2	6.3	0.3	ind.	250	2.0	0.9	1500	66,000	100
Osram	DH	universal	Y	5-A	16.0	0.25	ind.	200	3.0	6.0	3700	10,800	40
”	H30	”	Y	5-A	13.0	0.3	ind.	250	1.7	5.5	6000	13,300	80
Phil.	CC1	”	P	P-2	13.0	0.2	ind.	200	3.7	4.6	3000	18,000	50
Mul.	HL13	”	P	P-2	13.0	0.2	ind.	200	3.7	4.6	3000	18,000	50

* Osram MH4 is also available in “ Catkin ” type with identical characteristics.
** also in “ G ” and “ MG ” types.

Valve Socket Connections

Undersocket Connections are Given in Each Case

Electrode Designations

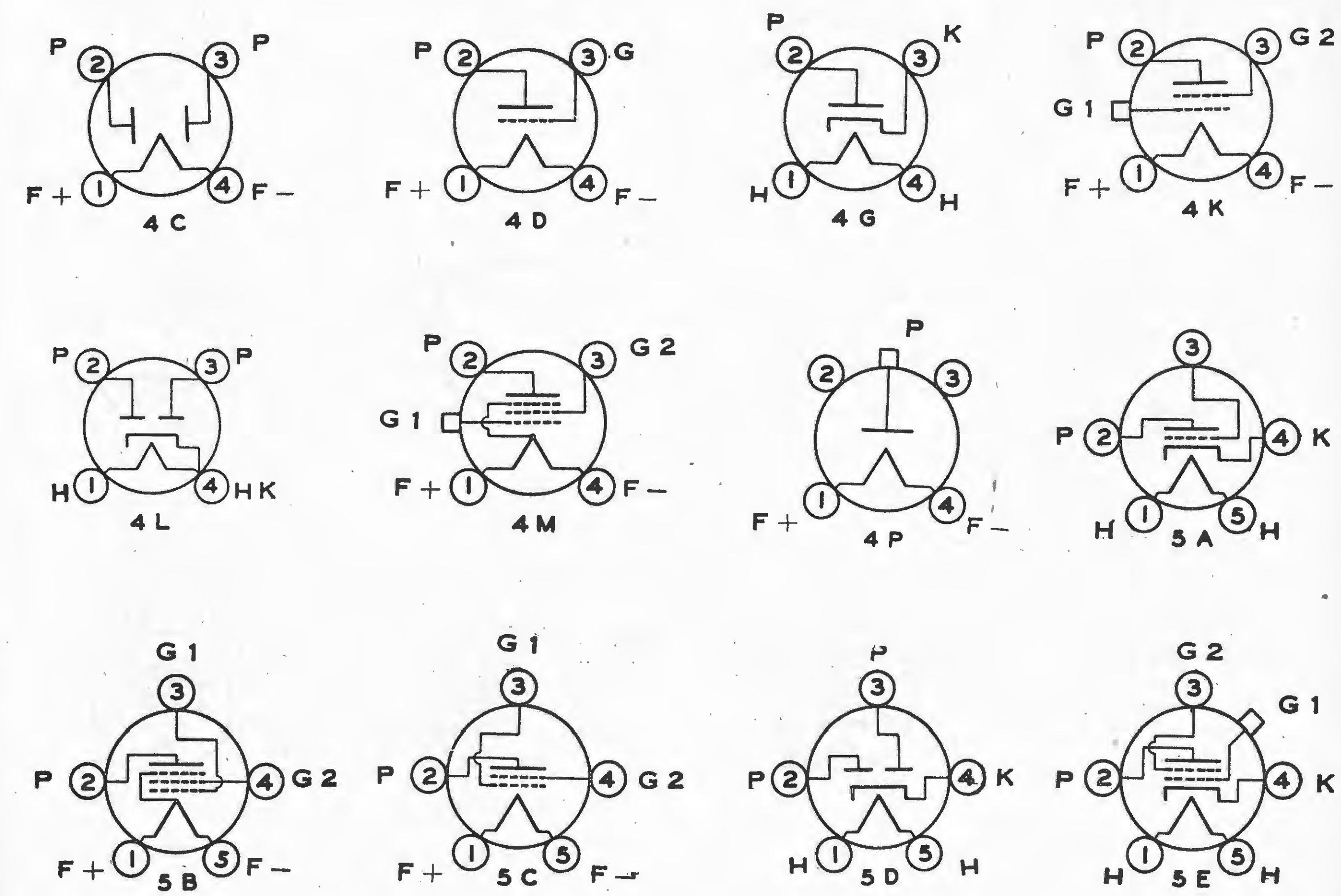
It will be noted that the electrode connection is named in many of the Continental tube type illustrations. In others, and all of the American types, an electrode index number is used. The following is a key to these index numbers.

- **H** — Heater or filament.
- **K** — Cathode.
- **P** — Plate.
- **G** — Control grid.
- **S** — Metal Shell (octal types only).
- **D** — Diode plate.
- **G1** — Control grid in pentodes and tetrodes. Osc. control grid in pentagrids and octodes.
- **G2** — Screen or auxiliary grid in pentodes and tetrodes. Osc. anode grid in pentagrids and octodes.
- **G3** — Suppressor grid in pentodes. First section of screen grid in pentagrids and octodes.
- **G4** — Control grid in pentagrids and octodes.
- **G5** — Second section of screen grid in pentagrids and octodes. Internally connected to G3.
- **G6** — Suppressor grid in octodes.

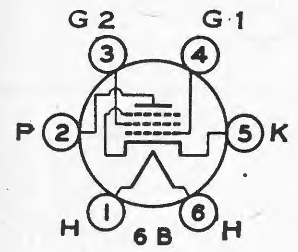
Type 6L7 (octal based pentagrid mixer) is an exception to the above, and in this tube G1 is the control grid: G2 and G4 form the screen grid; G3 is the oscillator voltage injection or auxiliary control grid, and G5 is connected internally to the cathode. Twin tubes (such as the 19, B240, 6A6, 6E6, 53, etc.), have the corresponding plate and grid connections clearly shown as Ga and Gb, Pa and Pb, or, in the case of the Continental type KDD1, as "grid, triode 1; grid, triode 2," so no difficulty should be experienced in sorting out the various electrodes.

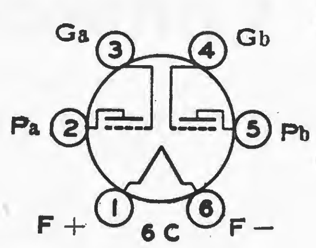
Care must be exercised in the connection of battery type duo-diode-triodes as these tubes are arranged so that the action of one diode is delayed (for A.V.C. rectifier application). The filament polarity is clearly marked in the socket illustration, and the delayed diode is the one nearest the positive end of the filament. This will be evident from an inspection of the symbol for the tube type under consideration.

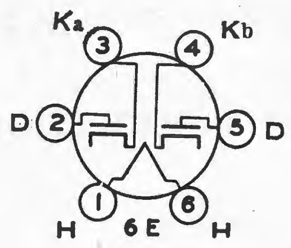
AMERICAN TYPES — 4C to 4P and 5A to 5E

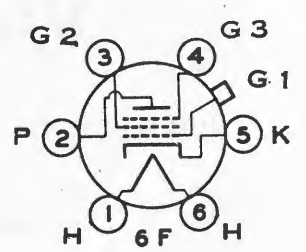


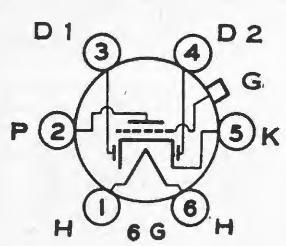
AMERICAN TYPES — 6B to 6M, 6R, 6S, 7B to 7E, and 0-1 to 0-7.

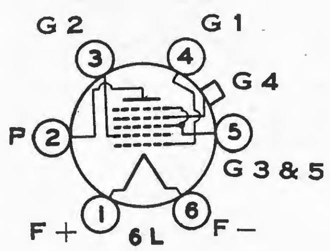


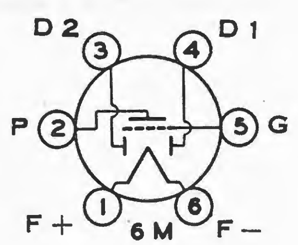


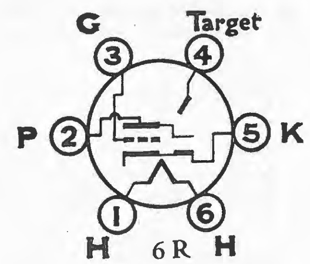


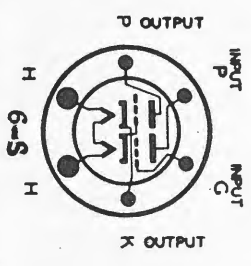


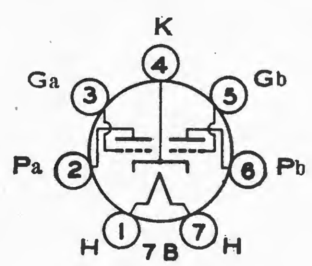


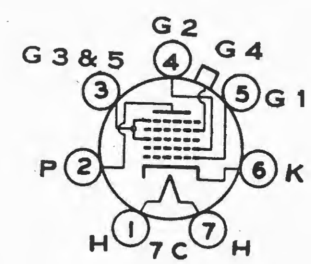


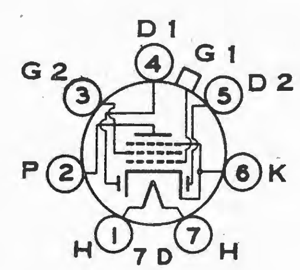


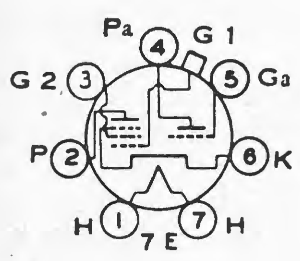


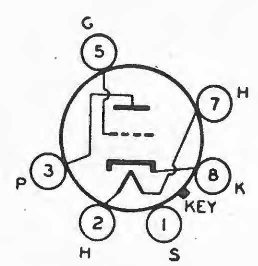




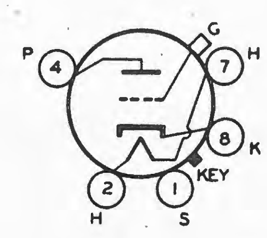




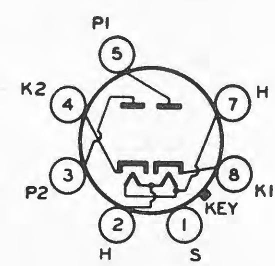




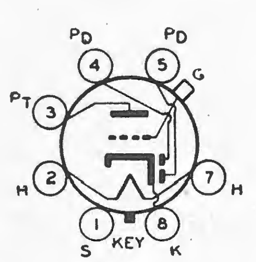
0-1



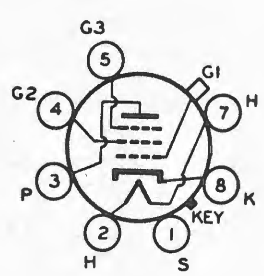
0-2



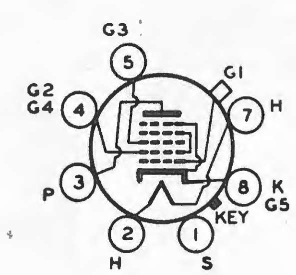
0-3



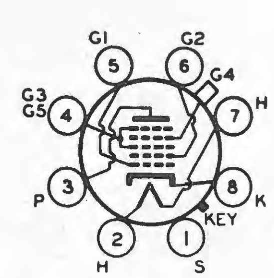
0-4



0-5

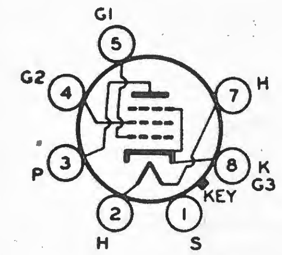


0-6

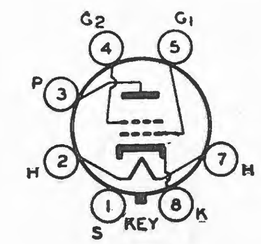


0-7

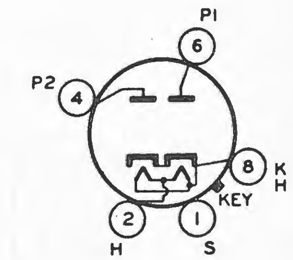
AMERICAN OCTAL BASED TYPES —— 0-8 to 0-13.



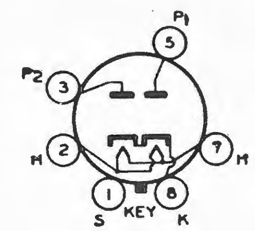
0-8



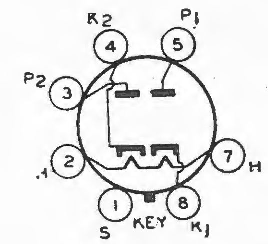
0-9



0-10



0-11

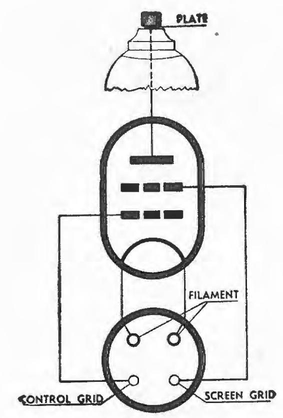


0-12

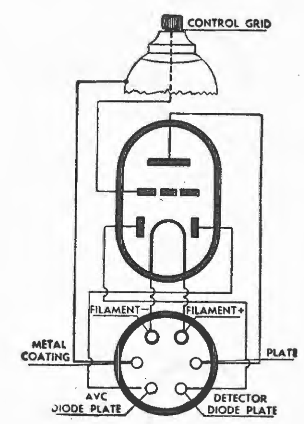
Socket connections for type 5Y3 are the same as for type 5Z4 the only difference being that the shell connection (No. 1) is left blank.

0-13

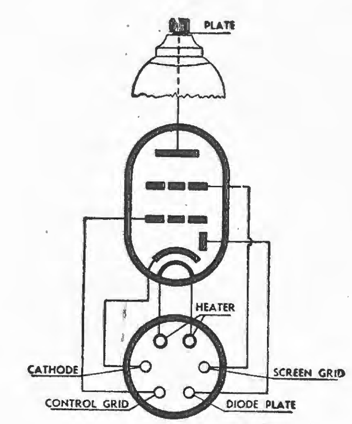
CONTINENTAL TYPES WITH STANDARD AMERICAN BASES—Types 4R, 6N & 6P



4 R



6 N

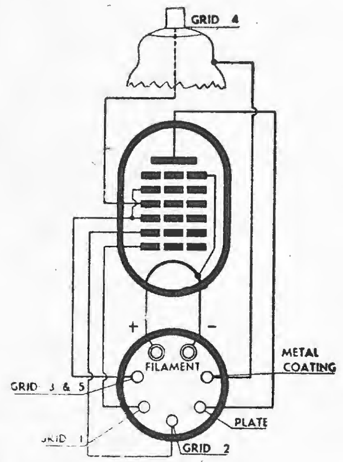


6 P

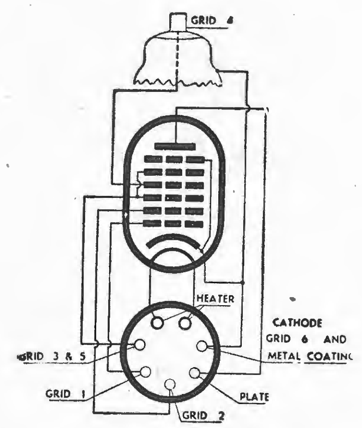
CONTINENTAL TYPES with S.A. bases — 7F to 7K.

PHILIPS & MULLARD TYPES with "V" bases — V-1, V-2.

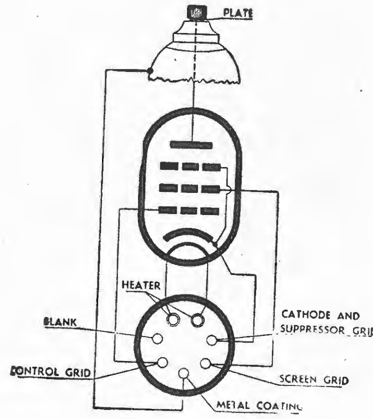
PHILIPS & MULLARD TYPES with "P" bases — P-1, P-2.



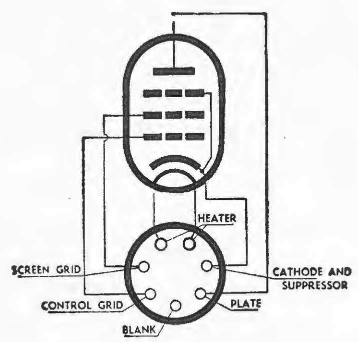
7 F



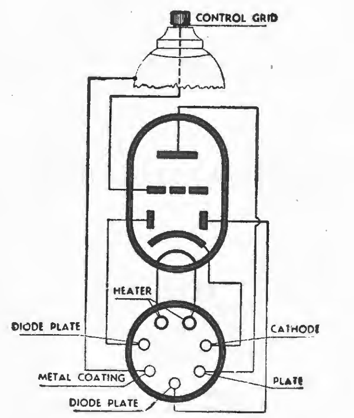
7 G



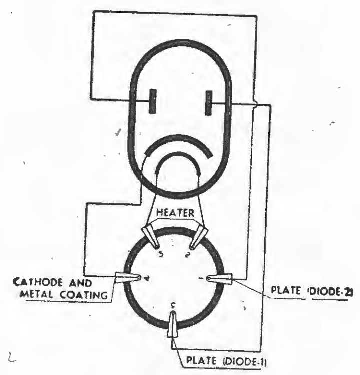
7 H



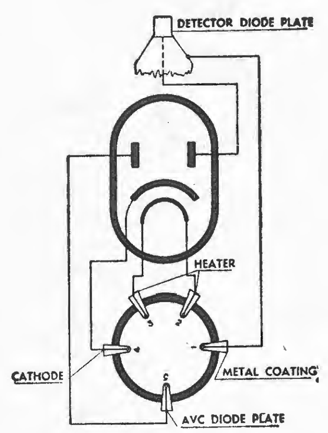
7 J



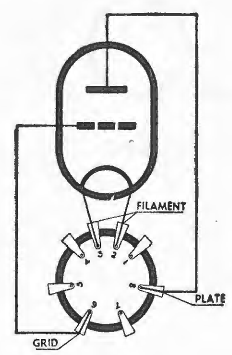
7 K



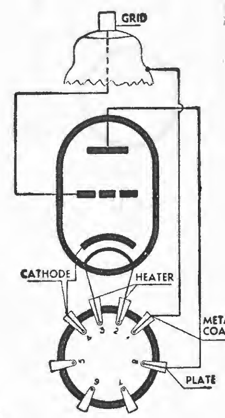
V-1



V-2

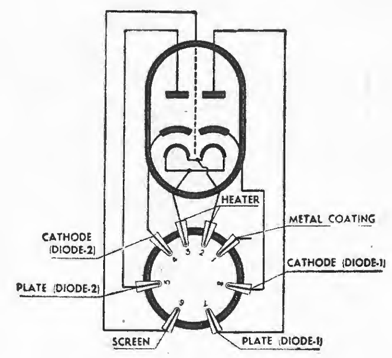


P-1

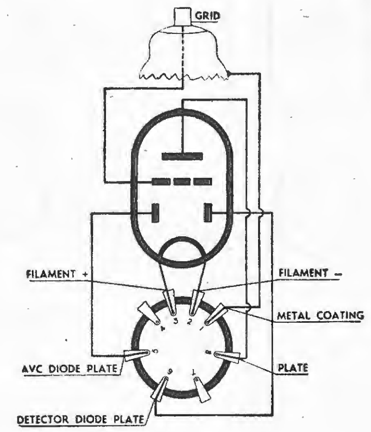


P-2

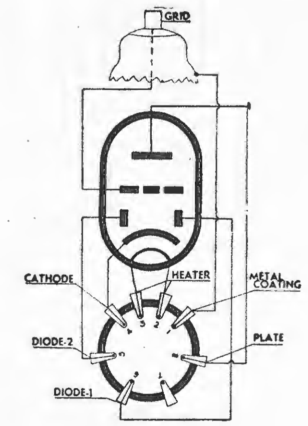
PHILIPS AND MULLARD TYPES —— P-3 to P-11.



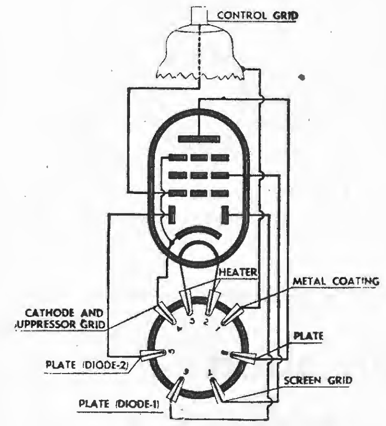
P-3



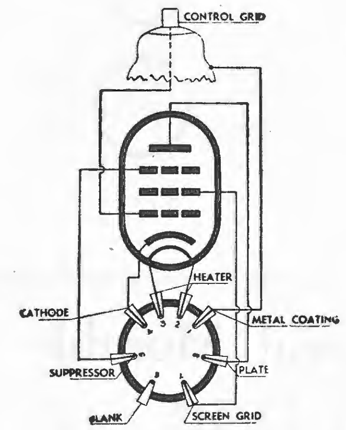
P-4



P-5



P-6



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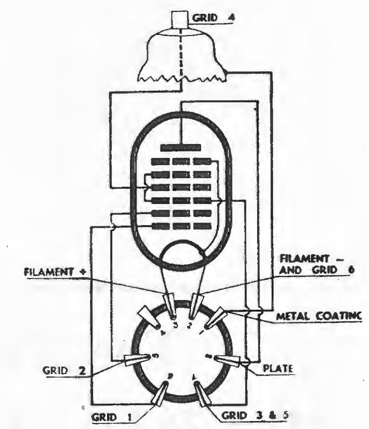

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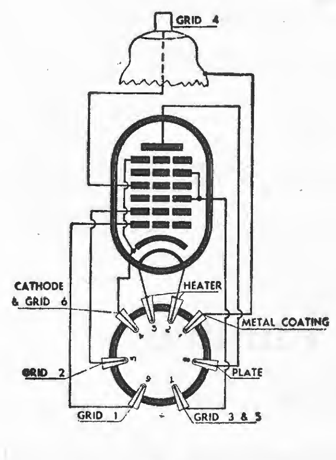

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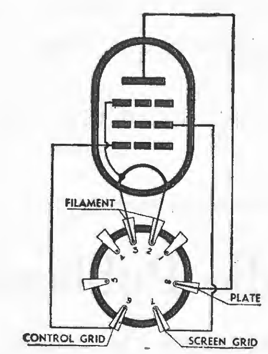

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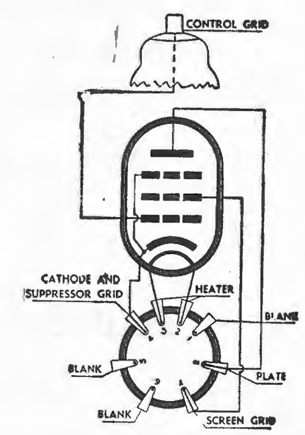

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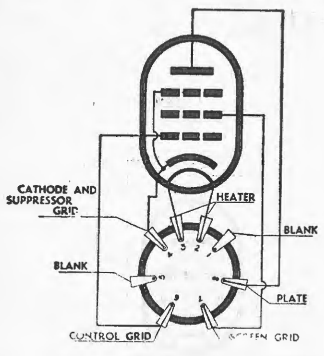
PHILIPS AND MULLARD TYPES —— P-11 to P-17



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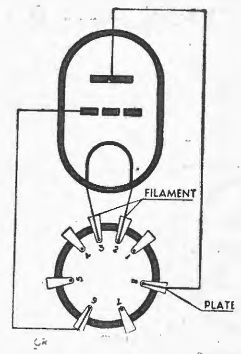

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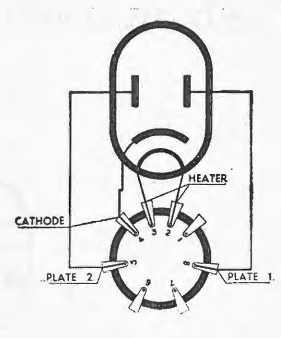

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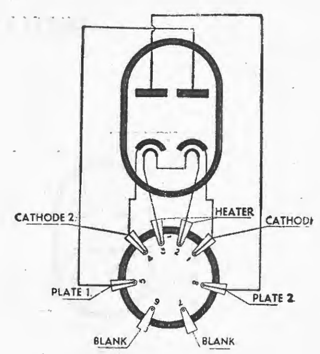

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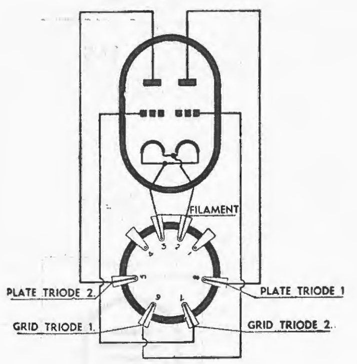

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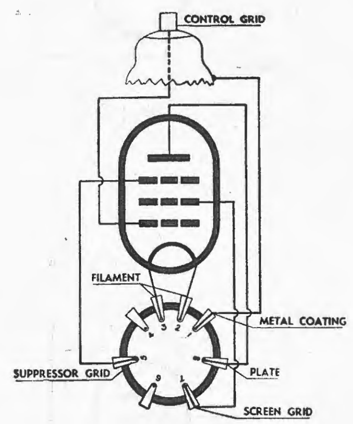

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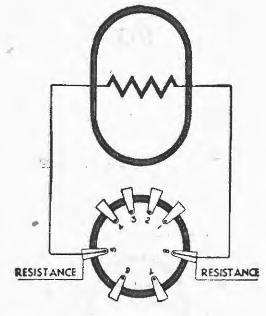

BARRETTER

MOULDING MATERIALS

Plastics for Many Purposes

HOW often the average person, when seeking the romance of fiction, overlooks the romance of fact?

Tourists will travel many miles from the beaten track to witness the mystic art of some Ancient Magician. They watch with awe and wonder while they are deceived by his cunning legerdemain—such is fiction.

How few realise, that at their own doorstep they may see the reality of modern magic, created by that modern magician—the chemist.

Through exhaustive research: by careful study, and with infinite patience, he has mastered the science of the transformation of matter, and discovered a new material, which in a little more than a decade has found a place in nearly every phase of our daily life—such is fact.

Not long ago, a group of business executives were discussing current conditions. After touching upon taxes, farm relief, and production problems, the conversation swung around to materials, one of the men present asked, "What is Plastics," and the answer to this one question led to numerous other queries, all of which indicated a keen interest in the subject of plastic materials, and a desire to know more about them.

It occurred to us that this conversation might serve to enlighten many others. In reply to the first interrogator, we said: "More than a quarter of a century ago Mr. L. H. Baekeland announced to the world the discovery of the Bakelite Resinoid, a 'man made' material produced from the interaction of carbolic acid (phenol) and formaldehyde. The initial material resembled amber in appearance, but possessed an unusual combination of properties and characteristics far different from existing materials. Down the years scientific research has permitted the development of new formulas, employing various fillers and solvents, so that to-day the list of plastic materials number many thousands."

"How extensively are these plastic products used?"

"From babies' teething rings to table tops, fishing reels to fireplaces, cameras to clocks, paints to pencils, typewriters to talking pictures—in fact there are one or more applications in every industry."

"We group these numerous plastic materials into six broad classifications:—

1. Moulding materials.
2. Luminated rods, sheets and tubes.
3. Cast resinoids in sheets, rods, tubes and special forms.
4. Varnish, Lacquer, enamel and cement of the baking type.
5. Synthetic Resins for paint and varnish products of the air drying type.
6. Special resinoids—for water proofing fabrics, for dentures, bonds for abrasive wheels, and for impregnation of brake linings, etc."

Plastic material uses seem to be endless, as illustrations, let us follow through an average day with an average family and find, perhaps to our amazement, the number of times we are apt to come in contact with this unique chemical creation.

As you begin the day with your morning shave, you encounter plastics first in the handle of your shaving brush and the box containing your safety razor. The material is also an indispensable part of the electric water heater.

At breakfast, your wife pours you a cup of coffee; the handle she takes hold of on the percolator is plastic moulded, as well as the button under the table she presses for service, and the twin outlet plug from which are carried the wires to the toaster.

You drive your wife down town for a morning's shopping. Before leaving, she gives the baby a teething ring to keep him contented while she is away. Of course, it never occurs to her that this childhood necessity is of the same material as the automatic fire extinguisher which stands silent watch over her home.

After lighting a plastic bowl and stem pipe, or perhaps it's a cigarette or cigar holder, you step into your car and can find within reach thirty or more parts, either entirely or partly made of it, such as the timing gear, distributor head, gear shift ball, horn button, etc.

The morning is cold and as you speed along the windy stretches between your home and town you button your overcoat snugly about you. Doubtless you would be surprised to know that the buttons on the coat are also made of this material.

Your wife stops at the butcher's to do the day's marketing. Little does she realise that the handles of the butcher's knives, or the pen or pencil she is using to check off various items as they are purchased, are plastic moulded. She steps into a booth to 'phone the dentist, confirming her appointment; again she encounters this remarkable material in the form of the telephone mouthpiece and receiver shell.

At the dentist's, not only the instrument handles and the arms on the chairs, but numerous other parts of his equipment are made of the material with so many uses.

In the meantime, you have arrived at the office, you take yesterday's date from the calendar pad on your desk. The frame that holds the pad is plastic moulded, as are also various parts on the typewriter and adding machine.

In the factory you find the material in still another form—large silent pinions are helping to reduce the noise and clatter of the shop. Investigation would reveal its use for grinding wheels, lathe hand-wheels and a dozen other places in your plant. Even in the laboratory it forms the "stage" for the microscope.

Your Chief Engineer informs you that, by adopting these materials, he has been able to produce one of the most intricate pieces you manufacture in a single operation, thus eliminating the assembly of many metal parts and effecting a substantial reduction in cost.

A telephone message from a customer makes a short train journey necessary. Your safety on the trip is partly due to this material, for the block system is protected by insulation made of plastic. On the switch board that controls the lighting system of the car there is a dash-pot composed almost entirely of plastic. Even the bulbs and bases of the electric lamps are cemented together with plastic in still another form.

Your customer gives you a large order and you plan to celebrate by taking your wife to the matinee.

On the way home you board a crowded trolley car. You grasp a strap hanger, the handle of which is made of this unique material.

After luncheon there is an hour to spare and you while away the time playing a game of billiards. Here again is plastic moulded for balls and the bridge is made of it.

At the theatre this modern chemical creation has even entered the field of music, for the mouthpiece on the clarinet, chin rest on the violin, the keys of the piano are all produced from this material. During the play a Spanish dancer enters gracefully from the wings and in her hands she is dexterously manipulating a pair of castanets made of plastic material.

Upon arriving home you find a letter from an old friend, inviting you to accompany him on a trip into the bush. You stroll into your den to look over your fishing rods and rifles: again you encounter this material, for the reel on the rod and the butt plates on the guns are formed of plastics.

Returning to the drawing room you join your wife for an evening's radio concert. Should you examine your Radio receiver you will find it is almost entirely made of plastic material probably including the cabinet.

(Continued on page 303)

MOULDINGS—PLASTICS.—(Cont.)

The clock strikes midnight; it is time to retire, and as you rest your head upon the pillow it may seem that you have exhausted the possibilities of this wonderful material—but have you? The bed you sleep in is lacquered with synthetic resin varnish, and the castors under the bed are made of plastic moulding material.

Hidden in the inventive minds of man are thousands of new uses for Plastic Materials. Perhaps the foregoing narrative has suggested to you some new application. It has already proven the solution to innumerable problems—why not yours?

Progress of Plastics in Australia

Moulding in Australia can look back over at least 10 years of steady progress and the industry is established now on a very firm and broad basis. To give an idea to what proportions this industry has grown, the following are some of the mouldings produced.

Radio cabinets, radio valve bases, radio knobs, radio escutcheons, valve sockets, volume control covers, and numerous other radio components, telephone sets, lavatory seats, door handles, furniture handles and fittings, fishing reels, bottle caps, condenser cases, cigarette containers, ash trays, ink stands, cosmetic containers for face powders, soaps, lip salve, etc., table lamps, cups, saucers, plates, jugs, salt and pepper shakers, tumblers, flower pots, golf clubs, domino sets, toilet roll holder, electrical switches, adaptors and apparatus too numerous to mention.

One of the greatest boons to modern mass production is the plastic moulding process. Through the medium of the hydraulic press and the use of multiple cavity dies, manufacturers have found plastic mouldings a new means of increasing the rate and decreasing the cost of production, and they are now equipped to render prompt and helpful information to present and prospective users of plastic moulded materials.

The Presses

Presses are of two general classes, hydraulic and mechanical. Of each class there are two types, the "hot plate" and the "semi-automatic." Removable or hand moulds are used in presses of the "hot plate" type, and the moulds are invariably bolted to the platens in the case of the "semi-automatic." The platens of the presses are heated by means of electricity or steam and in some cases by gas. In practice the hot moulds are charged with a predetermined volume of moulding power; the mould is closed and subjected simultaneously to heat and pressure. A pressure of up to 2 tons per square inch is applied for 5 or 6 minutes or such time depending on the thickness of the section of the moulding and the shape and size of the article being manufactured, and is determined largely by experience. The moulded pieces are then ejected hot and left to cool. Occasionally, when an exceptionally fine surface finish or a "close tolerance" is desired, the moulds are removed directly from the hot press to a chilling press for rapid cooling. They are then taken to the work bench to be unloaded and recharged.

There are two different designs of semi-automatic pressers, designated, respectivly, as "Tilting Head," and "Retracting Ram" presses. While varying more or less in design they are alike in the respect that the moulds can be clamped rigidly in place and do not have to be handled by the operator. The moulds for presses of this type are made with channels through which steam or cold water may be circulated alternatively. The moulded pieces are automatically ejected with the opening of the press.

The choice of press to be employed is determined largely by the size and shape of the pieces to be moulded, and the number of pieces required.

MOULDS

Function of the Mould

Moulds are forms or matrices for shaping the plastic moulding material. They are made with single or multiple cavities, according to the size and shape of the piece to be produced.

Moulds are made of steel. Steel is the only satisfactory material for mould construction. Bronze or brass moulds are occasionally used for experimental pieces, but for production work there is nothing that takes the place of steel.

Moulds whether made of tool steel or special steels developed for the plastic industry should be hardened, ground and polished, the higher the polish the better the lustre on the finished piece.

Moulding Process

Standard Moulding Materials. Moulding materials are supplied to the trade ready for use. There are two different forms, fine powder, and coarse grain powder or "flake." Frequently fine powder is compressed in a "tabletting" machine into pellets and thus saves time in measuring or weighing out the powder and in charging multiple cavity moulds. Each of the materials is supplied in a variety of flows and hardening characteristics which adapt them to practically any conditions encountered in production.

What Occurs During the Moulding Operations

When these materials are heated in a hot mould they flux. The hydraulic pressure applied to the mould when the material is in this state forces the plastic mass into intimate contact with all parts of the mould, permitting faithful reproduction of the mould form.

It is thus possible to obtain an infinite variety of shapes by the moulding operation.

Because of the plastic condition of the moulding material when it is in this state of flux, an interesting phenomenon is set up.

A thin film of the fluid resin is always brought to the surface of the moulded piece and it is in part due to this that the finished product reproduces with exact fidelity the surface of the mould.

While the first effect of the heat used in moulding as above described, is to soften or flux the material, it induces at the

(Continued on page 305)

MOULDINGS—PLASTICS.—(Cont.)

same time a "non returnable" chemical change which hardens it at a rate depending upon the size and shape of the piece and the temperature used. The "non returnable" change simply means that once the resin in a moulding has set hard it cannot by subsequent heat and pressure be converted into another moulding.

It is exceedingly important that this softening and subsequent hardening by heat be thoroughly understood by the operator. The improper co-relation between the application of heat and pressure is responsible for more spoiled work than any other one factor.

When this change has been completed, the moulding is finished, and the product cannot again be softened or fluxed by heat.

A Unique Combination of Superior Properties

Not only are moulded products exceptional in their strength, hardness, and electrical properties, but they are also highly resistant to heat. The woodflour-filled products, for instance, withstand for hours, without distortion or charring, temperatures up to 150° C. (320° F.). The tensile and impact strengths of certain of the mineral-filled products are unaffected for short periods by temperatures up to 235° C. (455° F.). Again, not only are these products highly resistant to water, but also to oil, to the common solvents, to mild alkalies, and to organic and dilute mineral acids. They are disintegrated, on the other hand, by strong sulphuric or nitric acid, or strong alkalies.

The electrical industry early recognised the value of plastics products as the solution to numerous insulation problems.

The automotive industry selected the moulding material for ignition parts, not alone for its good electrical properties, but because of its high resistance to heat, water and oils, and the accuracy and economy with which it can be fabricated. These characteristics have long been sought in structural materials generally; thus it is that we find moulded products widely employed for purely mechanical purposes, replacing metals, woods, and a number of other natural materials. The high impact materials are especially adapted for parts which must withstand rough handling, such as golf club heads, handles and ledger covers.

Because of their high corrosion resistance, these materials are also used for parts of apparatus in the chemical industry, such as moulded fittings for pipe lines conveying acids that would attack and destroy iron or brass.

It is this unique combination of superior properties that accounts for the many and varied ways in which moulded products are rendering valuable service.

Machines

For machining moulded products diamond cutters give the best results. "Stellite" and chrome-tungsten-steel alloy cutters also give good service.

Tools for machining should be similar to those used for working brass. These permit a scraping action rather than a cutting action and are better than tools used for machining steel.

Several manufacturers are now making drills especially designed for drilling moulded parts. These drills are made with an extra clearance on the edge of the flutes, to reduce friction and prevent overheating. A drill speed of 3,000 r.p.m. should be used for small diameters.

It is well to determine the number of holes that can be drilled in pieces of a given type before the drill becomes dull. Instructions can then be given the operator to change drills at this point. Avoid excessive pressure when forcing the drill into the material as this tends to heat the drill and destroy the cutting edge.

Such approved machining practice prevents rejects and greatly increases the life of the tools.

Special Materials

Uncommonly exacting service conditions have called forth special materials to meet them.

Thus there have been developed materials of exceptional water-resistance. Discs moulded from one of these materials, after immersion in water for a year, show a diameter increase of less than 0.001" per inch and no surface effect. In boiling water for a year the increase is only about 0.003" per inch, and the surface effect very slight.

Still another type of material shows only slight surface effect from immersion for twenty-four hours in boiling 5 per cent. caustic soda solution.

A special material of the mineral-filled type has been developed for use in moulded ash trays. Here there is exceptional heat resistance at the surface of the moulded tray. Such trays do not blister.

There is a "low loss" material especially useful in radio condenser forms and housings. It has a low power factor (audio 1.6 per cent., radio 0.75 per cent.) which suffers little change after a day's immersion in water. This material has a high volume resistivity (about 10^8 megohms per cubic centimetre) which drops off much less with rise in temperature than in the case of ordinary materials.

A special material developed for magneto insulation is finding use in aircraft ignition, where a material of high insulation resistance, high dielectric strength, and improved resistance to carbonisation under a low amperage arc is necessary. When moulded this material is less rigid than the regular materials. It has been found of advantage for use when moulding a relatively thin wall of material around a large metal insert.

Of interest is a special material which has marked opacity to the X-ray, and which finds use in the manufacture of X-ray shields.

Standard Tests for Moulded Products

Engineers have long recognised the need of standard methods for testing moulded products. Without agreement on methods, agreement in results is not to be expected.

It is well known, for instance, that, depending upon the method employed in making the test, a wide range of values may be obtained for the dielectric strength of any material. For one thing the voltage required to break down a given material is not proportional to the thickness. With moulded products it varies approximately as the square root of the thickness. It would be entirely incorrect, therefore, to assume that by doubling the thickness of a piece of insulation, the breakdown voltage would also be doubled. Conversely, it would not

(Continued on page 307)

MOULDINGS—PLASTICS.—(Cont.)

be proportionately reduced if the thickness were cut to one-half. The thickness of the piece tested is therefore a highly important factor and should always be stated when giving figures for dielectric strength. Also, the shape of the electrodes used and the rate at which the applied voltage is increased materially affect the value obtained.

Similarly the values obtained for other electrical properties depend on the conditions of test.

So also with mechanical tests; such, for instance, as the impact or shock-resistance test. This may be defined as the energy in foot pounds required to break a specimen having a cross-section an inch square; that is a square that measures an inch on a side, not a square inch of any shape of section.

To meet the need for methods of testing that would be acceptable to engineers and manufacturers generally, the American Society for Testing Materials some years ago appointed a committee known as "Committee D-9" composed of engineers from some of the leading electrical companies and the manufacturers of insulating materials, for the purpose of working out standardised methods for such tests.

As a result of the intelligent labours of this committee, "A.S.T.M." standards are to-day accepted generally in the electrical world.

Plastic Materials in Industry

Radio.

Long before listeners had heard the term radio, plastic materials were aiding the commercial producers of radio's parent, Wireless Telegraphy. When commercial wireless was being installed on ships and shore stations, plastic moulded and laminated were component parts of these sets. An advertisement of 1915 featured a large commercial set equipped with a laminated panel.

In 1916, pioneer amateurs, in constructing their spark type sets equipped with regulation telegraph keys and headphones, were also relying upon plastic materials.

Radio gave the public some inkling of its possibilities with the invention of the audion tube, and history records during this period, its first big steps forward. The first commercially manufactured receiving sets for the home made their debut.

Many of these sets were of the type where the components were assembled on a board. Practically all of these sets used plastic moulded parts. At the same time amateurs were taping the capacity of the industry for headphones, tube sockets, coil forms and numerous other parts made of plastic materials for their own "hook-ups." Moulded dials, three inches in diameter, were selling for over five shillings a piece. With the demand far exceeding the supply, radio started to grow up. About 1924, sets in wooden cabinets appeared on the market, adding handsomely finished front panels of laminated plastic material to the already established uses of the material.

Head sets gave way to horns, some of which were moulded. A host of new uses developed for plastic materials—static eliminators, lightning arrestors and inside aerial frames.

Almost overnight radio became an industry of national importance. In two years this howling, whistling era gave way to organised broadcasting. The number of stations was increased in the broadcast band—and some began to operate on higher power. To match this progress, the manufacturer of the receiving set, brought forth electrically operated receivers. The "furniture period" followed almost immediately, with consoles, highboys, and lowboys, concealing all operating parts except the dials and knobs.

With the successive steps of refinement in the receiving mechanism and radio cabinet, new uses for plastic materials were developed. Laminated translucent materials for the illuminated dials, base plates for the new metal tubes, tuning knobs of coloured materials to match the wood cabinets, and finely-moulded cabinets for the smaller sized sets are typical of improvements of the past two years.

Telephone

A review of industries utilising plastic materials in many forms would not be complete without specific mention of the application of these materials in the telephone, which is so important in the conduct of the world's business.

An industry serving millions of telephone subscribers must select its materials with care, for failure of a single part might cripple the carefully built up system. Plastic material has been used for the entire "Shell"-handle, mouth and earpieces—of the popular handset telephone.

And back of the maze of equipment in every telephone exchange plastic materials are employed in dozens of places—in grasshopper fuses, relaying insulators, armatures, dividers, sender finders, selectors, as insulators for the cams of sequence switches and for pulse machine drums.

A visit to a modern automatic exchange leaves one spellbound with the marvel of its mechanical efficiency.

Row after row of compact machines record by their almost inaudible "click" the connections that enable the city to expedite the transaction of its daily affairs. A handful of operators—plus the material of which the equipment is constructed—is responsible for the continuous performance of these machines.

Plastics for Packaging

The potentialities of plastic materials in the packaging field are tremendous.

Development can only come through the wide propagation of knowledge regarding synthetic plastics, and it is too often overlooked that the potential buyer may be quite unaware of developments or fail to realise their application to his own business.

Plastic moulded packages in addition to their attractive appearance, are tough and strong, they do not corrode, rust or affect the contents.

Distinctive colours and patterns innumerable are possible, and any symbol or trade name can be indelibly moulded in the container. Thus a manufacturer is able to maintain individuality of design and colour for his products by the use of plastic mouldings.

Some of the more important points which must be looked for by the manufacturer of beauty requisites who is contemplating new packaging materials are:—

1. General effectiveness and modernity of appearance.
2. Its ability to conform with preconceived colour schemes.
3. Light weight and unbreakability.
4. Ease of working into stylish containers.
5. Absolute chemical inertness (resistance to alkalis, etc.)
6. Commercial practicability, as regards price, in comparison with that of other materials.

Moulded products have an excellent claim to fulfilling each and every one of these requirements to an eminently satisfactory degree. In regard to variety of colour, for example, moulded plastics have no rival, the modern urea-formaldehyde resins constituting a very marked advance in gaiety of hue and texture on their dull and somewhat greasy looking predecessors.

Then again, plastic containers are light, thin, and of a clean, almost classic elegance of design.

The Development of Large Mouldings

The technique of moulding plastic materials has been developed in Australia in the comparatively short period of ten years. The earliest moulding, comprising electrical components and ash trays were limited in size by the capacity of the presses available at that time, by the lack of experience on the part of the moulders and by the limitations of the early materials. These mouldings however, rapidly became popular because of their unusual combination of physical properties, and, on account of their ease of manufacture, adaptability, pleasing finish and comparatively low cost. It was natural that the development of large mouldings should have been one of steady evolution. As moulders developed their art, larger and more complicated mouldings were produced, but time was required in which to obtain the necessary experience to evolve the large mouldings that are produced to-day.

Mould and press design and manufacture were important problems, as also was the production of a moulding powder possessing the characteristics necessary to permit of free flow into all the interstices of a large mould and which would, at the same time result in a moulding free from skin and surface blemishes, which would not distort on removal from the mould, and which would retain all the qualities associated with plastic mouldings. In order to appreciate the difficulties of the manufacture of moulding materials, it is necessary to again consider exactly what happens during the moulding process.

(Continued on next page)

MOULDINGS—PLASTICS.—(Cont.)

The material is loaded into the hot mould in definite quantities, either in loose granular form or as compacted pellets; the mould is then placed between the heated platens of a hydraulic press and pressure applied. The moulding material becomes plastic at a temperature of approximately 375° F. and the applied pressure, which is of the order of one ton per square inch of projected mould area, forces the plastic material into the remotest corners of the mould. The powder is initially placed in the bottom of the mould, and, the forced flow is upwards and outwards. Under the combined influence of heat and pressure the moulding finally sets and becomes both infusible and insoluble.

It will be obvious that in the case of deep mouldings very great pressure will be necessary to cause the material to flow up the sides of the mould; this pressure may amount to as much as six tons per square inch. To ensure a produce which is of uniform quality throughout, it is essential that the surface of the mould should be at uniform temperature.

Small moulds present little difficulty in this respect, they are merely heated by contact with the heated platens of the press. With increasing mould size, uniform heating of the mould surface presented a problem, which has been overcome to some extent by incorporating electric heating elements in the mould itself. In addition, enormous presses having almost machine-tool precision have been developed in order that the necessary pressure might be applied to the moulding materials without disturbing the accurate register of the various parts of the mould.

Designing to Sell

In the battle for the consumers' £ s. d., an increasing number of manufacturers have turned the spotlight on their own products, with the hope of discovering some new and salient salespoints, either through added operating features, or improved design.

Under the pressure of keen competition and in an endeavour to reduce cost, many have been forced to curtail their selling efforts. Thus the product itself is being relied on to carry a greater portion of the sales burden. As in all movements of this kind, there are obstacles to overcome, perhaps one of the greatest impediments to change is "Tradition"; the tendency to adhere strictly to "Standard Practice," doing something in an habitual way just because experience up to this time has shown it to be effective and economical. But the world does not stand still, and change is the order of the day.

Although standardisation has its place for such things as gears and materials, there is many a manufacturer of a venerable line of merchandise who could revive sales by revamping his products. The problem now is not one of mere quantity, it is a question of how to produce a quality product at a relatively low price. The engineer, the plant manager, and other executive, who are responsible for the conversion of materials into a finished product should consider the sales features above everything else. One of the most important selling factors is design. When the consumer has the choice of a number of articles, whether it be an electric toaster, a water-cooler or a radio receiver, he selects a design. A good design sells the goods, and brings the price.

The manufacturer of an instrument used in the home redesigned his product and placed it in an attractive plastic-moulded case. His sales in 1933 were 43% above those of 1932, and 90% above 1931, and in 1934 the sales broke all records. The public's appreciation for good design has been greatly underestimated. There is ample evidence that they are influenced by style changes, and, although they may not be in a position to initiate these changes, they show by the release or with-holding of their hard-earned money, whether they like it or not. An article may be made of the finest material, and be reasonably priced, it may be brilliantly advertised, but if it lacks pleasing proportion, symmetry and individuality, it will be hard to sell at a satisfactory profit. Now more than ever before, the public is seeking articles made from better materials. They are "fed-up" with inferior goods, and, above all, they want better workmanship and better design.

Readers are referred to various supplies of moulding material as advertised herein, for further information in respect to plastics.

Radio Education in Australia

Training is Essential

AT the moment of writing on radio education in Australia there is outstanding evidence that the radio industry throughout the Commonwealth—particularly in Sydney, where about 75 per cent. of the radio production is centred—is experiencing a dearth of both skilled and unskilled radio technicians of all kinds.

That is largely brought about by the hitherto predominant feature of seasonal production. In many cases factories have not started production until about February or March and have eased down considerably by July or September at the latest. It is unfortunate that this seasonal trend operates even to-day, but it is very pleasing to record that there is a definite trend towards the elimination of such a pronounced production curve during only the winter months.

A well planned factory, can and should—in fact must—so regulate its activities as to produce as even a flow of finished products as possible during the year.

Not only is this essential from a sales point of view, but from a production point of view, as it is becoming increasingly difficult even to secure untrained staff to work only for a few months, and during such time to be paid wages hardly commensurate with the value of the work performed. In other words the industry will no doubt find it necessary to pay more wages to attract a better staff.

Many people think, largely due to this seasonal employment aspect, that there is no future in radio, but such is not the case. It is quite true in every factory that the key men and the young people who are showing any signs of acquiring a radio technical knowledge are being kept on and improved in their positions from time to time. At the present moment there is not only a scarcity, as previously stated, of unskilled labour, but of the skilled technicians, which all indicates that at this juncture there are more positions available than men to fill them, and the position must become more acute as time goes on.

It is also extremely evident that the radio technician must be possessed of a thorough knowledge of electrical fundamentals. He must study electricity along organised lines and from recognised authorities. It is relatively easy for a young man to obtain a position in the radio industry to-day, but it is very much more difficult for him to hold that position as his years advance, and by the time he becomes 21 and more, he must have acquired a fairly high radio technique in order that he will not just hold his position, but will advance with the increasing development that is going on in radio all over the world.

There is positively no doubt that a man who is equipped with a thorough knowledge of radio technicalities and radio engineering can find good employment and excellent prospects, providing he continues to keep himself to the fore in every direction.

In Sydney there are a number of places where radio instruction may be obtained.

Sydney Technical College

At the Sydney Technical College the Diploma Course of Radio Engineering is now in operation and takes about 8 years to complete, the first 5 of which constitute practically electrical engineering instruction, and the balance of the term is mainly on specialised radio subjects.

Full particulars of this Radio Diploma Course may be obtained from the Registrar of the Sydney Technical College, Harris Street, Sydney.

Sydney University

The following is a report on the position relating to the Electrical Engineering Course by Professor J. P. V. Madsen. The report states that while no provision is made for carrying out a full course in radio engineering, nevertheless, as an alternative to a portion of Electrical Engineering II (Fourth Year), a course in Electrical Communication may be taken by students with the necessary scientific training, subject to the approval of the Faculty of Engineering.

In co-operation with the Radio Research Board of the Council for Scientific and Industrial Research, a considerable amount of research work has been in progress during the past 6 years, and it has been found possible to provide very material assistance in training by the contacts which senior students have been able to make with those who are engaged upon research work. The development of a more regular and complete course in Communication Engineering, of which Radio Engineering would form a part, is looked forward to as means become available. The fundamental scientific principles of radio are dealt with in a general manner in the courses of Physics and Mathematics leading to the B.Sc. (Bachelor of Science Degree).

According to Professor O. U. Vonwiller, Professor of Physics at the Sydney University, a course of about 20 lectures on electrical oscillations designed to give a thorough and advanced knowledge of the principles of radio, is included in the curriculum of the Third Year in Physics, Faculty of Science. About half of the practical work done during the year is devoted to experiments having a direct bearing on radio matters. The total time allotted to practical physics in a year is 360 hours. The Third Year curriculum also includes courses of 20 lectures each on electricity and gases, and on physical optics.

Full particulars in regard to these courses can be had from the Registrar, University of Sydney.

Marconi School

The oldest established school of wireless in Australia is that conducted under the auspices of Amalgamated Wireless A/sia Ltd., under the name of the Marconi School of Wireless. It was originally formed for the training of wireless operators on ships.

It was established 23 years ago, during which time it has trained nearly 4,000 students. Primarily a training centre for marine operators, but as the radio industry expanded other and more advanced courses have been added to the school's curriculum.

At the present time, six courses are being conducted, viz.:—Radio Engineer, Technician, Operator, Mechanic, Serviceman and Motion Picture Operator.

Course A—Radio Engineer. The student must be of Leaving Certificate standard in mathematics, physics, chemistry and English. The Radio Engineer's course covers a period of 5 years, two of which are conducted by correspondence and the last three by the student attending personally every day at the school or various centres of activity of A.W.A., such as the Radio-Electric Works at Ashfield, Transmitting Centre at Pennant Hills, Receiving Centre of La Perouse, the Works Laboratory and the Broadcasting Studio. Subjects in this course cover practically everything possible.

Course B—Radio Technician. Designed for students to obtain P.M.G. Broadcast Operator's Certificate. Instruction in general principles of electricity and radio, especially as applied to broadcasting stations and studios. The first section of the course is conducted by correspondence, the second section by practical tuition in the school, in conjunction with actual apparatus.

Course C—Radio Operator. Enables the student to qualify for P.M.G. 1st or 2nd Class Commercial Operator's Certificate of Proficiency. First 15 months conducted by home study papers and telegraphy is practised at home. The student then attends the school for further practice and instruction.

(Continued on next page)

RADIO EDUCATION—(Continued)—

Course E — Radio Mechanic. Period of course 12 months. The theoretical portion deals with the principles of electricity and radio as applied to broadcast receivers, and is conducted by correspondence, after which the student attends the school for two months' practical instruction in set building. During this part of the course instruction is given in the location of faults, the use of testing equipment, tools, etc., and a period is spent in the Service Department of A.W.A. Works at Ashfield.

Course F — Radio Serviceman. Five months' correspondence course dealing with broadcast receivers.

The engineering section of the Marconi School of Wireless is supervised by Dr. W. G. Baker, B.Sc., Dr. in Eng., D.Sc. Eng., while the marine section is conducted by Mr. H. E. Buik, who was one of the first to adopt radio as a profession 25 years ago.

Full particulars may be obtained from the Principal of the Marconi School, 97 Clarence Street, Sydney.

Australian Radio College

The Australian Radio College has been established for about 6 years and took over the classes previously conducted by the N.S.W. Division of the Wireless Institute of Australia.

The College is directed by Mr. L. B. Graham as the Principal. Day and night classes and correspondence training are conducted and individual, personal instruction is the keynote of all A.R.C. training. There are five instructors, and each student receives direct personal attention.

Day classes are confined to about 50 members, while night classes and correspondence students number several hundreds.

The night classes consist of practical instruction set upon printed lessons which are supplied to all students, and lectures which embrace most radio subjects. Students may commence night classes at the A.R.C. at any time.

Practical instruction and experiments are possible.

For those who cannot attend in Sydney, a direct correspondence course is available from the Australian Radio College.

In the day classes students may also commence at any time, as the instruction is entirely individual. The hours of instruction are Monday to Friday 9.30 a.m. to 4.30 p.m., and the course takes about 8 months.

Night classes are conducted on Monday and Thursday evenings from 7 to 9 p.m.

The radio engineer's and serviceman's course by day classes, by night classes and by correspondence.

The Radio and Television Engineer's Advanced Course, is by correspondence training only.

The Amateur Operator's Proficiency Certificate course, by night classes and by correspondence.

Both the Australian Radio College and the Marconi School are well recommended.

Other Courses

Other radio instruction courses available are from the Australian School of Radio Engineering, located at Wembley House, Railway Square, Sydney, the Principal of which is Mr. R. T. Andrew. The instruction by this school, it is understood, is mainly by correspondence, and full particulars will be gladly sent on application.

The International Correspondence School, which is a worldwide and very old-established organisation, favourably accepted everywhere, issues a very interesting booklet on "Keeping Step with Radio Progress." As their name denotes, this is purely a correspondence course, and in that direction can be very well recommended.

Adelaide

The South Australian School of Mines in Adelaide has a wireless course covering a two-year period, which is primarily designed for those in the radio trade or who are desirous of entering that trade. These classes are not designed to take the place of trade experience, but rather to give a sound knowledge of fundamental principles so that later experience may be more easily acquired and more usefully applied. No previous knowledge of the subject is necessary, but students who have some practical experience are given, as far as possible, more advanced practical work. Students are expected to have a knowledge of elementary mathematics and physics.

(Continued on next page)

RADIO EDUCATION—(Continued)—

The course is conducted by Mr. W. W. Honnor, B.Sc., B.E., F.F.A.S.M., M.Inst.R.E.Aust., assisted by Mr. S. M. Ackland, M.Inst.R.E.Aust., and Mr. J. M. Honnor, A.F.A.S.M.

Mr. W. W. Honnor has just returned from 12 months' leave of absence which he spent in England and on the Continent with a view to obtaining the latest experience in radio engineering, and investigating modern methods of radio education. Whilst abroad, he secured valuable testing equipment and apparatus for the classes.

About 40 students can be enrolled for the First Year classes and 15 for the Second Year. The Full Year course is always filled to capacity. The fee is 30/- per term for both First and Second Year. The syllabus is certainly very comprehensive indeed. Full particulars in regard to the syllabus can be obtained from the Principal of the South Australian School of Mines, North Terrace, Adelaide.

Melbourne

The Melbourne Technical College, Latrobe Street, has a series of classes for Radio Technicians, established since 1928. The course generally takes 3 years. There are four courses.

Courses 1, 2 and 3 are for evening students, and course 4 is for the student able to attend a full day course. The three evening courses are of progressive standard so arranged that the student who has completed an inferior course can complete a course of higher standard merely by taking the additional subjects if required.

Course No. 1—Radio Technician's Course—Evening. Radio Technology, Grade 1, 2 and 3 for two evenings per week.

Course No. 2—Radio Technician's Course—Major Course, 3 years. First and second year, 4 evenings per week, third year 3 evenings per week. That course is suitable for those concerned with more senior positions in radio factories, when they would be able to deal with problems on machines, transformers and other general electrical engineering problems.

The above courses are expanded still further to fall into line with those evening courses known as "Expert Certificates" and course No. 3 covers a period of 4 years, which is suitable for men who are already in radio laboratories and who find that the work already completed in the previous courses is insufficient. It would also be suitable for station engineers whose field of work is considerably wider than the average factory or manufacturing field.

Day Diploma Course No. 4. Comparing the various College courses it appears that the Diploma Day Course in communication engineering is best based on the existing electrical engineering course, and this takes 4 years for the full day course.

Full particulars will be gladly supplied by the Principal of the Melbourne Technical College, Latrobe Street, Melbourne, and furthermore the Melbourne Technical College radio classes are considered some of the best of their kind in the Commonwealth and are very well recommended.

MODERN TECHNICAL LITERATURE

"A.R.R.L. RADIO AMATEURS HANDBOOK." Handy and Hull. 1936. 7/6 (post 8d.)

"ADMIRALTY HANDBOOK OF WIRELESS TELEGRAPHY." 1932, with 1935 addendum. 1012 pp. 500 illus. 12/6 (post 1/3).

"APPLICATIONS OF THE CATHODE RAY OSCILLOGRAPH IN RADIO RESEARCH." Watson Watt and Bainbridge-Bell. 1935. 290 pp. illus. 16/6 (post 1/-).

"APPLIED ACOUSTICS." Olsen & Massa, 1934. 430 pp. 228 illus. 24/6 (post 1/-).

"BRINGING ELECTRIC SETS UP TO DATE." 3/6 (post 3d.)

"CATHODE-RAY TUBE AT WORK," Rider. 1935. 335 pp. illus. 16/6 (post 8d.).

"DRAKE'S RADIO CYCLOPEDIA." 1936. 1048 pp. 1178 illus. 39/- (post 1/6).

"DEFINITIONS AND FORMULAE FOR STUDENTS OF RADIO ENGINEERING." Starr. 1935. 35 pp. illus. 9d. (post 1d.).

"ELEMENTARY WIRELESS COURSE FOR BEGINNERS." Reyner. 1933. 279 pp. 131 illus. 5/3 (post 6d.).

"ELECTRON TUBES AND THEIR APPLICATIONS." Morecroft. 1933. 578 pp. 36/- (post 1/-).

"ELEMENTS OF RADIO COMMUNICATION." Morecroft. 1934. 269 pp. illus. 24/- (post 9d.).

"ELECTRON TUBES IN INDUSTRY." Henney. 1934. 490 pp. 32/6 (post 1/-).

"ELEMENTS OF LOUD SPEAKER PRACTICE." McLachlan. 168 pp. illus. 7/6 (post 6d.).

"HANDBOOK OF TECHNICAL INSTRUCTION FOR WIRELESS TELEGRAPHISTS." Dowsett. 1934. 572 pp. 525 illus. 22/6 (post 9d.).

"HOW WIRELESS CAME." Langdon-Davies. 1935 275 pp. 58 illus. 9/- (post 6d.).

"HOW TO BECOME A RADIO SERVICE MAN." 3/6 (post 3d.).

"HOME RECORDING AND ALL ABOUT IT." 3/6 (post 3d.).

"HIGH FREQUENCY MEASUREMENTS." Hund. 1934. 491 pp. illus. 32/6 (post 1/-).

"INDUCTANCE AUTHORITY." Shiepe. 1935. 14/-.

"LOUD SPEAKERS." McLachlan. 1934. 412 pp. 165 illus. 36/- (post 1/6).

"LIGHTNING RADIO CALCULATOR." 1935. 6/6 (post 4d.).

"MODERN RADIO SERVICING." Ghirardi. 1300 pp. 706 illus. 27/6 (post 1/3).

"MODERN RADIO COMMUNICATION," Vol. 1. Reyner. 5th edit., 1935. 157 illus. 7/6 (post 6d.).

"MODERN RADIO COMMUNICATION," Vol. 11. Reyner. 1935. 165 pp. 108 illus. 11/3 (post 6d.).

"MEASUREMENTS IN RADIO ENGINEERING." Terman. 1935. 400 pp. 210 illus. 26/- (post 1/-).

"MODERN VACUUM TUBES." 3/6 (post 3d.).

"MODERN RADIO HOOK-UPS." 3/6 (post 3d.).

"MODERN ACOUSTICS." Davis. 1934. 345 pp. 102 illus. 25/- (post 1/-).

"MATHEMATICS OF WIRELESS." Stranger. 1932. 193 pp. 6/- (post 4d.).

"NEW ACOUSTICS." McLachlan. 1936. 172 illus. 11/3 (post 6d.).

"NEWNES' EVERYMAN'S WIRELESS BOOK." Camm. 1935. 288 pp. 200 illus. 4/- (post 6d.).

"NEWNES' TELEVISION AND SHORT-WAVE HANDBOOK." Camm. 1935. 256 pp. 230 illus. 4/- (post 4d.).

TECHNICAL LITERATURE—(Continued)—

"OUTLINE OF WIRELESS." Stranger. 1934. 828 pp. illus. 9/6 (post 10d.).

"PROBLEMS IN RADIO ENGINEERING." Rapson. 5/3 (post 3d.).

"PHOTO-ELECTRIC AND SELENIUM CELLS." Fielding. 140 pp. 74 illus. 10/- (post 6d.).

"PHOTOCELLS AND THEIR APPLICATION." Zworyken & Wilson. 1934. 348 pp. 180 illus. 24/- (post 10d.).

"POPULAR TELEVISION." Barton Chapple. 1935. 112 pp. 46 illus. 3/9 (post 4d.).

"PHOTOELECTRIC CELLS." Campbell & Ritchie. 1934. 223 pp. 69 illus. 18/6 (post 8d.).

"PRACTICAL RADIO COMMUNICATION." Nilson & Hornung. 1935. 754 pp. 434 illus. 32/6 (post 1/-).

"PHOTOELECTRIC CELL APPLICATION." Walker & Lance. 1935. 193 pp. 112 illus. 12/- (post 6d.).

"PRINCIPLES OF RADIO COMMUNICATION." Morecroft. 1933. 1081 pp. illus. 60/- (post 1/6).

"PRINCIPLES OF RADIO." Henney. 1934. 491 pp. 28/- (post 1/-).

"PHYSICS OF ELECTRON TUBES." Koller. 1934. 205 pp. 19/6 (post 8d.).

"PHENOMENA IN HIGH-FREQUENCY SYSTEMS." Hund. 1936. 657 pp. illus. 39/- (post 1/2).

"PUBLIC ADDRESS SERVICING & INSTALLING." 3/6 (post 3d.).

"POINT-TO-POINT RESISTANCE MEASUREMENTS." 3/6 (post 3d.).

"RADIO MANUAL." Sterling. 1933. 797 pp. 347 illus. 36/- (post 10d.).

"RADIO PHYSICS COURSE." Ghirardi. 986 pp. 508 illus. 30/- (post 1/4).

"RADIO RECEIVER SERVICING AND MAINTENANCE." Lewis. 1935. 183 pp. 81 illus. 9/- (post 6d.).

"RADIO FIELD SERVICE DATA." Ghirardi & Freed. 1935. 240 pp. 41 illus. 9/6 (post 6d.).

"RADIO ENGINEERING HANDBOOK." Henney. 1935. Second Edit. 850 pp. illus. 32/6 (post 9d.).

"RADIO DESIGN PRACTICE." Millen. 1936. 7/- (post 4d.).

"RADIO RECEIVING & TELEVISION TUBES." Moyer & Wostrel. 1936. 3rd edition. 646 pp. 26/- (post 1/-).

"RADIOTRON DESIGNER'S HANDBOOK." 1/- (post 2d.).

"RADIO TRADE ANNUAL." 1936. 10/- (post free).

"RADIO KINKS AND WRINKLES." 3/6 (post 3d.).

"RADIO QUESTIONS AND ANSWERS." 3/6 (post 3d.).

"RADIO ENGINEERING." Terman. 1932. 750 pp. 418 illus. 32/6 (post 1/-).

"RADIO AMATEUR NEWCOMER." Jones. 1935. 2/- (post 3d.).

"RADIO HANDBOOK." Jones. 1935. 298 pp. illus. 6/6 (post 6d.).

"RADIO RECEIVER MEASUREMENTS." Barnard. 1934. 116 pp. 53 illus. 7/6 (post 4d.).

"RADIO REVIEW." Monthly technical journal incorporating Proc. I.R.E. (Aust.).

"SHORT-WAVE WIRELESS COMMUNICATIONS." Ladner & Stoner. 1935. 22/6 (post 10d.).

"SERVICING RECEIVERS BY MEANS OF RESISTANCE MEASUREMENTS." Rider. 203 pp. 94 illus. 6/6 (post 4d.).

"SERVICING SUPERHETERODYNES." Rider. 6/6 (post 4d.).

"SUPERHETERODYNE RECEIVER." Witts. 135 pp. 5/3 (post 3d.).

"SHORT WAVE RADIO HANDBOOK." Denton. 1935. 127 pp. illus. 6/6 (post 3d.).

"THERMIONIC EMISSION." Jones, T. J. 108 pp. 17 illus. 4/6 (post 3d.).

"THEORY OF THERMIONIC VACUUM TUBES." Chaffee. 1933. 652 pp. 357 illus. 39/- (post 1/-).

"THEORY OF RADIO COMMUNICATION." 1934. 11/6 (post 6d.).

"THERMIONIC EMISSION." Reimann. 1934. 324 pp. 64 illus. 21/- (post 1/-).

"TELEVISION THEORY AND PRACTICE." Reyner. 1934. 208 pp. 18/6 (post 9d.).

"WIRELESS TELEGRAPHY OPERATORS HANDBOOK." 1935. 1/3 (post 3d.).

"WIRELESS CONSTRUCTORS ENCYCLOPAEDIA." Camm. 1935. 392 pp. 490 illus. 7/6 (post 9d.).

"WIRELESS TELEGRAPHY NOTES FOR STUDENTS." Crook. 1935. 196 pp. illus. 11/3 (post 6d.).

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"BROADCASTING BUSINESS," published by Australian Radio Publications Ltd., 30 Carrington Street, Sydney. 'Phone B 7188 (3 lines). National weekly trade paper covering activities of Commercial "B" Class Broadcasting Stations throughout Australia. Circulating to broadcast advertisers, national advertisers, advertising agencies, broadcasting stations, etc., throughout Australia. Price 1/- per copy or by subscription, 15/- p.a. (52 issues post free) including copy of the "Broadcasting Business Year Book." Melbourne office:—Mingay Publishing Company, 2nd Floor, 422 Little Collins Street, Melbourne ('Phone M 5438). Interstate Reps.:—C. R. Porter, Esq., C/o Broadcast Services, A.M.P. Buildings, Queen & Edward Streets, Brisbane, Queensland; Ronald M. Catt, Esq., Claridge House, Gawler Place, Adelaide, S.A.; W. E. Coxon, Esq., A.M.P. Chambers, William Street, Perth, W.A. Advertising page size, 9 ins. x 7 ins. Three 13 em columns (2 1-6 ins.) per page. Overall size 11 ins. x 8½ ins. Blocks—half-tone, 110 screen.

"BROADCASTING BUSINESS YEAR BOOK."—Published annually by Australian Radio Publications Ltd., 30 Carrington Street, Sydney. 'Phone B 7188 (3 lines). Containing full particulars of all commercial stations in Australia, also "Who's Who in Broadcasting" and various other matters of interest to broadcasting stations, advertising agencies, national advertisers, etc. Price 10/- per copy post free in Australia; 15/- overseas. Included free in annual subscription to "Broadcasting Business" of 15/- p.a. in Australia. Advertising page size, 9 ins. x 7 ins., two columns 20 ems (3¼ ins.) per page. Overall size, 11 ins. x 8½ ins. First published in 1936.

ERDA.—Official organ of the Electrical and Radio Association of N.S.W., The Assembly Buildings, Jamieson & Margaret Streets, Sydney. 'Phone B 7503. Price 6d. per copy, 5/- per annum. Advertising page size, 9 ins. x 7 ins. Column 13 ems. 3 columns per page. Overall size, 11 ins. x 8½ ins. Editorial Committee: Chairman, J. Russell Greenwood; Editor-Secretary, Andrew F. O. Brown; Members—G. K. Dunbar, W. J. Wing, A. E. Pepper, N. H. Woollett. Monthly publication circulating throughout Australia.

"LISTENERS' WEEKLY & SCREEN NEWS."—Published by King Publicity Service, Victory Chambers, 249 Adelaide Street, Brisbane, Queensland. Price 2d., or by subscription, 8/6 p.a. All radio programmes, topical radio and screen articles, competitions, etc. Advertising page size, 9¼ ins. x 7 ins., 13-em column, three columns to a page. Distributed by King Publicity Service and Gordon & Gotch Ltd. Official organ of The Queensland Listeners' League.

"RADIO RETAILER OF AUSTRALIA" (Incorporating "Electrical News"). Published by Australian Radio Publications Ltd., 30 Carrington Street, Sydney. 'Phone B 7188 (3 lines). National weekly trade newspaper circulating throughout Australia covering the whole of the radio and electrical industries, dealing chiefly with the merchandising side of all radio and electrical domestic appliances and service problems. Price 1/- per copy, or by subscription 15/- p.a. (52 issues post free) including a copy of the "Radio Trade Annual." Managing Editor, Oswald F. Mingay. Victorian Branch Office:—Mingay Publishing Company, 422 Little Collins Street, Melbourne. 'Phone M 5438. Interstate Reps.:—C. R. Porter, Esq., C/o Broadcast Services, A.M.P. Buildings, Queen & Edward Streets, Brisbane, Queensland; Ronald M. Catt, Esq., Claridge House, Gawler Place, Adelaide, S.A.; W. E. Coxon, Esq., A.M.P. Chambers, William Street, Perth, W.A. Advertising page size, 9 ins. x 7 ins. Three 13 em columns (2 1-6 ins.) per page. Overall size, 11 ins. x 8½ ins. Blocks—half-tone, 110 screen.

"RADIO TRADE ANNUAL OF AUSTRALIA."—Published by Australian Radio Publications Ltd., 30 Carrington Street, Sydney. 'Phone B 7188 (3 lines). A stiff covered cloth bound year book, published for the first time in Australia in March, 1933. Contains over 300 pages covering all subjects allied to radio, including particulars of broadcasting station activities, acts and regulations, patents information, trade association data, company particulars, an extensive technical section, "Who's Who in Radio," a complete directory of the industry throughout Australia and much other essential information. Price 10/- per copy, post free (included in subscription to "Radio Retailer" of 15/- p.a.). Managing Editor, Oswald F. Mingay. Melbourne Office:—Mingay Publishing Company, 422 Little Collins Street, Melbourne. 'Phone M 5438. Interstate Reps.: C. R. Porter, Esq., C/o Broadcast Services, A.M.P. Buildings, Queen & Edward Streets, Brisbane, Queensland; Ronald M. Catt, Esq., Claridge House, Gawler Place, Adelaide, S.A.; W. E. Coxon, Esq., A.M.P. Chambers, William Street, Perth, W.A. Advertising page size, 9 ins. x 7 ins. Two columns, 20 ems (3 1-3 ins.) per page. Overall size, 11 ins. x 8½ ins.

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"RADIOPROGRAM PICTORIAL."—Published by Radioprogram Pty. Ltd., 148 Queen Street, Melbourne, Vic. M 2900-M 2041. Dated as published every Sunday. On sale everywhere Thursday evening. A weekly news pictorial tabloid newspaper covering the full programmes of all Victorian country and metropolitan broadcasting stations. "Radioprogram" was recently reorganised as a much larger paper, but still preserves the original features that gave it initial success. Managing Editor, H. Drysdale Bett. 32 pages, selling at 1½d. per copy. Overall size, 16½ ins. x 12 ins. Type size, 15 ins. x 10½ ins. Five columns, 12½ ems. Screen 65. Member of the A.B.C.

RADIO PUBLICATIONS—(Continued)—

"RADIO PICTORIAL OF AUSTRALIA."—Published and edited by W. J. Martin, State Building, Market Street, Sydney. 'Phone MA 7040. Published monthly. A radio pictorial of broadcasting activities especially for listeners. Profusely illustrated. Sold on bookstalls at 6d. per copy. Advertising page size, 9 ins. x 7 ins.

TELERADIO.—Printed and published by The Telegraph Newspaper Co. Ltd., Queen and Elizabeth Streets, Brisbane. 'Phone B 1383. A weekly radio magazine containing technical matter and programmes of all stations throughout Australia. Published on Saturday each week. Price 3d. per copy. Subscription rate, 52 issues, 13/- per year, post free. Advertising page size, $9\frac{3}{4}$ ins. x 7 ins. Column 13 ems (2 1-6 ins.); three columns per page. Overall size, 11 ins. x 8 ins. N.S.W. Office, Wm. C. Hubble, 15 Castlereagh Street, Sydney. 'Phone B 3141.

"THE BROADCASTER."—Published by West Australian Newspapers Ltd., Newspaper House, St. George's Terrace, Perth, W.A. 'Phone B 8161. Sydney Office:—Warwick House, Hamilton Street. 'Phone B 4802. (Rep., G. Bunstead). Melbourne Office, Newspaper House, Collins Street. (Rep., B. Rieusset). Published weekly every Saturday, containing programmes, technical features, wireless information and sporting. 64 pages, selling at 3d. per copy. Overall size, $12\frac{1}{2}$ x 9 ins. Advertising page size 11 ins. x $7\frac{1}{2}$ ins. Three columns, 15 ems. Blocks—half-tone, 55-65 screen newsprint.

"THE LISTENER-IN."—Published by United Press, Herald Buildings, 62-74 Flinders Street, Melbourne. 'Phone: Central 6853. Published every Saturday, containing technical and programmes. Deals with development of broadcasting, etc. Price 3d. per copy. Advertising page size, $9\frac{1}{4}$ ins. x $6\frac{3}{4}$ ins.; column 10 ems, four columns per page. Overall size, 11 ins. x 8 ins. Member Audit Bureau of Circulations. N.S.W. Office, George Snape, Manager, 15 Hamilton Street, Sydney. 'Phone B 4186.

"WEST AUSTRALIAN WIRELESS NEWS."—Published by R. S. Sampson Printing Company, 971-973 Hay Street, Perth, W.A. 'Phone B 4435 and B 7244. Published fortnightly on Fridays, dated Saturday. Containing programmes of principal W.A. stations, children's pages, technical articles and queries service, short-wave section and general features. Subscription, 6/6 p.a. post free, 3d. per single copy. Advertising page size, $9\frac{1}{2}$ ins. x 7 ins. Three columns to a page, 13 ems (2 1-6 ins.). Blocks 85 screen (inside) and 120 screen (covers and insert). Overall size, 11 ins. x $8\frac{1}{2}$ ins. Manager, N. McRae. Editor, J. H. Morrison. Children's pages, Mrs. W. S. Halliday.

WIRELESS WEEKLY.—Published by Wireless Newspapers Ltd., 60-66 Elizabeth Street, Sydney, telephone B 0333. A weekly radio magazine, containing technical and programme matter. Published on Friday of each week. Price 3d. per copy. Advertising page size, $9\frac{3}{4}$ ins. by 7 ins. Technical page columns 13 ems (2 1-6 ins.) Programme page columns, 10 ems (1 2-3 ins.). Technical pages, 3 columns per page. Programme pages, 4 columns per page. Overall size, 11 ins. by 8 ins. Member of Audit Bureau of Circulations. Advertising Representative, Norman Jeacocke.

Manufacturers' and Wholesalers' DIRECTORY

Most of the information contained in this Directory Section has been obtained direct from the manufacturers and wholesalers concerned, and although every care has been taken to prevent inaccuracies or errors, no responsibility is assumed by the Publishers. Omissions or inaccuracies should be notified to the Editor so that the next edition can be revised.

A

ACME RADIO LABORATORIES, 276 Orange Grove, East St. Kilda, Vic. Windsor 6827. Amplifying systems and public address systems.

ACORN PRESSED METAL CO. LTD., 66-72 Shepherd Street, Chippendale, N.S.W. MJ 4681 (2 lines). Governing Director, E. A. Parmiter. Secretary, D. Hinwood. Cables & Telegrams, "Acornmetal," Sydney. Metal stampers, metal spinners, electroplaters, electric welders, manufacturers of chassis, valve shields, dies, tools, etc.

AIRMASTER RADIO CO. (Radiokraft Pty. Ltd.), 131 Brunswick Road, Brunswick, Vic. FW 8854-7 & FW 8878. Managing Director, L. C. Hargreaves. Directors, F. G. Canning and J. R. Dowling. Manufacturers of "Airmaster" radio receivers. Interstate distributors: Queensland—Airmaster Radio Co., Hendorff House, Queen Street, Brisbane; Tasmania—John King & Sons, Brisbane Street, Launceston, Oldham Beddome & Meredith Ltd., Elizabeth Street, Hobart.

AIRZONE (1931) LTD., 16-22 Australia Street, Camperdown, Sydney, N.S.W. L 2851 (6 lines). Managing Director, Claude Plowman. Walter B. Homewood, Sales Manager; Phillip S. Parker, Works Manager; Geoffry J. Menon, Chief Engineer; Eric H. Donges, Secretary. Manufacturers of "Airzone" Electric and Battery Receivers. Component parts, Line and Aerial filters. Distributors of Crosley Electric and Absorption Refrigerators. Branch Offices:—414 Bourke Street, Melbourne, Central 632 (Harvey L. Smith, Manager), Q.P.I. Buildings, Adelaide Street, Brisbane, B 6206. (William O. Barber, Manager), Rundle Chambers, Rundle Street, Adelaide, Central 5223. (W. E. Gill, Manager), 886 Hay Street, Perth, B 5726, B 5808. (R. Plowman, Manager), N.Z., Wakefield Chambers, Wakefield Street, Wellington, No. 53-999. Peter Scott Ramsay, Manager).

AMALGAMATED WIRELESS (A/SIA) LTD., 47 York Street, Sydney, N.S.W. BW 2211. G.P.O. 2516 BB, Sydney. 167-9 Queen Street, Melbourne, Vic. (F 4161). Interstate Distributors:—J. B. Chandler & Co., Brisbane, Q.; Newton McLaren Ltd., Leigh Street, Adelaide, S.A.; Wyper Howard Ltd., 671 Hay Street, Perth, Nicholson's Ltd., Barrack Street, Perth, W.A.; Findlay's Pty. Ltd., 67 Brisbane Street, Launceston and Elizabeth Street, Hobart; Noyes Bros. (Melb.) Ltd., 36 Argyle Street, Hobart; The National Electrical & Engineering Co. Ltd., Wellington, N.Z. Manufacturers of Radiola radio sets. Amalgamated Wireless prepare specifications and manufacture and instal all manner of wireless equipment, all of which is designed and manufactured at Radio-Electric Works, Parramatta Road, Ashfield, Sydney.

AMALGAMATED WIRELESS VALVE CO. LTD., Head Office, 47 York Street, Sydney. BW 5059. Sales Manager, A. P. Hosking. Manufacturers of Radiotron valves at Valve Works, Ashfield, distributed through all recognised trade channels.

AMPLION (AUST.) LTD., 70 Clarence Street, Sydney. B 6694 (3 lines). Telegrams & cables "Amplion," Sydney. Managing Director, P. J. Manley. Sales Manager, E. S. Cox. Manufacturers of "Amplion" loudspeakers. Distributors of:—Amplion loudspeakers, microphones, etc., Westinghouse Metal Rectifiers, Lekmek Coil Kits, transformers, etc., Volta Batteries, Hammond electric frequency clocks, Carboncel batteries, Lion microphones, Emicol radio meters, Block plateless accumulators, Carter Genemotors, Audak pick-ups. Interstate Distributors:—Edgar V. Hudson Ltd., 284 Edward Street, Brisbane, Q.; Australasian Engineering Equipment Co. Ltd., 415 Bourke Street, Melbourne, Vic.; Newton McLaren Ltd., Leigh Street, Adelaide, S.A.; Carlyle & Co., 915 Hay Street, Perth, W.A.; W. & G. Genders Pty. Ltd., 53 Cameron Street, Launceston, and 69 Liverpool Street, Hobart, Tas.

H. C. ANDERSON & FRANTZEN, Johnson Street, Alexandria, N.S.W. Mascot 284. Proprietor, V. Frantzen. Manufacturers of radio cabinets.

Apex Metal Products Pty. Ltd., 52 Gwynne Street, Richmond, Vic. J 2091. Pressed metal workers, specialising in wireless chassis.

ARNOLD & BEARD LTD., 62-64 Pine Street, Chippendale, N.S.W. MA 6609 (2 lines). Managing Director, J. Arnold. Director and Secretary, E. H. Beard. Manufacturers of "Challenge Brand" Radio Chassis, coil and I.F. cans, galleries, ceiling flanges and electric light fittings, all metal stampings and spinnings, all kinds of plating, Neon Boxes. N.Z. Reps.:—Scott & Holladay Ltd., Wellington, N.Z.

MANUFACTURERS' AND WHOLESALERS' DIRECTORY—(Continued)—

Atkins (W.A.), Ltd., 894 Hay Street, Perth; B 3151, B 1901; G.P.O. D147. Telegrams, "Calcolim," Perth. Managing Director, M. M. Nathan. Sales Manager, J. J. Nathan. Branches, Fremantle and Kalgoorlie. Wholesalers and distributors. N.S.W. Rep., Atkins McLean Ltd., 301 Castlereagh Street, Sydney.

Australasian Engineering Equipment Co. Pty. Ltd., 415-419 Bourke Street, Melbourne. Cl. 11315. Telegrams, "Eniquip," Melbourne. Managing Director, D. Doughton. Director, W. M. Hipgrave. Australasian distributors for T.C.C. condensers, Durham I.R.C. resistors, Harley microphones, and pick-ups. Interstate Reps.: N.S.W., Wm. J. McLellan; Qld, Trackson Bros.; West Aust., Carlyle & Co.; Sth. Aust., South Australian Radio Co.

Australian General Electric Limited, 95 Clarence Street, Sydney, BW 2261. Chairman and Managing Director, F. B. Clapp; Deputy Chairman & Assistant Managing Director, A. Maling; (N.S.W. Manager, L. F. Burgess), (Assistant Manager, C. E. Crome). Manufacturers of "Bandmaster" Radio, "Ageite" Wiring devices; "A-G-E" Motors, Starters, Knife Switches, Circuit Breakers, Power & Instrument Transformers, and Soldering Irons, Heater Elements. Distributors of "B-T-H," "Ediswan," "G-E (U.S.A.)" and "Radiotron" Valves; "B-I" Cables and Winding Wires; "M-M" Copper Wires, etc.; "M-I-C" Insulating materials; Pickups, Phonograph Motors; "Hotpoint" Appliances; "G-E (N.S.A.)" Refrigerators, Washers, Ironers, Dishwashers, Phonograph Motors, Tungars, Clocks, "Telechron" Clocks. Branches: Cnr. Queen & Little Collins Street, Melbourne, Central 7900. (Manager, H. C. Van Valzah, Assistant Manager, W. W. Cooper); Kelvin House, 252 Adelaide Street, Brisbane, B 2151 (Manager, L. G. Hinwood, Assistant Manager, N. R. Johnston), also Townsville and Rockhampton. 73 Pirie Street, Adelaide, Central 8210 (Manager, C. F. Sharpe); 33 Elizabeth Street, Hobart, Tas., Central 3036 & 3037 (Manager, J. A. Smith), and at Newcastle and Lismore. Interstate Distributors: (General) Atkins (W.A.) Ltd., 894 Hay Street, Perth, W.A. (Ediswan Lamps), Coventry Motors Ltd., Perth, W.A. (Ediswan Lamps), M. J. Bateman Ltd., Perth, W.A. Overseas Reps.: The British Thomson-Houston Co. Ltd., Rugby, England; Ediswan Swan Electric Co. Ltd., London, England; Ferguson-Pailin Ltd., Manchester, England; International General Electric Co. Inc., Schenectady, New York, and London, England; Metropolitan-Vickets Electrical Co. Ltd., Manchester, England.

AUSTRALIAN RADIO COLLEGE LTD., Cnr. Broadway & City Road, Sydney. MA 2419. Managing Director, L. B. Graham. Superintendent, F. W. Freeman. Chief Instructor, R. Lackey. Resident and Correspondence tuition in radio, television and refrigeration. New Zealand Reps.: N. Z. General Electric Ltd., Wakefield Chambers, Wakefield Street, Wellington.

Australian School of Radio Engineering, 1st & 2nd Floors, Wembley House, Railway Square, Sydney. MA 4642. Principal, R. T. Andrew. Director-General, C. R. Donnelly, Assoc. I.W.T. Chief Examiner, A. Middleton, Assoc. I.W.T. Correspondence tuition in all branches of radio engineering. Interstate Reps.: Brisbane—E. G. Roper, C/- Beldam's, Albert Square, Albert Street; Adelaide—J. Pitcher, No. 3, Basement, National Mutual Buildings, King William Street; Perth —L. Buchholz, 177a Murray Street. London Rep.: E. W. Andrew, London House, 4 Caroline Place, London, W.C.1.

A.Z. Radio Pty. Ltd., 52 Buckhurst Street, South Melbourne SC5.; M 3169. Sole distributors Essanay radio and wholesalers of radio equipment. Managing director, H. Coles. Directors, W. M. Sweeney, E. A. Austin. Bateman, M. J., Ltd., 12 Milligan Street, Perth, W.A. Manager, F. Beames. B 9346. Branch, 119 High Street, Fremantle (FM 2630).

B

Baty, C. S. & Co., 357 Murray Street, Perth. B 5219. Box A33. Telegrams and Cables, "Batycoy," Perth.

Beale & Co. Ltd., 41-47 Trafalgar Street, Annandale. L 2791, Telegrams and cables, "Beale." Box 1621 BB, Sydney. Managing Director, Ronald M. Beale. Sales Manager, J. M. Davis. Interstate Reps.: Maples Ltd., Melbourne and Prahran, Vic.; Maples, Wagga, Albury and Cootamundra; Maples, Launceston, Tas.; Maples, Hobart, Tas.; G. J. Grice Ltd., 90-92 Queen Street, Brisbane, Q.; Savery's Pianos Ltd., 29 Rundle Street, Adelaide, S.A.; Thompson's Ltd., 209 Murray Street, Perth, W.A.

William Begg & Sons, 343 Little Collins Street, Melbourne, Vic. M 1835. Proprietor, Reginald H. Begg. Factory representatives. Distributors of Emmco Radio, Emmco meters, Alpha switches and lamps.

Norman Bell & Coy. (Pty.) Limited, 403 Adelaide Street, Brisbane, Queensland. B 3561. Managing Director, Norman McLeod Bell. General Manager, H. E. Lintott. Distributors of "Magnet" range of electrical fittings, "Genelex" radios and refrigerators.

Bland Radio, Hindmarsh Buildings, Hindmarsh Square, Adelaide, S.A. C 5581. Proprietor, W. J. Bland. Sales Manager, J. E. Varden. Manufacturers of "Operatic" radio receivers. Factory: Queen Street, Knoxville, S.A. (F 5581).

Bloch & Gerber Ltd., 48 York Street, Sydney, N.S.W. MA 6291 (9 lines). G.P.O., 2282M, Sydney. Managing Director, Eugene Gerber. Director, Otto Raz. Radio Distribution Manager, A. Chapman. Manufacturers of Weldon Radio. N.S.W. distributors for Emmco synchronised radio, Metropolitan distributors for Radiola and Airzone receivers.

B.R. (Radio) Limited (Langford, Pickles & Co.), 59-65 Elizabeth Street, Melbourne, C.1. Cl. 4480. Managing Director, H. Tatnall. Manager, C. A. Morris. Sales Manager, J. Carew. Accountant, J. S. Jenkins. Distributors of many radio lines.

MANUFACTURERS' AND WHOLESALERS' DIRECTORY—(Continued)—

Brash, M. & Co. Pty. Ltd., 108-110 Elizabeth Street, Melbourne C.1. Cl 3729. Cables, "Brashpiano," Melbourne. Managing Director, A. G. Brash. Sales Manager, J. E. Rowson. Radio Dept. Manager, C. R. Graham. Radio Foreman, J. Jackson. Distributors for Stromberg-Carlson and Radiola. Australian distributors for Linconola and Studeberg.

BREVILLE RADIO, 486 Elizabeth Street, Sydney, N.S.W. M 6391. Proprietors: W. J. O'Brien and C. H. Norville. Sales Manager, W. J. O'Brien. Chief Engineer, C. H. Norville. Factory Manager, H. Hart. Manufacturers and distributors of a complete range of receiving sets. Branch Office: Breville Radio Pty. Ltd., 191 Queen Street, Melbourne (Manager, E. Beal). Interstate Reps.:—Pike Bros. Ltd., Queen Street, Brisbane, and at Toowoomba, Townsville, Roma and Lismore. Wyper Bros. Ltd., Bundaberg, Q.; Williams' Pty. Ltd., Rockhampton. Stanley B. Davis & Co., Electra House, 85 Custom House Quay, Wellington, N.Z. Universal Distributors Pty. Ltd., 30a Argyle Street, Hobart, South Tas. Wills & Co. Pty. Ltd., 7 Quadrant, Launceston North Tas. Stott & Hoare, 21 Grenfell Street, Adelaide, S.A. Stott & Hoare Typewriters Ltd., 55 William Street, Perth, W.A.

British General Electrical Co. Ltd., Magnet House, 104-114 Clarence Street, Sydney, N.S.W. BW 2941. Telegrams & Cables "Osram" Sydney. G.P.O., 1594BB. Managing Director, E. E. Hirst. Melbourne Manager, T. E. Morgan, 388 Bourke St., Melbourne (Cl. 9940); Perth Manager, T. W. John, 370 Murray Street (B 5141); Newcastle Manager, K. W. Bullough, 141 Scott Street ('phone 1259); Hobart Manager, K. B. Hayes, 55 Elizabeth Street ('phone 3789). Agents: Brisbane—Norman Bell & Co. (Pty.) Ltd., 403 Adelaide Street (B 3561); Adelaide—A. G. Healing Ltd., 171 Pirie Street.

BRITON ELECTRICAL & RADIO CO., 25-27 Mountain Street, Broadway, Sydney, N.S.W. MA 6438 (3 lines). Proprietors, James and John N. Briton. Sales Manager, B. Pain. Production Manager, C. C. Fogg. Manufacturers of Briton radio receivers ("Aeolian" in N.Z.). Interstate Distributors: Vic., A. P. Sutherland, Queen's Bridge, 2 Maffra Street, South Melbourne; Queensland, Irvine & Shea, Perry House, Elizabeth Street, Brisbane; W.A., Duncan Preston Ltd., 36-38 King Street, Perth; New Zealand, Corderoy, Wells & Co. Ltd., 127 Caskell Street, Christchurch.

Broadway Radio Laboratory, Bank Chambers, Cnr. Broadway & City Road, Sydney. MA 7038. Proprietor, R. Chilton. Laboratory consulting service. Radio repair and service. Specialised radio equipment.

Wm. L. Buckland Pty. Ltd., 139-141 Franklin Street, Melbourne, Vic. F 6644 (6 lines). Telegrams, "Willbuck," Melbourne. Managing Director, Wm. L. Buckland. Secretary, W. E. W. Hodgkiss. Distributors for Airmaster Radio Receivers, Celebrity Mastermade Radio, Emmco. Wholesale Distributors for Diamond and Ever-Ready Batteries, U.S.L. car and radio batteries, Philips and Radiotron valves, etc. Interstate Branches:—Cnr. Charles & Cameron Streets, Launceston, Tasmania (L'ton 1900—W. A. Wheeler, Manager); 57 Liverpool Street, Hobart, Tas. (H'bart 4130—Manager, M. Thomson). Overseas Reps.: Brown Bros. Ltd., Great Eastern Street, London, E.C.2.

C

Carlyle & Company, 915-917 Hay Street, Perth, W.A. B 9371 (3 lines), Box J716. Telegrams, "Lylecar," Perth. Manager, C. Cohen. General wholesalers of all radio components.

J. B. Chandler & Co., 43 Adelaide Street, Brisbane, Queensland. B 2041 (6 lines). Managing Director, John Beale Chandler. Manager, W. G. Duncan. General Sales Manager, V. F. Mitchell. Wholesale distributor for all radio, electrical heating and lighting supplies. Distributors for Radiola receivers, public address equipment and accessories; Radiotron valves; Diamond batteries; Masse accumulators; Carboncels, Lewcos; Amplion; Lekmek kits; I.R.C.; Bradley Resistors; Radiokes; Wetless Crown accessories; Slade test equipment. Branch Offices:—J. B. Chandler & Co., 122 Flinders Street, Townsville, Queensland ('phone 13—Manager, T. Alexander); Rockhampton Broadcasting Co. Pty. Ltd., Cr. William & East Streets, Rockhampton, Q. ('Phone 452—Manager, E. J. Rheuben); Gold Radio Service Pty. Ltd., Ruthven Street, Toowoomba, Q. ('Phone 88—Director, E. Gold). Secretary, W. G. Duncan.

A. M. Clubb & Co. Ltd., 45 King Street, Sydney, N.S.W. M 4065. Managing Director, Alexander Murrison Clubb. Manager Radio Electric Dept., A. M. Clubb. Manager Merchandise Dept., T. Tobias. Distributors for Telefunken radio valves and equipment, Presto Universal disc recorders and parts. Overseas Reps.: Francis Chapman, Sons & Deekes Ltd., London.

CLYDE ENGINEERING CO. LTD., Clyde Works, Granville, N.S.W. UW 8881-5. Cables: "Phoenix," Sydney. Telegrams, "Clyde Engineering," Granville. Directors: G. Weymouth, J. H. S. Angus, A. B. F. Rofe, C. G. Hudson, Wm. Sinclair. General Manager, A. D. J. Foster. Sydney Main Sales & Service Division, 61-65 Wentworth Avenue, Sydney. Sales Manager, F. Cavin Young. Branches: Queensland—115 C.E.H. Buildings, Albert & Charlotte Streets, Brisbane (Manager, C. A. Hammond); Vic.—194-6 Latrobe Street, Melbourne (Manager, C. M. Nightingale); S.A.—155-7 Grenfell Street, Adelaide (Manager, A. G. Evennett). Manufacturers of general engineering, electric powr plants, batteries, etc.

Colton, Palmer & Preston Limited, Currie Street, Adelaide, S.A. Cl. 3580 (10 lines). Joint Managing Directors, E. F. Hamilton and Roy H. Palmer. Distributors of Masterpiece Radio and Astor Radio.

MANUFACTURERS' AND WHOLESALERS' DIRECTORY—(Continued)—

C

COLVILLE WIRELESS EQUIPMENT COMPANY, 4 Rowe Street, Sydney, N.S.W. B 2261. Proprietor, S. V. Colville. Designers and Manufacturers of broadcast transmission equipment, communication transmitters and receivers, ultra high frequency apparatus, aircraft and portable transmitters and receivers, custom-built broadcast receivers and amplifiers, Colvilleco transmitting condensers. Australian agents for National Coy. Inc., Malden, Mass., U.S.A., and E. F. Johnson Coy., Waseco, Minn., U.S.A.

COMMONWEALTH MOULDING CO. LTD., 242 Princes Highway, Arncliffe, N.S.W. LW 2480-1. Managing Director, S. C. Mitchell; Director, A. W. Baker; Sales Manager, J. P. Taylor; Secretary, R. Clancy. Interstate Branches: Marquis Mouldings Pty. Ltd., 208 Lonsdale Place, Melbourne, Central 6218. Sales Executive, L. D. Sheehy. Distributors: G. P. Embelton & Co., 208 Lonsdale Place, Melbourne; P. H. Phillips, 195 Elizabeth Street, Brisbane; A. M. Ralph, 68 Flinders Street, Adelaide; Carlyle & Co., 915 Hay Street, Perth; Fox & MacGillycuddy Ltd., York Street, Sydney; O. H. O'Brien, 37 Pitt Street, Sydney; Noyes Bros., Clarence Street, Sydney; Lawrence & Hanson, York Street, Sydney. Manufacturers of Marquis Radio Components.

CONDENSER SPECIALTY CO. LTD., 112 Rothchild Ave., Rosebery, N.S.W. 'Phone Mas 700. Manager, Keith D. Davison. Manufacturers of "C.S.C." paper di-electric radio receiving, industrial and transmitting condensers Mica transmitting condensers.

CONTINENTAL CARBON CO. PTY. LTD., 174 Queen Street, Melbourne. Cl. E5259. Telegrams and cables, "Resis," Melbourne. Trade name, "Continental." Managing Director, F. W. Clark. Adelaide Rep.: National Radio Co. Ltd., 96 Pirie Street, Adelaide, Cl. 2069. Manufacturers and distributors of electrolytic condensers, carbon resistors, auto radio suppressors and resistors.

Crammond Radio Mfg. Co., 8 Queen Street, Brisbane. B 6431. Managing Director, A. Crammond. Manufacturers of Crammond Receivers, full range of all-electric and battery receivers, comprising fourteen models.

Crown Radio Manufacturing Company, 155 Bourke St., East Sydney, N.S.W. F 3109-F 3100. Proprietor, J. B. Phillips. Sales Manager, Manufacturers of all types of wire wound components, dual wave kit assemblies, kit-sets and broadcast and dual wave dials. Factory Reps.: G. P. Embelton & Co., 208-210 Lonsdale Place, Melbourne, Vic.; A. E. Harrold, 123-125 Charlotte Street, Brisbane, Queensland; J. G. Pritchard Ltd., 18 William Street, Perth, W.A.

D

DALTON, H. & CO., 85 Eveleigh Street, Redfern, N.S.W. MA 5580. Proprietor, H. Dalton. Manufacturers of moulded formers, sockets, etc. Interstate Distributors: N.S.W.—Bloch & Gerber Ltd., James & Vautin; Vic.—R. E. Trickey & Co.; S.A.—R. C. Forbes & Co.; W.A.—Associated Distributors.

Davis, A. G. & Co., Wembley House, Railway Square, Sydney. MA 2866. Proprietor, A. G. Davis. General Wholesaler.

Dickin, F., Ltd., 18-34 Lords Road, Leichhardt, P.O. Box 18, Leichhardt. Products, "Dickin" cabinets. Managing Director, A. J. Dickin. Sales Manager, T. H. Dickin. LM 4431-2.

A. W. Dobbie & Company, 53-55 Gawler Place, Adelaide, Central 6170. Managing Director, H. R. Pinkerton. Manager, J. T. Altass. Distributors of Radiophone Radio Receivers, Stanmor Dry Batteries. Wholesale & Retail Distributors Radio & Electrical goods.

Dual Tone Radio Co., 81 Station St., Fairfield, Vic. JW 3464. Directors: W. S. Begg and J. C. Begg. Manufacturers and distributors of Dual-tone radio.

DUCON CONDENSER PTY. LTD., 73-83 Bourke Street, Waterloo, Sydney, N.S.W. MA 6104 (3 lines). Telegrams, "Hecht," cables "Esoxur." Manufacturers of electric condensers and resistors. Products: "Ducon" Electrolytic Condensers, "Chanex" Paper and Mica Di-electric Condensers, and "Chanex" moulded mica condensers, "Chanex" Silent Metallised Resistors, "Chanex" wire-wound resistors. Managing Director, A. R. Persson. Sales Manager, C. S. Gittoes. Melbourne Office, 450 Collins Street, Melbourne. Interstate Representatives, H. Hecht & Co. 450 Collins Street, Melbourne, Vic.; W. T. Matthews, 95 Grenfell Street, Adelaide, S.A.; P. H. Phillips, 193 Elizabeth Street, Brisbane, Queensland; Carlyle & Co., 915-917 Hay Street, Perth, W.A.; W. H. Huthnance, "Nathans Building," Grey Street, Wellington, N.Z.; W. & G. Genders, 53 Cameron Street, Hobart, Tas.

Duke, Alan, Pty. Ltd., 486 Bourke Street, Melbourne, Vic. Cl. 1255. Representative of: D. Falshaw & Sons, Gerard Electric Manufacturers Ltd., Australian Westinghouse Electric Co., Mackenzie and Holland (Aust.) Pty. Ltd., Jensen (Aust.) Ltd. (Ohmeg Resistors), Raytheon Valves.

Duncan & Co. Ltd., 107-109 Pirie Street, Adelaide, S.A. C 3344 (5 lines). Managing Director, H. F. Peake. Branch office:—110 Commercial Street, Mount Gambier (Mt. Gambier 587). Manager, C. E. Hill. Manufacturers and distributors of Vasco radio receivers.

Dunlop-Perdriau Rubber Co. Ltd., Flinders Street, Melbourne, C.1., Vic. Dept. Manager, E. Hine. Sydney office, 27-33 Wentworth Avenue. M 2901. Manufacturers of rubber, and plastic moulders.

MANUFACTURERS' AND WHOLESALERS' DIRECTORY—(Continued)—

D.W. Radio Co., 210 Willoughby Road, Crow's Nest. X 5019-X 5010. Proprietors, H. A. and F. M. Warby. Engineer, B. F. A. Brown. Sales Manager, R. W. Patterson. Manufacturers and proprietors of Tela-Verta radio and all classes of chassis and short-wave converters.

E

EASTERN TRADING CO. LTD., 155 Clarence Street, Sydney, N.S.W. B 6305-7. Telegrams and Cables, "Quietando," Sydney. G.P.O. 2920NN. Managing Director, Arthur C. Millingen. Radio Sales Manager, Hillstead I. Hobden. Melbourne office: 486 Bourke Street (M 5693-4—Sales Manager, K. Stevenson). Interstate Distributors: Edgar V. Hudson Pty. Ltd., 284 Edward Street, Brisbane, Q. (B 3733); Newton McLaren Ltd., Leigh Street, Adelaide, S.A. (Cl. 8341); Carlyle & Co., 915 Hay Street, Perth, W.A. (B 9371); W. & G. Genders Pty. Ltd., Launceston and Hobart, Tasmania.

Eclipse Radio Pty. Ltd., 212 City Road, South Melbourne, Vic. M 4681. 137 Clarence Street, Sydney (B 6937). Telegrams and cables, "Eclipse." Products: "Croyden" sets, "Univox" sets, "Alpha" parts, "Saxon" parts. Directors: Albert Aarons, Saul C. Aarons, Charles O. Welsh. Sales Manager, Arch. McPhee. Works Manager, Wm. Kerr. Interstate Branches: Adelaide, Manager, H. Collocott, 43 Austin Street, Adelaide (Cl. 929); Brisbane, Manager, B. Purvis, 156 Creek St., Brisbane, Q.; Sydney, Manager, R. V. Smith, 137 Clarence Street, Sydney (B 6937); Perth, W.A. (B 7430).

EFCO MANUFACTURING CO. LTD., 108 Princes Highway Arncliffe, N.S.W. L 2667 (3 lines). Managing Director, Richard Facer; Thomas Facer, Director; Reginald Facer, Radio Manager. Manufacturers of Efco Dials, Tuning units, Visual Tuning Meters, I.F. Stampings and sundry metal fittings. Distributors: O. H. O'Brien, Melbourne; Newton McLaren, Adelaide; Carlyle, Western Australia.

Eilbeck & Co. Ltd., 70-72 King Street, Sydney, N.S.W. B 5090. Managing Director, W. B. Eilbeck. Distributors of Arcturus Radio Valves, Cornell-Dubilier Condensers. Distributors: Noyes Bros. (Sydney) Ltd., Noyes Bros. (Brisbane) Ltd., Henry G. Small, 374 Post Office Place, Melbourne. Overseas representatives:—Deep Sea Export & Import Co., Inc., New York.

Electrical Service Company, 6 Pacific Street, Newcastle, N.S.W. Newcastle 299. Partners: J. M. Bailey and A. O. Banks. Distributors of "Aristocrat" Radio. General wholesalers and distributors of radio and electrical supplies.

ELECTRICAL SPECIALTY MANUFACTURING CO. LTD., 17-19 Glebe Street, Glebe. MW 2608-9. Telegrams & Cables, "Essemco," Sydney. Directors, O. C. Turner and G. Schliesman. Secretary, G. Hunt. Radio set manufacturers. Distributors: Queensland—Trackson Bros., Brisbane; W.A.—Carlyle & Co. Perth; Tasmania—McCann Bros., Hobart.

Electricity Meter Mfg. Co. Ltd., Joynton Avenue, Waterloo, N.S.W. MA 6043. General Manager, J. I. Carroll. Directors: M. J. MacFarlane (Chairman), J. K. Schartl, E. K. Schulz, J. Bryden-Brown and W. A. Elder. Secretary, J. D. Fitz. Manufacturers of Emmco Radio Sets and Electrice Refrigerators. Distributors of radio products: Radio Industries Ltd., Joynton Avenue, Waterloo; J. G. Pritchard, Perth, W.A. Distributors of Electrice Refrigerators: New System Telephones Pty. Ltd., Sydney, Melbourne and Adelaide.

G. P. Embelton & Co., 208-211 Little Lonsdale Street, Melbourne. Central 9132-9133. Proprietor, G. P. Embelton; Manager, J. Magrath; Accountant, R. J. Gibson. Factory representatives for Crown Radio Products, Marquis Moulded Products. Overseas reps.: E. D. C. C., Old Kent Road, London, Swift Levick & Sons, Sheffield, England.

Essanay Mfg. Co. Pty. Ltd., 54 Buckhurst Street, South Melbourne, Vic. M 3169. Set and parts manufacturer. Directors: E. A. Austin and W. M. Sweeney.

EVER-READY CO. (AUST.) LTD., Marshall Street, Surry Hills, N.S.W. FL 3191 (3 lines). Telegrams and cables, "Readyworks," Sydney. Managing Director, R. P. Walter. Director and Manager, A. Jewell. Director and Production Manager, S. W. H. Newman. Sales Manager, G. K. Herring. Publicity Manager, F. H Tisbury. Secretary, O. Armstrong. Interstate branches: Melbourne, 360 Collins Street, Cl 4417, Manager, John Leeman. Brisbane, Perry House, Elizabeth Street, B 9811—Manager, Chas. H. Hart. Dry battery manufacturers. Ever-Ready Batteries and torches distributed by all wholesalers.

Exide Batteries of Australia Limited, 77 York Street, Sydney, N.S.W. M 3001 — MA 4795. Interstate Distributors: Deering Engineering Co. Ltd., Wattle Street, Sydney, N.S.W.; A. P. Sutherland, 2 Maffra Street, Melbourne, Vic.; Exide Battery Service (Q.) Pty. Ltd., Adelaide Street, Brisbane, Queensland; Unbehaun & Johnstone Ltd., Gawler Place, Adelaide, S.A.; M. J. Bateman Ltd., Milligan Street, Perth, W.A.; Medhurst & Sons Pty. Ltd., 95 Collins Street, Hobart, Tasmania. Manufacturers of "Exide" Secondary Batteries for all purposes.

EXPRESS ELECTRICAL INSTRUMENT CO. LTD., 118-124 Bourke Road, Alexandria, N.S.W. (Subsidiary of Stromberg-Carlson A/sia Ltd.). Makers of radio and electrical testing equipment.

Eyelets Pty. Ltd., 42-8 Green Street, Windsor, S.1. Windsor 7084-5. Telegrams and cables, "Eyelets," Melbourne. Interstate Reps.: C. H. R. Johnston, cnr. Cleveland and Buckingham Streets, Sydney; P. G. Lavers, 125 Adelaide Street, Brisbane, Queensland; F. L. Runge, Edments' Buildings, Rundle Street, Adelaide, S.A.; C. R. Palmer, 75 King Street, Perth, W.A. Makers of metal parts.

MANUFACTURERS' AND WHOLESALERS' DIRECTORY—(Continued)—

F

Fallshaw D. & Sons, 1 Boundary Road, North Melbourne, Vic. F 4636. Director, F. Fallshaw. Manufacturers of radio cabinets.

Ferrocart (A/sia) Pty. Ltd., 174 Queen Street, Melbourne. M 5343. Managing Director, Fred W. Clarke. Distributors: Simplex Radio. Manufacturers of Ferrocart Inductances and vibrators for elimination of B & C batteries.

Findlays Pty. Ltd., Cnr. George & Brisbane Streets, Launceston. 'Phone 482. Directors: A. P. Findlay, S. H. Findlay. Distributors of A.W.A. Radiola and Stromberg-Carlson radio apparatus. Branch offices: 80-82 Elizabeth Street, Hobart (Manager, S. H. Findlay); Wilson Street, Burnie (Manager, A. D. Towner); Rooke Street, Devonport (Manager, E. Foster).

Fox & MacGillycuddy Ltd., Merino House, 57 York Street, Sydney, N.S.W. G.P.O. 2144LL. B 2409. Telegrams, "Fox Radio," Sydney. Managing Director, A. R. Fox. General Manager, G. T. Swanson. Wholesalers and distributors of all radio lines.

G

Gage, H., Tempany Street, North Fitzroy, Vic. JW 1138. Manufacturers of radio cabinets.

J. R. W. Gardam & Co., 138 Murray Street, Perth, W.A. B 9241-2. G.P.O. L903. Telegrams and cables, "Gardam," Perth. Sales Manager, R. A. Hull. Distributors Philips, Volta, Igranic, Ferranti, Jensen.

General Mica Supplies (Aust.) Pty. Ltd., 496 Church Street, Richmond, E.1., Vic. J 2774. Mica specialists, mine owners. All mica requirements. Managing director, R. Coggan. Telegrams, "SuperMicas."

Genkay Electric Co., 379 Kent Street, Sydney, N.S.W. MA 2872. Manufacturers of soldering irons.

Gerard & Goodman Ltd., Synagogue Place, Adelaide, S.A. C 5040 (4 lines). Managing Director, A. E. Gerard. Director, A. Hubert Gerard. Sales Manager, R. L. Culley. Distributors of "Gerard" Radio Receivers and all radio and electrical components. Branch office: 132 Rundle Street, Adelaide (C 5043). Chief Salesman, F. Chalk; Chief Radio Mechanic, C. Tilbrook.

A. H. Gibson (Electrical) Company Pty. Ltd., 23-25 Hardware Street, Melbourne, C.1, Vic. F 3123 (4 lines). Managing Director, A. H. Gibson. Directors, J. J. Yourelle and C. W. Bryant. Radio Manager, E. E. Seabridge. Sole Victorian agents for Sylvania valves and Paton Electrical Testing Instruments. Victorian country distributors for Essanay. London Office: 3 South Place, Moorgate, E.C.2.

THE GRAMOPHONE CO. LTD., H.M.V. (Australian Branch of British Company at Hayes, Midd.), 2 Parramatta Road, Homebush, N.S.W. UM 6671. General Manager, W. A. Donner. Sales Manager, W. C. Simpson. Manufacturers of "His Master's Voice" H.M.V. Radio Receivers. Distributors: Melbourne—Columbia Graphophone (Aust.) Ltd., 347 Flinders Lane, C.1 (M 5675); Brisbane—A. E. Harrold, 123 Charlotte Street; Adelaide—S. Hoffnung & Co. Ltd., 83 Grenfell Street (Cl. 4170); Perth—Nicholsons Ltd., 86 Barrack Street (B 6131); Hobart—Findlays Music Warehouse, 80 Elizabeth Street ('Phone 3718); Launceston—Wills & Co. Pty. Ltd., 7 The Quadrant ('Phone 501). Overseas Reps.:—Gramophone Co. Ltd., Hayes, Middlesex.

G. J. Grice Limited, 90-92 Queen Street, Brisbane, Queensland. B 1674. Managing Director, Arthur Baynes. Manager Radio Dept., R. J. Boulton. Queensland Reps.: J. Wylie, Cairns; P. J. Bodkin, Toowoomba; R. Musgrave, Townsville; L. Shaw, Rockhampton. Distributors of Beale and Tasma radio sets and Impex Batteries. Darling Downs Distributors for Astor Radio.

H

D. Harris & Co., 140 Rundle Street, Adelaide, S.A. C 6122 (2 lines). Partners, D. T. Harris and S. D. Harris. Manufacturers of "Radion" radio receivers. Distributors for "Fairbanks-Morse" refrigerators, "Rola" speakers, "Simplex" condensers, "Hygrade" radio cabinets. All radio accessories, electrical appliances.

Harris, Scarfe & Sandovers Ltd., Hay Street, Perth, W.A. B 8131. Wholesalers.

Harris, Scarfe Limited, Grenfell Street, Adelaide, S.A. Cl. 3300. Directors: P. J. A. Lawrence (Chairman), Harold Law Smith, C. C. Deeley, F. E. Robertson, F. W. Trowse. Distributors of Airzone, Emmco, National, Serenader, Prelude and General Electric radio receivers. General hardware merchants. Branch offices at Pt. Adelaide and Broken Hill.

A. S. HARRISON & CO. LTD., 85 Clarence Street, Sydney, N.S.W. B 6541 (2 lines). Managing Director, A. S. Harrison. Distributors of "Nestorite" Moulding Powders. Overseas Reps.: London House, 11 Dowgate Hill, Cannon Street, London, E.C.4.

A. E. Harrold, 123-125 Charlotte Street, Brisbane B 2729 (2 lines). Telegrams, "Harrold," Brisbane. Proprietor, A. E. Harrold. Distributors of His Master's Voice Radio, Crown Radio Mfg. Co., Simplex Radio, Continental Carbon Co., The Rola Co. Aust. Pty. Ltd. Hartleys Pty. Ltd., 270 Flinders Street, Melbourne, C.1. Central 4970. Managing Director, H. W. Joseph, Associate Directors:—R. Lyne, T. Stevens, A. Steward; Manager, Radio Department, A. Steward. Branch Office: 148 Swanston Street, Melbourne, C.1. Central 6065. Manager, T. R. Robertson. Interstate representatives: R. W. Cameron & Co., Inc., 34 Queen Street, Melbourne, C.1. Manufacturers of Silvatone, Cruiser and Hartsport Radio receivers. Distributors of Radiola and Tasma receivers. Overseas Reps.: Forbes Munn & Co., 1 Bishopgate, London, E.C.2.

MANUFACTURERS' AND WHOLESALERS' DIRECTORY—(Continued)—

Hartley's Teleray. Proprietor, H. Hartley, 5 Daley Rd., Sandringham, S.8, Vic. XW 1623. Manufacturer of short wave converters (specialising). Trade names, "The Pigmy" and "Air Scout."

A. G. Healing Ltd., 167-173 Franklin Street, Melbourne, C.1, Vic. F 5171 (10 lines). Telegrams and cables, "Healing," Melbourne. Manufacturers of Healing Golden Voiced Radio Receivers and Healing Refrigerators. Managing Director, N. Broomhall. Radio Manager, Ross M. Walker. Interstate Branches: S.A., 155 Pirie Street, Adelaide (Cl. 4635); N.S.W., 164 Goulburn Street, Sydney (FL 2601); Queensland, A. Higgins, "Aloomba," Dornack Terrace, Highgate Hill, South Brisbane; W.A., Australian Radio Supply Co., 804 Hay Street, Perth; Tasmanian Rep.: C. J. Irvine, Wyatt Street, Hillside Crescent, Launceston.

Henderson, P. A. & Co., 571 Pacific Highway, Crow's Nest, N.S.W. (X 1214-X1087). Trade name, "Henderson." Products, Henderson power equipment. Manager, P. A. Henderson.

Hilco Transformers Pty. Ltd., 97-107 Berkeley Street, Carlton, N.3, Vic. F 5651. Telegrams and cables, "Hilcoy," North Melbourne. Products: Transformers for all electrical purposes.

HOELLE, J. J. & CO., 47 Alma Street, Darlington, N.S.W. MA 5762. Manufacturers of lugs, terminals, and electrical goods. Sales Manager, J. J. Hoelle. Interstate Reps.: Queensland—Electrical Agency, 193 Elizabeth Street, Brisbane; Vic.—G. P. Hordern, 499 Little Collins Street, Melbourne; N.S.W.—D. Beston, Kent Street, Sydney (M 3926).

HOMECRAFTS PTY. LTD., 211 Swanston Street, Melbourne, Vic. Cl. 8200-1. Managing Director, Sladen Gibson. Country Sales Manager, D. Campbell. Country traveller, G. Bryce. Suburban traveller, G. Hetherington. Victorian Distributors for Astor Radio, Mullard Valves, etc. General wholesalers radio and electrical and all cycle accessories. London office, 12 Howard Road, Walthamstow.

HOWARD RADIO PTY. LTD., Vere Street, Richmond, Vic. J 5148. Manager & Director, F. Henderson. Sales Manager, J. Phillips. General wholesalers, manufacturers of radio receivers, pianos, player pianos, radio components, switchboard frames. Agents for Garrad products, Mullard valves, "Hashe" bowls, Enwell products, "Silverex" crystal, "Radior" auto globes, Apex washing machines and ironers. Distributors for Condor Lamps, Hecla products, Diamond and Ever-Ready batteries, Greengate cables. Interstate Reps.: N.S.W.—Stanley E. Green, C/- McPherson & Foster Co., Brougton House, 181 Clarence Street, Sydney; Queensland—Carnegie Bros., 210 Queen Street, Brisbane.

International Radio Company Ltd., 254 Castlereagh Street, Sydney, N.S.W. M 4896 (3 lines). Managing Director, Chas. E. Forrest. Sales Manager, Clifford G. Salmon. Secretary, W. G. Frizelle. Distributors of Jensen Speakers, Goat Valve Shields, Amphenol Valve Sockets and Plugs, Ohiohm Resistors; National Union Valves—cathode ray tubes, pilot lamps and photoelectric cells; "Shure" microphones; Pioneer Gen-E-Motors and Chargers; Amperite Microphones; Lenz Hook-up Wire; Sprague condensers; Ohiohm Suppressors; Ohiohm Volume Controls; General Industries Electric Motors and record changers; Magicores; Easy Washing Machines and Ironing Machines; Sparton Refrigerators. Branch Offices: 403 Bourke Street, Melbourne, Vic. (F 2858); 178 Rundle Street, Adelaide, S.A. (Cl. 2425); C.T.A. Buildings, Elizabeth Street, Brisbane, Queensland (B 9411); Courthouse Lane, Auckland, New Zealand (40-400). Melbourne Manager, Norman Swann; Adelaide Manager, H. Lyne; Brisbane Manager, G. W. Lindsay; Auckland Manager, Miles Nelson.

INTERNATIONAL RESISTANCE COMPANY (A/SIA) LTD., 55 Addison Road, Marrickville. BW 2385-6. Telegrams "Ircal." Directors, Wm. J. McLellan, and Maxwell Walker. Secretary, G. E. Lucas. Distributors, Wm. J. McLellan & Co., 55 York Street, Sydney. Manufacturers of I.R.C. Ceramic Metallised Resistors, Insulated Metallised Resistors, Wire Wound Resistors.

Jackson & Macdonald, 360-362 Kent Street, Sydney, N.S.W. M 226. Directors: S. J. Jackson and D. S. Macdonald. Manufacturers of Radio cabinets.

James & Vautin, 661 George Street, Sydney, N.S.W. MA 2437. Cables, "Tokalon." Directors: W. H. James and C. M. Vautin. Sales Manager, K. Ritchie. Interstate Distributors:—W.A.—Atkins Ltd., 894 Hay St., Perth; Queensland—Irvine & Shea, Perry House, Elizabeth Street, Brisbane; Victoria—R. E. Trickey, 403 Bourke Street, Melbourne; S.A.—R. E. Trickey, Adelaide. Distributors for: Hytron radio valves, "Perthane" Insulating materials, "Empire" clocks, paper and tapes, wires cables and flexibles, bakelite mouldings, "Whitford" all-wave switches.

John Martin Ltd., 116-118 Clarence Street, Sydney. B 1492. Telegraphic address, "Jonmar," Sydney. Managing Director, John Martin. Distributors of Radiokes Products, Lekmek Products, Hammerlund Products, Speer Resistors.

K

KRIESLER A/SIA LTD., Cnr. Pine, Myrtle & Beaumont Streets, Chippendale, Sydney, N.S.W. M 4391 (2). Makers of Kriesler radio receivers and components. Australian distributors for Milnes battery units and Winchargers (wind-driven charger). Trade name, Kriesler. Chairman of Directors, P. G. Tuit; Technical Director, Rae Weingott.

MANUFACTURERS' AND WHOLESALERS' DIRECTORY—(Continued)—

Keep Bros. & Wood Pty. Ltd., 200 Latrobe Street, Melbourne, C.1, Vic. F 1155. Distributors "Astor" radio receivers.

L

Lawrence & Hanson Electrical Co. Ltd., 33 York Street, Sydney. B 6476. Box 2551. Telegrams and Cables: "Lawhanson" (all States). Branches: 172-6 William Street, Melbourne, Cl.10394; 87 Elizabeth Street, Brisbane, B 1407; 120 Collins Street, Hobart; 20 Leigh Street, Adelaide, Cl. 2106; 26 Hunter Street, Newcastle. Managing Director, A. J. Hanson. Directors, A. E. Kaleski and A. R. Hanson. Wholesalers and distributors Glover's C.M.A. wires and cables; Smith's synchronous electric clocks; Philips electric lamps. Distributors Philips valves.

LEKMEK RADIO LABORATORIES, 75 William Street, Sydney, N.S.W. FL 2626 (3 lines). Telegrams and cables, "Lekmek," Sydney. Proprietor, N. S. Gilmour, Chief Engineer, J. Paton; Factory Supt., A. V. Bates. Manufacturers of Radio Receivers, Superfine Kits and Components, special High Fidelity Telegraphic and Broadcast Equipment, Standard Signal Generators, etc., etc. Receivers distributed by:—The Lawrence & Hanson Electrical Co. Ltd., Sydney, Melbourne, Hobart and Brisbane; H. C. Little & Co. Ltd., 858 Hay Street, Perth; A. & S. McCrum, 352 Hunter Street West, Newcastle; L. G. Lovell & Co., 562 Ruthven Street, Toowoomba. "Superfine" Kits and Components distributed by:—Fox and MacGillycuddy Ltd., 57 York Street, Sydney; Bloch & Gerber Ltd., 46-48 York Street, Sydney; The Lawrence & Hanson Electrical Co. Ltd., 33 York Street, Sydney; John Martin Ltd., 116 Clarence Street, Sydney; A. & S. MacCrum, 352 Hunter Street, Newcastle; E. V. Hudson Pty. Ltd., 284-6 Edward Street, Brisbane; Australian Engineering Equipment Co. Pty. Ltd., 415 Bourke Street, Melbourne; H. C. Little & Co. Ltd., 858 Hay Street, Perth; The Lawrence & Hanson Electrical Co. Ltd., 172-6 William Street, Melbourne; The Electric Lamp House Ltd., 27 Manners Street, Wellington; Electric and General Import Co., 209 Manchester Street, Christchurch; A. & W. McCarthy, 295 Stuart Street, Dunedin; Newton McLaren Ltd., Leigh Street, Adelaide.

Little, H. C. & Co. Ltd., 858 Hay Street, Perth, W.A. B 7148. Box D154. Telegrams and Cables: "Litelectra." Managing Director, H. C. Little. Distributors of Lekmek Radio products.

Liverpool Electric Cable Co. Ltd. (in conjunction with its associated company, London, Electric Wire Co. and Smith Ltd.), Lewcos House, 233 Clarence Street, Sydney. MA 6001 (3 lines). Australian Manager, A. Maughan. Interstate representatives: Vic.— 586 Bourke Street, Melbourne (J 4966—Manager, T. E. Dukes); W.A.—Carlyle & Co., 915 Hay Street, Perth; Q'land—(industrial) Intercolonial Boring Co. Ltd., Ann Street, Brisbane; (radio) J. B. Chandler & Co., 43 Adelaide Street, Brisbane; S.A.—Robert C. Forbes & Co., 30a Currie Street, Adelaide; Tasmania—W. L. Buckland Pty. Ltd., 57 Liverpool Street, Hobart and Charles Street at Cameron Street, Launceston. Wholesalers for all kinds of electric wires.

M

McColl Electric Works Pty. Ltd., 104-112 Moor Street, Fitzroy, N.6, Vic. J 3197. Manufacturers of B battery eliminators, D.C. and A.C. converters and battery chargers.

McKenzie & Holland (Aust.) Pty. Ltd., Electrical & Mechanical Engineers, Newport, W15, Vic. Williamstown 429. Telegrams: "Holland-Spotswood," Vic. Cables: "Schwirren." Branch office: McKenzie & Holland, Northgate, Brisbane, Q'ld. M 6001. Telegraphic address, "Nundah," Brisbane. J. B. Jacobson, Mgr. Dir. Manager, A. W. Beauchamp. Distributors: E. V. Hudson Pty. Ltd., Brisbane, Queensland; Amplion (A/sia) Ltd., Sydney, N.S.W.; Alan S. Duke Pty. Ltd., Melbourne, Vic.; Newton McLaren Ltd., Adelaide, S.A.; Carlyle & Co., Perth, W.A. Manufacturers of "Westinghouse" metal rectifiers, "Holanite" plastic moulding, "Westric" battery chargers, etc.

WILLIAM J. McLELLAN & CO., Bradbury House, 55 York Street, Sydney, N.S.W. BW 2385-6. Telegrams, "Normac," Sydney. Proprietors, Wm. J. McLellan and M. Walker. Distributors: Fox and MacGillycuddy Ltd., Noyes Bros. (Sydney) Ltd., John Martin Ltd., Martin de Launay Ltd., Australasian Engineering Equipment Co. Pty. Ltd., Victoria, Australasian Engineering Equipment Co. Pty. Ltd., South Australia, Edgar V. Hudson Pty. Ltd., Queensland, J. B. Chandler & Co., Brisbane, W. & G. Genders Pty. Ltd., Hobart and Launceston. Distributors of "I.R.C." Insulated Metallised Resistors, Volume Controls, Precision Resistors, Wire Wound Resistors, "T.C.C." Mica Moulded Condensers, Tubular Paper Condensers, Electrolytic Condensers, Transmitting Condensers. Overseas Reps.: Gambrell Bros. & Co. Ltd., London, Baldwin Instrument Co., London, Rubicon Instrument Co., Philadelphia.

C. A. Maddern, 7 Twin Street, Adelaide, S.A. C 6383. Proprietor, C. A. Maddern. Manufacturers of Keystone Radio, all types.

Magnavox (Australia) Ltd., 61 Dowling Street, East Sydney, N.S.W. FL 4174. Managing Director, D. T. Hinchen. Manufacturers of dynamic speakers.

Mica Insulating Supplies Co., 562-4 Bourke Street, Melbourne, Vic. Cl. 3669, F 5307. Telegrams, "Mandisco," Melbourne. S.A. Rep.: A. M. Ralph, 68 Flinders Street, Adelaide (Cl. 4803). Proprietors, J. W. and G. W. Griffiths and W. C. Pitcher. Manufacturers of micanites and insulating materials.

MANUFACTURERS' AND WHOLESALERS' DIRECTORY—(Continued)—

M

Micanite and Insulating Manufacturers, 31 Guildford Lane, Melbourne, Vic. Cl. 5479. Proprietor, P. J. O'Hanlon (Electrical Manufacturer). Mica, micanite tube and section manufacturers. General moulders of radio and electrical trade.

Mick Simmons Ltd., 720 George Street, Haymarket, Sydney, N.S.W. M 6311. Managing Director, R. M. Simmons. Distributors of Radiola, Airzone, Astor, Oceanic, Kriesler, Emmco radio sets.

MILLS, Wm. J., 187 Catherine Street, Leichhardt, N.S.W. Petersham 2191. Carbon resistor manufacturer. Trade mark, "Bifrost."

Moulded Products (A/sia) Pty. Ltd., 37-41 Scotchmer Street, North Fitzroy, N.7, Vic. JW 1144-5. Telegrams and cables: "Vocal-Gramo." Bentley's Code. General Manager, J. C. Dickens. Manager, John W. Derham. Sydney Reps.: Dobson Agency Co., 142 Clarence St.; Adelaide, Lodge & Hill, 91 Grenfell Street; Melbourne, Aust. Moulding Corp. Pty. Ltd., 302 Flinders Lane. Manufacturers of all types of synthetic resin mouldings.

THE MULLARD RADIO COMPANY (AUST.) LIMITED, 26-30 Clarence Street, Sydney, N.S.W. B 7446-7. Cables and Telegrams, "Mulvalve," Sydney. G.P.O., 2118L. General Manager, Eric Dare. Sub-distributors: Victoria and Tasmania—Howard Radio, Melbourne; S.A.—R. C. Woollard, Adelaide; Queensland—V. J. Griffiths, Brisbane and Elphinstones Pty. Ltd.; W.A.—Carlyle & Co., Perth.

Musgrove's Ltd., Lyric House, Murray Street, Perth, W.A. B 1971. G.P.O. Box 195. Telegrams: "Pianoforte," Perth. Manager Radio & Electrical Depts., F. C. Kingstone. Branches: Atwell's Arcade, Fremantle (FM 2829); Victoria Street, Bunbury ('phone 151); Albany Road, Victoria Park. W.A. distributor of Stromberg-Carlson receivers.

N

Nally Limited, 15 Castlereagh Street, Sydney, N.S.W. B 6751-2. Managing Director, Arthur A. Kelly. Secretary, H. R. Griffiths. Manufacturers of Nally Ware and Plastic Mouldings.

National Radio Co. Ltd., 96 Pirie Street, Adelaide, S.A. 'Phone 2069. Directors: E. R. Smith and Oswald Smith. Manager, E. R. Lindberg. Sales Manager, K. Wadham. Secretary, John Scherd. Manufacturers of National radio receivers, broadcast and dual wave. Branch office: Victoria House, Perth, W.A., Manager, E. Kanke.

New Herberholds (A/sia) Ltd., 431 Hoddle Street, Abbotsford, N.9, Victoria. J 4377-8. Managing Director, W. F. Winter. Sales Manager, Colin W. Smith. Accountant, V. S. Rankin. Manufacturers and distributors of Impex Oxygenated Batteries (all types), Impex Fixed Carbon Resistors, Impex radio valves, Impex torches. Interstate distributors: 181 Clarence Street, Sydney, N.S.W. (MA 3602—Manager, A. J. Solomon); V. J. Griffiths, Exton House, Queen Street, Brisbane, Queensland; R. C. Woollard, 18 Chessar Street, Adelaide, S.A.; G. G. Martin, 26 King Street, Perth, W.A.

NEW SYSTEMS TELEPHONES PTY. LTD., 276-278 Castlereagh Street, Sydney, N.S.W. M 6425. Telegrams, "Newsyaust." General Manager, J. I. Carroll. N.S.W. Manager, R. M. Davies. Branches: 276 Flinders Street, Melbourne, Vic. (M 3191—Manager, M. Butler); 155 Rundle Street, Adelaide, S.A. (Cl. 6676—Manager, R. M. Sadler). Interstate Distributors: Kohn Bros. Pty. Ltd., 118 York Street, Launceston, Tas.; McCann Bros., 180 Elizabeth Street, Hobart, Tas.; Howards Ltd., 317-27 Adelaide Street, Brisbane, Q.

NEWTON, McLAREN LIMITED, Leigh Street, Adelaide, S.A. Cl. 8341 (6 lines). Managing Director, D. Eardley McLaren. Secretary, B. H. Kelsey. Accountant, H. E. Morgan. Radio Manager, John P. Hale. Elec. Manager, J. F. Pettersen. Engineer, F. A. McIntosh. Distributors of: A.W.A. Radiolas, Efco Dials, Stromberg gangs, Wetless, Diamond Batteries, E.T.C. generally, Amplion, Reynolds, etc. Radio electrical and mechanical engineers manufacturers importers and wholesalers. Overseas reps.: Keep Bros. Ltd., 35 Great Charles Street, Birmingham 3, England; Deep Sea Export & Import Co., Inc., 73 Pearl Street, N.Y., America.

Nicholson's Ltd., Barrack Street, Perth, W.A. B 6131. Branch: 85 High Street Fremantle (FM 2266). Wholesalers.

Nilsen, O. J. & Co. Pty. Ltd., 45-47 Bourke Street, Melbourne, Vic. Cl. 572, and 35 King William Street, Adelaide, S.A. Telegrams: "Nilseno," Melbourne. Manager, Oliver J. Nilsen. Sales Manager, C. T. Cromie. Manager Adelaide branch: Vic. Lawford.

NOYES BROS. (SYDNEY) LTD., 115 Clarence St., Sydney, N.S.W. B 7581. Telegrams and Cables: "Noyes." Box 1587B, G.P.O., Sydney. General, Manager, T. Malcolm Ritchie. Merchandising Dept., A. W. L. Ellis. Electrical Supplies Section, J. A. Bull. Makers and designers of "Seyon" receivers, "Seyon" signal generators and oscillators, "Seyon" valve tester and set analysers. Distributors for: Ferranti products. Gladstone transmitting equipment, Arcturus valves, Whiting pick-ups, Simpson electric turntables and general wholesalers of practically all lines.

Noyes Bros. (Melb.) Ltd., 597-603 Lonsdale Street, Melbourne, C.1. Cl. 10105. G.P.O. 779H. Telegrams & Cables: "Noyes," Melbourne. Manager Electrical Dept., F. A. Gordon. Interstate branches: 89 Grenfell Street, Adelaide (Cl. 2357); A. E. Keegan, 138 Murray Street, Perth (B 9241); 36 Argyle Street, Hobart, Tasmania; 59 George Street, Launceston. Distributors for Tasma, S.T.C. and Van Ruyten Radio, and Simpson Electric Turntables. Manufacturers of Seyon radio receivers.

MANUFACTURERS' AND WHOLESALERS' DIRECTORY—(Continued)—

O

O'BRIEN, O. H. (SYDNEY), 37-39 Pitt Street, Sydney, N.S.W. BW 1305 (6 lines). Telegrams and Cables, "Beldas," all States. Proprietor, O. H. O'Brien. Manager, E. R. Tidswell. Branch: 654-64 Bourke St., Melbourne, Vic. (Cl. 2179). Interstate Rep.: W. E. Peterman, 160 Edward Street, Brisbane, Queensland (B 5704). Suppliers of all raw materials for radio and electrical industries.

Ohmegga Resistors (Aust.) Pty. Ltd., 21 Station Street, Carlton, N.3, Vic. F 2867. Managing Director, S. P. Stroud. Factory Manager, E. Petterson. Manufacturers of "Ohmeg" metallized carbon resistors.

OTTO SANDEL LTD., 73 York Street, Sydney, N.S.W. BW 2028. Managing Director, Otto Sandel; Manager, H. Kefford; Accountant, E. Hewitt; Secretary, Harry E. Davis. Branch offices: 248-250 Oxford Street, Woollahra, FW 2625, Manager, J. Sandel. 376 New South Head Road, Double Bay, FM 2111, L. Evans, Manager. 313 Beamish Street, Campsie, Manager, R. W. Bullivant, UY 3110. Manufacturers of "Sandel" Radio; A.C. & B/O Sets, Auto Sets, Coil Kits, Transformers, Resistors. Distributors of "Sandel" Radio, Radiolas.

P

Paramount Radio Mfg. Co. Ltd., 301 Castlereagh Street, Sydney, N.S.W. MA 3875. Manufacturers of resistors, coils, coil kits, dials, etc. Manager, D. Maskall. Victorian Distributor: Henry G. Small.

Parsons & Robertson Ltd., 172-4 Pulteney Street, Adelaide, S.A. Cl. 6696. Managing Director, F. Lancelot Parsons. Distributors of radio and electrical lines.

The Paton Electrical Instrument Co., 90 Victoria Street, Ashfield, N.S.W. UA 1960. Proprietor, Frederick H. Paton. Chief Engineer, A. H. Mutton, B.E. Sales Manager, V. Bullimore. Manufacturers of cathode ray oscillographs and d'Arsonval type moving coil meters. Distributors: Bloch & Gerber Ltd., and Fox & MacGillycuddy Ltd., Sydney, N.S.W.; A. H. Gibson (Electrical), Melbourne, Vic.; Lawrence & Hanson Elec. Co. Ltd., all States; The Electric Lamp House, Wellington, N.Z.

Peerless Metal Works, 832 Lygon Street, Melbourne, Vic. 'Phone 5236. Proprietor, S. Earney. Manufacturers of coil cans, valve cans, electric canopies, etc.

PHILCO RADIO & TELEVISION CORPORATION (AUSTRALIA) LTD., Joynton Avenue, Waterloo, N.S.W. M 6425. Managing Director, J. I. Carroll. Superintendent, R. J. W. Kennell. Manufacturers of Philco receivers, testing equipment and valves. Interstate Distributors: N.S.W.—New System Telephones Ltd., and Mick Simmons Ltd. Sydney, city and metrop. only—David Jones Ltd. and Allisons. Victoria and Adelaide, New System Telephones Pty. Ltd. Overseas Reps.: Philco Radio at Philadelphia and London.

PHILIPS LAMPS A/SIA LTD., Philips House, 69-73 Clarence Street, Sydney. BW 2121-6, B 1469. Factory, 10-16 Dowling Street, East Sydney (FL 1729). Telegrams & Cables, "Argenta," Sydney. Managing Director, A. den Hertog. Assist. General Manager, J. A. Overdiep. Manufacturers and agents, Philips lamps, valves and Radioplayers, X-Ray, transmitting, lighting equipment, etc. Branches: 590 Bourke Street, Melbourne, Vic. (F 3191—Manager, Keith Nichols); Perry House, Elizabeth Street, Brisbane, Queensland (B 7462—Manager, A. H. Hills); 65 Scott Street, Newcastle, N.S.W. (Manager, E. Beams); Hayward Buildings, Charles Place, Adelaide, S.A. (Manager, A. Thomas); 381 Murray Street, Perth, W.A. (Manager, Alec Dening). Distributors: Sydney—Lawrence & Hanson Elec. Co. Ltd., 33 York Street, Wm. Adams & Co. Ltd., 175 Clarence Street, Warburton Franki Ltd., 307 Kent Street; Melbourne—Brooks Robinson Pty. Ltd., 59 Elizabeth Street, Warburton Franki Ltd., 380 Bourke Street, Lawrence & Hanson Elec. Co. Ltd., 172 William Street, Wm. Adams & Co. Ltd., 521-523 Collins Street; Adelaide—Unbehaun & Johnstone Ltd., 58 Gawler Place, Newton McLaren Ltd., Leigh Street, Wm. Adams & Co. Ltd., 157 Waymouth Street, Lawrence & Hanson Elec. Co. Ltd., 38 Waymouth Street; Perth—Wm. Adams & Co. Ltd., 432 Murray Street; Brisbane—Lawrence & Hanson Elec. Co. (Q'ld.) Ltd., 85-86 Elizabeth Street.

Pidgeon, Arthur (The Bird for Wireless), 814 Hay Street, Perth, W.A. Telephone B 2576. Distributor Kriesler Radios and Milne battery units.

Precision Engineering Co., 25 Little Collins Street, Melbourne, Vic. Proprietors, C. A. O'Halloran and A. H Lane. Cl. 4930. Telegrams, "Peco," Melbourne. Manufacturers of general radio apparatus and special gear for transmitting stations.

J. G. Pritchard Ltd., 18 William Street, Perth, W.A. B 4710, B 4711. Managing Director, James G. Pritchard; Sales Manager, H. U. Kendall; Secretary, B. Hartnell. Bulk Store and Refrigeration Showroom, Queens Place, William Street, Perth. Distributors: Alpha Engineering Co. Ltd., Crown Radio Mfg. Co. Ltd., Electricity Meter Manufacturing Co. Ltd., The Lawrence & Hanson Electrical Co. Ltd., F. C. Lovelock Limited, New System Telephones Pty. Ltd., Nilsen Cromie Pty. Ltd., Radio Industries Ltd., Rows Electric Patents Ltd., Tomlinson Bros. & Co., Tyme Ltd., Union Manufacturing Co.

Pyrox Pty. Ltd., 264 Latrobe Street, Melbourne, Vic. F 4157. Telegrams, "Pyrox." Managing Director, A. Hoette. Manager, F. Hill. Sydney Office, 97 Palmer Street, East Sydney (FL 4960). Manager, P. G. Perkin. Australian agents for American Bosch Radio. Proprietor of "Pyrox" car radio.

MANUFACTURERS' AND WHOLESALERS' DIRECTORY—(Continued)—

R

RADIO CORPORATION PTY. LTD., 21 Sturt Street, South Melbourne, Vic. M 4711 (10 lines). Joint Managing Directors: Louis Abrahams and A. G. Warner. Secretary, N. D. Gray. Manufacturers of Astor Radio, Mickey Mouse Radio. Importers, manufacturers, financing hire purchase for radio, refrigerators, automobiles, etc. Overseas Reps.: Ajax Radio Corpn., 37 Rue Deguingard, Lavallois-Perret, France; Louis Coen Wireless Pty. Ltd., 113 University Place, New York City, U.S.A.; A. Warner & Son Ltd., 201-207 Forest Rd., Walthamstow, England. Branch Offices: 160 Goulburn St., Surry Hills, N.S.W. (F1363); 10 Alfred Chambers, Currie St., Adelaide, S.A.; 905 Hay St., Perth, W.A. (B8459); 104 Collins Street, Hobart, Tas. (6096); 25 Quadrant, Launceston, Tas. (371); Albert House, Albert Square, Brisbane, Q. (B 6658). Sydney Manager, L. Solomons. Factory Reps.: Adelaide, W. Whitley; Perth, H. E. Pead; Hobart, L. Lucke; Brisbane, A. P. Taylor. Distributors: Smith Sons & Rees Ltd., 30 Wentworth Ave., Sydney, N.S.W.; A. W. Chessell, c/- Princess Theatre, Toowoomba, Q.; J. Gillan, Denham St., Rockhampton, Q.; Herbert Jones & Son Pty. Ltd., 476 Adelaide St., Brisbane, Q.; J. Michelmore & Son Pty. Ltd., Mackay, Q.; McWhirters Ltd., The Valley, Brisbane, Q.; Pittard, Diack & Co. Ltd., Abbott Street, Cairns, Q.; F. Heatley & Sons Pty. Ltd., Flinders St., Townsville, Q.; Thompsons Ltd., Murray St., Perth, W.A.; Colton, Palmer & Preston, Currie St., Adelaide, S.A.; Gerard & Goodman Ltd., Synagogue Place, Adelaide, S.A.; Harris Scarfe Ltd., Rundle St., Adelaide, S.A.; Burrows & Meek Pty. Ltd., Elizabeth St., Hobart, Tas.; A. Osborne Pty. Ltd., Universal Corner, Burnie, Tas.; Watson's Wireless, 109 Collins St., Hobart, Tas.; Homecrafts Pty. Ltd., 211 Swanston St., Melbourne; E. A. Machin & Co. Pty. Ltd., 535 Elizabeth St., Melbourne; Keep Bros. & Wood Pty. Ltd., 200 Latrobe St., Melbourne, Vic.

Radio Industries Ltd., Joynton Ave., Waterloo, N.S.W. MA6043. Sales Manager: E. Searson. Distributors of Emmco radio products and Leonard Refrigerators.

Radio Merchants Ltd., 6th Floor, Australia House, Carrington St., Sydney, N.S.W. BW6673-B2490. Chairman of Directors: E. D. Huckell. Secretary: E. R. Einsiedel. General radio wholesalers.

Radio Wholesalers Ltd., James Place, Adelaide, S.A. Central 8000 (3 lines). Managing Director: H. R. Pinkerton (Chaiman), A. D. Young, J. A. Hele, Wm. Queale, H. R. Pinkerton. Secretary: A. J. Carvosso. A. E. Stephen, Assistant Manager. Distributors of Stromberg-Carlson Radio Receivers, Express Electrical Instruments, Sylvania Valves, Diamond Dry Batteries. Wholesale distributors of radio receivers, accessories, electrical goods, etc.

RADIOKES LTD., Cnr. George & Cleveland Streets, Redfern, N.S.W. MA 6671. Cables and Telegrams, "Radiokes," Sydney. Codes, "Bentleys." Managing Director, R. K. Stokes. Manufacturers of Radiokes components, distributed through all trade wholesalers.

Radio Maintenance Pty. Ltd., 408 Swanston Street and 367 Bourke Street, Melbourne, Vic. F 1869. Manufacturers of power radio and all types of battery sets.

Radiomobile Company, The. 56 Hunter Street, Sydney, B 5003. Manager, David Campbell. Manufacturers of "Radiomobile" auto radio and transportable radio receivers. Assembling and patent rights.

Radix Power Supplies, 64 Lawler St., Subiaco, W.A. B4812. Proprietor: Edgar Albert Dix. Manufacturers of "Radix" transformers and chokes and all wire wound work. Distributors: W.A., J. G. Pritchard Ltd., William St., Perth (B4710); Carlyle & Co., Hay St., Perth; Atkins (W.A.) Ltd., Hay St., Perth; Harringtons Ltd., Hay St., Perth.

Raycophone Ltd., Booth & Trafalgar Streets, Annandale, N.S.W. MW 1834-1874. Telegrams, "Raycophone," Sydney. Managing Director, G. D. Cree. Director & Chief Technical Engineer, Ray Allsop. Manufacturers of radio sets, components, talking picture equipment, public address systems and sound reinforcement systems. Distributors—Harringtons Ltd. (all States).

R.C.S. RADIO, 21 Ivy St., Darlington, N.S.W. MA6041-2. Proprietor: Ronald A. Bell. Interstate Reps.: Vic., Henry G. Small Pty. Ltd., 374 P.O. Place, Melbourne; S.A., A. G. Healing Ltd., Pirie St., Adelaide; Q'ld., Trackson Bros., Elizabeth St., Brisbane; W.A., Carlyle & Co., 915 Hay St., Perth. Products, wire-wound components.

REGENT RADIO PTY. LTD., 975 Burke Road, Camberwell, E.6, Vic. Hawthorn 905. Managing Director: Geoff D. Searle. Directors: Ivor Morgan, George Searle. Manufacturers of all types of radio receivers, public address amplifiers, low-power transmitters.

Ricketts & Thorp Ltd., Kimpton St., Rockdale, N.S.W. LW2641. Manager: F. E. Thorp. Cabinet makers.

ROLA CO. (AUSTRALIA) PTY. LTD., 81-83 City Road, South Melbourne, S.C.4. M1278 (3 lines). Director: A. Leonard C. Webb. Manager: Raymond H. Yeend. Manufacturers of Rola loudspeakers.

Rose, Reg., & Co. Ltd., Kembla Bldgs., Margaret St., Sydney, N.S.W. BW2114. Cables, etc., "Esor," Sydney. Governing Director: Reg. Rose. Sales Manager: C. J. Rose. Wholesalers of radio and electrical goods. (N.S.W. distributors Diamond batteries).

Rutty, M. & Co., Australia House, Carrington Street, Sydney, N.S.W. B1205. Cables: "Macrutty," Sydney. Telegrams: "Rutty," Australia House, Sydney. Distributors of Decca radio-gramophone combination units.

Savery's Pianos Limited, 29 Rundle St., Adelaide, S.A. Cl. 8000 (3 lines). Managing Director: H. R. Pinkerton. Secretary: A. J. Carvosso. Distributors of Stromberg-Carlson and Beale Radio Receivers, Domestic Kelvinators. Radio, piano, refrigerator, washing machine and music warehouse. Overseas Rep.: H. S. Pearce & Co., London.

MANUFACTURERS' AND WHOLESALERS' DIRECTORY—(Continued)—

S

Scott & Holladay Ltd., 35 Clarence St., Sydney, N.S.W. BW 1278-9. Managing Director: G. L. Murray. Secretary: E. A. Richards. Factory representatives, specialising in electrical, radio, motor and allied lines. Interstate Branches: 592 Bourke St., Melbourne (Cl. 2166; Manager, R. W. Sholly); Civic Chambers, Cuba St., Wellington, N.Z. (Manager, Norman S. Lawn). Interstate Reps.: V. J. Griffiths, Exton House, Queen St., Brisbane, Q'land (B 8532); R. C. Woollard, 16 Chesser St., Adelaide, S.A. (Cl. 858).

SIEMENS (AUSTRALIA) PTY. LTD., 257 Clarence St., Sydney, N.S.W. M4161. Managing Director: J. P. Duggan. Sales Manager: J. R. Parrin. Manufacturers of Siemens Electric Lamps, Siemens wires and cables, Siemens Neophone. Distributors of Marelli Electric Fans, Benjamin Reflectors, "Santer" time switches, "Elliott" instruments, English Electric Co. Ltd. motors, alternators and Diesel engines. Branch Offices: 189-191 William St., Melbourne, Vic.; 85 Grenfell St., Adelaide; 132-134 Charlotte St., Brisbane, Q.; 45 Watt St., Newcastle, N.S.W. Interstate Reps.: H. C. Little & Co. Ltd., 858 Hay St., Perth, W.A.; W. & G. Genders, 53 Cameron St, Launceston, and at Hobart and Burnie, Tasmania.

SIMPLEX RADIO, 716 Parramatta Rd., Petersham. Pet. (L4) 3100. Proprietor: H. H. J. Hankin. Manager: G. Rich. Manufacturers of "Simplex" fixed mica condensers and padders, "Rotary" tone controls, "Simplex" moulded products. Distributors of "Continental" carbon resistors, wet and dry types of electrolytic condensers, "Ferrocart" iron cores. Manufacturers of all types of mica condensers and comprehensive plastic moulders. Distributors and agents for radio components. Metal press workers. Interstate Distributors: Continental Carbon Co. Pty. Ltd., 174 Queen St., Melbourne, Vic.; D. Harris & Co., 130 Rundle St., Adelaide, S.A.; Atkins (W.A.) Ltd., 894 Hay St., Perth, W.A.; A. E. Harrold, 123 Charlotte St., Brisbane, Q.; Electric & General Import Co., Manchester St., Christchurch, N.Z.

Henry G. Small & Co. (also Airdok Radio Valve Co. Ltd., valves only), 374 Post Office Place, Melbourne, C.1, Vic. Cl. 11455. Managing Director: Henry G. Small. Director: Chas. A. Small. Distributors of Hammond Clocks, Carter Genemotors, etc., Triod Tubes, Kelvin radio parts and sets, R.C.S., Paramount, Apex Electrical Products, Concourse Condensers. Factory representative and wholesaler. Overseas Reps.: International Forwarding Co. Inc., New York and Chicago; Chipman & Co.. New York.

Smart, H. & Co., 163 Swanston St., Melbourne, Vic. Cl. 7997. Indent agents for wire cables, flexes, sheet metal condensers, resistances and insulating material.

Smith, Sons & Rees Ltd., 30-32 Wentworth Ave., Sydney, N.S.W. MA6551 (10 lines). Telegrams: "Speedomet," Sydney. Managing Director: M. W. Rees. Sales Manager: E. A. McLean. N.S.W. "Astor" distributors.

SLADE'S RADIO, Lang Street, Croydon, N.S.W. UJ 5381-2. Proprietor, Charles W. Slade. Chief Radio Engineer, A. Ferguson; Chief Electrical Engineer, A. Alldridge. Manufacturers of high grade radio sets and test equipment and Calstan meters. Distributors: N.S.W.—Bloch & Gerber Ltd., Martin De Launay, Murdochs Ltd.; Queensland—J. B. Chandler & Co., Brisbane; Vic.—A.G.E. Ltd., Melbourne; W.A.—Carlyle & Co., Perth; N.Z.—New Zealand General Electric Co., and Carrick Wedderspoon, Wellington.

STANDARD TELEPHONES & CABLES (A/SIA) LTD., 71 York Street, Sydney, N.S.W. BW1226. Telegrams and Cables: "Relay," Sydney. Managing Director: H. C. Trenam. Sales Manager: James Clarke. Radio Mgr.: H. F. Pearce. Interstate Reps.: C. R. Foster, 588 Bourke St., Melbourne, Vic. Distributors: Vic., Noyes Bros. (Melb.) Ltd., 597 Lonsdale St. (Cl. 10105); Brooklands Accessories Pty. Ltd., 150 Lonsdale St., Melbourne; Q'ld., Edgar V. Hudson Ltd., 47 Charlotte St., Brisbane (B3733); S.A., Lenroc Ltd., Pirie St., Adelaide; Tas., W. & G. Genders Pty. Ltd., 53 Cameron St., Launceston, and 59 Liverpool St., Hobart; W.A., M. J. Bateman, 12 Milligan St., Perth. Australian distributors for Raytheon valves. Manufacturers of S.T.C. receivers and components, broadcasting stations, etc.

STANDARDISED PRODUCTS (REG.), 14 Hedger Ave., Ashfield, N.S.W. U3957. Proprietor: R. J. Ray. Manufacturers of all types of inductances, transmitting equipment, light and heavy duty radio frequency chokes, bakelite mouldings and short-wave formers.

Stan-Mor Dry Cell Co., 212 Bay Street, Brighton, Vic. X 1432. Proprietor, Stanley Morgan. Cables, "Magrom." Manufacturers of dry cells and batteries. Interstate Reps.: Queensland—Electrical Agencies, 193 Elizabeth Street, Brisbane; N.S.W.—A. J. Veall Agencies Ltd., 127 York Street, Sydney; W.A.—Thomas W. Egan, 75 King Street, Perth.

Stanton Indicator Company, 140 Elizabeth St., Sydney, N.S.W. M6058. Proprietor: V. E. Stanton. Branch Office: Robert Street, Rose Bay (FU7596); Manager, L. Mason. Manufacturers of radio station indicators.

W. A. Syme & Company, Braefield Bldg., cnr. Bourke & Liverpool Sts., Sydney, N.S.W. FL2463, F2730. Proprietor: W. A. Syme. Manager: R. Syme. Manufacturers of "Symfona" radios—A.C., A.C./D.C. and battery-operated. Interstate Distributor: Electrical Agencies, 193 Elizabeth St., Brisbane, Q.

STERLING RADIO LTD., 539 Elizabeth Street, Sydney, N.S.W. M 3261. Directors: J. M. Tait and N. H. Buchanan. Manufacturers of "Sterling" Radio Receivers. Interstate Reps.: W.A.—Ray J. Sharpe, 860 Hay Street, Perth; Queensland—Trackson Bros. Pty. Ltd., 157 Elizabeth Street, Brisbane.

STROMBERG-CARLSON (A/SIA) LTD., 118-124 Bourke Road, Alexandria, N.S.W. MA 6283. Telegrams & Cables, "Strom," Sydney. Trade names:—"Stromberg-Carlson," "Audiola," "Roamer." Managing Director, L. P. R. Bean. Director, R. Breden.

MANUFACTURERS' AND WHOLESALERS' DIRECTORY—(Continued)—

STROMBERG-CARLSON (A'SIA) LTD.—(Cont.) Sales Manager, A. Freedman. Associate Director and Factory Manager, G. E. Eglon. Victorian and Tasmanian representative, W. C. F. Hill, 191 Queen St., Melbourne, Vic. Queensland rep., B. Martin, Wilson House, Charlotte Street, Brisbane. Makers of radio receivers, auto radio, variable gang condensers. Distributors: N.S.W.—Bennett & Wood Ltd., Pitt Street, Sydney; Heiron & Smith (Salonola), 91 Hunter Street, Newcastle; Wagga Wireless Distributors, Box 93 P.O., Wagga. Victoria—M. Brash & Co. Pty. Ltd., Elizabeth Street, Melbourne & 146 Ryrie Street, Geelong; A. J. Veall & Co. Pty. Ltd., 243 Swanston Street, Melbourne; Warburton Franki (Melb.) Ltd., Bourke Street, Melbourne. Queensland—Noyes Bros. (Sydney) Ltd., Burton House, Elizabeth Street, Brisbane; Lawrence & Hanson Elec. Co. Ltd., 87 Elizabeth Street, Brisbane. Distributors for the Darling Downs—Electric Shop Ltd., 57 Russell Street, Toowoomba. Tasmania—Findlay's Pty. Ltd., 80 Elizabeth Street, Hobart and George Street, Launceston; Wills & Co. Pty. Ltd., 7 The Quadrant, Launceston; Findlay & Wills (Devonport) Pty. Ltd., Devonport. S.A.—Radio Wholesalers Ltd., James Place, Adelaide; Savery's Pianos Ltd., 29 Rundle Street, Adelaide. W.A.—Musgroves Ltd., Lyric House, Murray Street, Perth. New Zealand—Gough, Gough and Hamer Ltd., Christchurch.

Sutherland, A. P., 2 Maffra Street, South Melbourne. SC4. M 2291. Telegrams and Cables: "Essanay." Proprietor, A. P. Sutherland. Manager, H. J. Green. Victorian agents for Westinghouse dual-automatic refrigeration, washing machines, vacuum cleaners and domestic appliances; Lister electric lighting plants; Exide batteries; Briton Radio; general motor and radio accessories; battery chargers; "Keep-a-lite" emergency lighting systems; full automatic Diesel lighting plants; Rosebery commercial refrigeration; and Kanode batteries.

T

Television (Australia) Limited, Barrack House, 16 Barrack St., Sydney. B4649. Managing Director: R. M. Ross. Secretary: J. E. W. Wright. Importers and distributors of television apparatus. Branch Office: Union Bank Chambers, Queen St., Brisbane, Q. (B5610).

THOM & SMITH LTD., 55-57 Dowling St., East Sydney, N.S.W. F2117 (3 lines). Directors: F. W. P. Thom and J. E. Smith. Sales Manager: R. H. Jennings. Chief Engineer: E Fanker. Secretary: S. T. Lindsay. Manufacturers of Tasma A.C. electric radio receivers, combined A.C./D.C. radio receivers, battery-operated radio receivers and auto radio. Branch Offices: R. J. S. Bryce, London Stores Building, Elizabeth St., Melbourne, Vic.; E. Cupit, 25 Perkin St., Newcastle, N.S.W.; C. R. Donnelly, 45 Cathcart St., Lismore. Distributors of Tasma Radio Receivers and Valve Sockets. Interstate Distributors: Victoria, Noyes Bros. (Melb.) Pty. Ltd., 597 Lonsdale Street, Melbourne (Cl. 10105); Hartleys Pty. Ltd., 270 Flinders Street, Melbourne (Cl. 4970); Queensland, G. J. Grice Ltd., 90 Queen Street, Brisbane (B 1674); Rosenstengels Pty. Ltd., Ruthven Street, Toowoomba ('phone 45); South Australia, O. J. Nilsen, & Co. Ltd., 49 King William Street, Adelaide (Cl. 4881); Chas. Birks & Co. Ltd., 44 Rundle Street, Adelaide (Cl. 7130); W.A., Thomsons Ltd., 674 Hay Street, Perth; Tasmania, Noyes Bros. (Melb.) Pty. Ltd., 36 Argyle Street, Hobart (Cl. 457); Noyes Bros. (Melb.) Pty. Ltd., 59 George Street, Launceston (Cl. 121); New Zealand, N.Z. General Elec. Ltd., Wakefield Chambers, Wellington (50-628).

Thomsons Ltd., 674 Hay St., Perth, W.A. B9571. Managing Director: Alan L. Thomson. Sole W.A. Distributors Beale Panchromatic Radio and Thom & Smith (Tasma) Radio.

Tilbury & Lewis Pty. Ltd., main factory and auto radio service, 51 Wangaratta St., Richmond, Vic. Radio assembly factory, 8 Margaret St., Richmond, Vic. J5171. Telegrams and cables: "Lewbury." Managing Director: Reg. Lewis. Radio Sales Manager: Norman L. Lewis and George R. Clarke. Manufacturers of "Van Ruyten" Radio and "Lewbury" products.

Tree Radio-Electric Co. Head Office: 88 Willoughby Road, Crow's Nest (X 5713) and at 318 Penshurst Street, Willoughby Junction, N.S.W. Manufacturers of Treeray Radio Receivers. Wholesale radio and electrical supplies (Northern Suburbs only).

Trickey, R. E. & Co., 403 Bourke St., Melbourne, Vic. MU1263. Radiokes Components and kit sets, Lovelock Refrigeration Supplies.

Tyme Ltd., 280 Castlereagh Street, Sydney, N.S.W. M 3084. Telegrams & Cables "Amsta." Managing Director, J. J. Kerin. Interstate Distributors: Radio Wholesalers Ltd., Adelaide, S.A.; Electrical Services Ltd., Brisbane, Q.; A. G. Healing Ltd., Melbourne, V.; J. G. Pritchard Ltd., Perth, W.A.; Findlay & Wills Pty. Ltd., Devonport, Tas.; Wills & Co. Pty. Ltd., Launceston, Tas.; Findlay Bros. Pty. Ltd., Hobart, Tas. Australian distributors for Hygrade Sylvania valves.

U-V

United Radio Distributors Ltd., 234 Clarence St., Sydney, N.S.W. MA2382. Managing Director: H. C. Long. W. J. Mawer, Sales; S. P. Crittenden, Technical. Manufacturers of "URD" chasses, audio transformers, input transformers, etc. Distributors of "Hyflux" speakers and the majority of well-known accessories.

A. J. VEALL (AGENCIES) LTD., 127 York St., Sydney, N.S.W. MA3524. Director: Arthur J. Veall. Managing Director: H. V. Prior. Manager & Secretary: W. Blackmore. Wholesale manufacturers' agents. Distributors of Eupen Wires & Cables, Van Ruyten Car Radio, Stan-Mor Batteries, etc. Branch Office: Vealls Agencies Pty. Ltd., Lonsdale St., Melbourne, Vic. (Manager, A. N. Fyffe). Overseas Reps.: Keep Bros., Birmingham, England.

MANUFACTURERS' AND WHOLESALERS' DIRECTORY—(Continued)—

VEALL, ARTHUR J. PTY. LTD., 247 Swanston St., Melbourne, Vic. Cl. 3053 (7 lines). Governing Director, Arthur J. Veall. Managing Director, A. Prior. Wholesalers and distributors of Stromberg-Carlson and Radiola radio receivers, "Leonard" refrigerators, "Victor" accumulators, "Condor" Lamps. Branch Offices: Vic.—168 Swanston Street, Melbourne (Cl. 10524 — Manager, Mr. Winter); 301 Chapel Street, Prahran (Windsor 1065—Manager, Mr. De Figureidio); 5 Riversdale Road, Camberwell (Windsor 118 — Manager, Mr. Grimwood). Interstate Agents: N.S.W.—A. J. Veall, 127 York Street, Sydney; Queensland—B. Martin, Charlotte Street, Brisbane; S.A.—G. Proctor, 40 Pirie Street, Adelaide; W.A.—F. Morgan, Central Avenue, Perth. Overseas Reps.: Keep Bros., Birmingham, London.

VESTA BATTERY COMPANY (AUSTRALIA) LIMITED, 14 George St., Leichhardt, N.S.W. Petersham 1844-5-6. Managing Director: A. R. Allen. Assistant General Manager: S. J. Bickerton. Manufacturers of storage batteries for cars, radios, homelighting. Distributors of Vesta Plate-lock, Imperial and Defiance Batteries. Branch Offices: 16-22 Bowen St., Brisbane, Q. (B2383-4); 11-13 Stanley St., Melbourne, Vic. (F2525); 886b Hay St., Perth, W.A. (B7585); 148 Wakefield St., Wellington, N.Z. (40440); 177 Albert St., Auckland, N.Z.; 462 Princess St., Dunedin, N.Z. (13267). Branch Managers: Melbourne, W. S. Taylor; Brisbane, G. Le Quesne; Perth, H. H. Manion; Wellington, G. W. Bloom; Auckland, C. W. Haines. Interstate Distributors: W. & G. Genders Pty. Ltd., 53 Cameron St., Launceston, 69 Liverpool St., Hobart, and at Burnie, Tasmania; Motors Ltd., 145 Gawler Place, Adelaide, S.A. Overseas Reps.: International Forwarding Co., 431 South Dearborn St., Chicago, Illinois, U.S.A.

Volta Dry Batteries Ltd., 351 Elizabeth St., Melbourne, Vic. MU1374. Interstate Distributors: N.S.W., Amplion (A/sia) Ltd., 70 Clarence St., Sydney; Q'land, Edgar V. Hudson Ltd., 284 Edward St., Brisbane; S.A., Harris Scarfe Ltd., Grenfell St., Adelaide; W.A., A. C. McCallum Ltd., 96 Murray St., Perth; Tasmania, Noyes Bros. (Melb.), 36 Argyle St., Hobart, Noyes Bros. (Melb.), 59 George St., Launceston; New Zealand, Brown & Paul, 58-60 Queen St., Auckland.

W

Warburton Franki (Melb.) Ltd., 380-82 Bourke Street, Melbourne, Vic. Cl. 8888. Cables: "Ignition." Telegrams: "Warburton Franki," G.P.O. 487.

Watson, W. G. & Co. Ltd., 279 Clarence St., Sydney, N.S.W. M4331 (5 lines). Branches: 31 Hunter St., Newcastle, N.S.W. (New. 275); 398 P.O. Place, Melbourne, Vic. (Cl. 1525); 91a Currie St., Adelaide, S.A. (Cl. 4067); 75 King St., Perth, W.A.; 21 Gray St., Wellington, N.Z. Overseas Reps.: Sanderson, Murray & Elder Ltd., 47 Gresham St., London, E.C.2; Ira A. Snyder, Inc., 50 Church St., New York.

Warburton Franki Ltd., 307-15 Kent Street, Sydney, N.S.W. BW 1251 (5 lines). Cables and telegrams, "Booster," Box 1523DD. Distributors of Weston Instruments and Jewell Meters.

Wendel Electric Co., 14 St. Francis St., Melbourne, C.1., Vic. F6917. Managing Director: A. A. Elliott. Manufacturers of all wire-wound components.

Werring Radio Company, 213-215 Queensberry St., Carlton, N.3, Vic. F5483. Proprietor: O. C. Werring. Manufacturers of Werring sets and parts. Branch Office: 285 High St., Prahran, S.1. (Win. 55).

Westcott, Hazell & Co. Ltd., 225 Castlereagh St., Sydney, N.S.W. M2402-M2711. Managing Director: E. J. Hazell. Radio Sales Manager: C. H. Jensen. Branches at Newcastle and Lismore. General radio wholesalers. Metropolitan Distributors for Airzone, S.T.C. and Radiola receivers.

Westinghouse Sales and Roseberry Ltd., 13 Market St., Sydney, N.S.W. MA 6321. Joint Managing Director, F G. Carr. Director and International Rep., J. W. G. Henderson. Director and Electrical Engineer, S. F. Palmer. Sales Manager, K. P. Forman. Engineering Sales, L. S. Tippett. Secretary, H. R. Gourlay. Works —Dunning Avenue, Waterloo. Mascot 389. Joint Managing Director, W. V. Buzacott. Works Manager, A. E. Buzacott. Production Manager, A. Treglown. Switchgear Department, N. F. Palmer. Works Acct., G. Thompson. Manufacturers of Westinghouse radio receivers, refrigerators, electrical appliances and switchgear. Distributors: N.S.W.—E. F. Wilks & Co. Ltd., 124 Castlereagh Street, Sydney; Vic.—A. P. Sutherland, 2 Maffra Street, Melbourne; Queensland—Buzacott (Q'ld.) Ltd., Adelaide Street, Brisbane; S.A.—Clarkson Ltd., Rundle Street, Adelaide; W.A.—Wyper Howard Ltd., Hay Street, Perth; Tas.—Stewart's Agencies Pty. Ltd., Hobart and Launceston.

WESTMINSTER RADIO TELEVISION CO. LTD. Managing Director: C. Whatmuff. Head Office, 26 George St., Parramatta. UW 9601. Manufacturers of Westminster radio sets. Distributors of all principal radio lines and domestic electrical appliances.

Wetless Electric Mfg. Co., 281 Princes Highway, St. Peters, N.S.W. L2824 (2 lines). Proprietor: A. P. J. Wetless. Sales Manager: R. K. Blackwell. Secretary: M. C. Parry. Manufacturers of "Wetless" Fixed Paper, Mica, Radio and Transmitting condensers; Motor Ignition Coils. Distributors: Fox & MacGillycuddy Ltd., 57 York St., Sydney; Lawrence & Hanson Elec. Co. Ltd., 33 York St., Sydney; O. H. O'Brien (Sydney), 39 Pitt St., Sydney and 664 Bourke St., Melbourne, C.1; Newton McLaren Ltd., Leigh St., Adelaide; J. B. Chandler & Co. Ltd., Adelaide St., Brisbane; Atkins (W.A.) Ltd., 894 Hay St., Perth.

MANUFACTURERS' AND WHOLESALERS' DIRECTORY—(Continued)—

WIDDIS DIAMOND DRY CELLS, 119 Hawke St., West Melbourne, Vic. F1175 (2 lines). General Manager and Director: Clive Evans. Sales Manager: C. F. Swift. Works Manager: T. Anderson. Chief Chemist: H. Webb. Manufacturers of Dry Batteries. Factory Reps.: N.S.W., Reg. Rose & Co., Kembla Bldgs., Margaret St.; Q'land, J. B. Chandler, Adelaide St., Brisbane; S.A., Newton McLaren Ltd., Leigh St., Adelaide; W.A., Carlisle & Co., Perth; Tasmania, Howard Radio, Hobart. N.Z. Reps.: S. Huthnance, Nathan Bldgs., Grey St., Wellington.

E. F. WILKS & CO. LTD., 124 Castlereagh St., Sydney. M6361 (8 lines). Telegrams and Cables: "Factors," Sydney. Directors: H. J. Howes (Chairman), E. R. Wilks and G. H. Horton. Secretary: E. O'Bree. Radio Managers: A. R. Turner (City), and E. W. Burrow (Country). Works Manager: V. Bale; Factory, 52 Shepherd Street, Chippendale. Branches: 583 Hunter St., Newcastle, Parramatta, Manly and Chatswood. Distributors of Westinghouse Radios.

Wireless & Electrical Services Ltd., C.M.L. Bldgs., 41-47 King William St., Adelaide, S.A. C3226. Managing Director: A. K. Richardson. Distributors of "Airmaster" Pigmy Short-wave converters, and Standardised Products, Sydney. Branch Office: "Superhets" Radio, 104 Grenfell St., Adelaide, S.A.

Wyper Howard Ltd., 671 Hay Street, Perth, W.A. B4697. General Manager: H. R. Howard. N.S.W. Representatives: R. B. Wyper Ltd., Grace Buildings, Sydney. Radiotron Valve and Radiola distributors, Westinghouse products.

Yelland, L. J., 44-50 Glen Eira Road, Ripponlea, S.4., Vic. L3130. Manager: L. J. Yelland. Manufacturers of radio receivers, condensers and transformers.

Zenith Radio Co. Ltd., 37 Oxford St., Paddington, N.S.W. FL2248-FL2143. Managing Director: Jose Alberti. Technical Adviser & Designer: G. Brownlee. Factory Manager: F. Garland. Sales Manager: R. Evans. Manufacturers and distributors of complete range of Zenith radio receivers. Branch Office: Hibernian Bldgs., Brisbane, Q. Brisbane Managing Director: Mr. Rymer. Technical man: Mr. Nicholson. Overseas Reps.: N. Alberti Sitja & Co., Spain, and Findlay Durham & Brodie Ltd., London.

Trade Names Directory

Inclusion of a trade name in this section of the Directory does not necessarily mean the name is registered. No responsibility is accepted for omissions, or errors, but the Editor should be advised if any occur.

Letter "D" or "M" after the name indicates "Distributor" or "Manufacturer"; "W" indicates "Wholesaler"; "F.R." indicates "Factory Rep." Refer to Manufacturers' & Wholesalers' list for full address.

A

ACORN—(M.) Acorn Pressed Metal Co. Ltd. (Aluminium chassis, coil cans, sockets, etc.)
A.G.D.—(D.) A. G. Davis & Co. (Chassis and components).
A.G.E.—(M.D.) Australian General Electric Ltd. (Insulating material).
AIR-CELLS—(D.) Amplion (A/sia) Ltd. (Batteries).
AIRDOK—(M.) Henry G. Small Pty. Ltd. (radio and television apparatus).
AIR LORD—Boans Ltd., Perth (radio sets).
AIR-MASTER—(M.) Airmaster Radio Co. (Radio receivers).
AIRSCOUT—(M.) Hartley's Teleray (Receivers).
AIRWAY—(D.) Lawrence & Hanson Electric Co. (Receivers).
AIRVOYCE—(D.) Charles Birks & Co. Ltd. (Radio receivers).
AIRZONE—(M.) Airzone (1931) Ltd. (Electric and battery receivers. Component parts, line and aerial filters).
AMPERITE—(F.R.) International Radio Co. Ltd. (Microphones).
AMPHENOL — (F.R.) International Radio Co. Ltd. (Valve sockets and plugs).
AMPLION—(D.) Amplion A/sia Ltd. (Loud speakers, microphones and dynamic units).
ALPHA and device—(M.) Alpha Engineering Co. Ltd. (Radio switches).
ARROW—(M.&W.) Wm. J. McLellan & Co. (Switches and wiring devices).
ARISTOCRAT—(D.) Electrical Service Co. (Radio and electrical supplies).
ASTOR—(M.) Radio Corporation. (Radio receivers).
AUDAK—(D.) Amplion A/sia Ltd. (Pick-ups).
AUDIOLA—(M.) Stromberg - Carlson A/sia Ltd. (Radio receivers).
A.W.A.—(M.D.) Amalgamated Wireless (A/sia) Ltd. (All wireless apparatus and equipment).

B

BANDMASTER—(M.D.) Australian General Electric Ltd. (Receivers).
BATYPHONE—(M.) C. S. Baty & Co. (Radio receivers).
BELDAS—(D.) O. H. O'Brien (Sydney). (Components).
BELDON—(D.) O. H. O'Brien (Sydney). (Wire).
B.I.—(D.) Australian General Electric Ltd. (Condensers, cables & wires).
BIFROST—(M.) Wm. J. Mills (Carbon Resistors).
BIRNBACH—(M.W.) Wm. J. McLellan & Co. (Insulators, white porcelain wet process).
BOSCH—(D.) Pyrox Pty. Ltd. (Auto radio).
BRADLEYOMETERS — (D.) Eastern Trading Co. Ltd. (Variable resistors).
BRADLEYUNITS—(D.) Eastern Trading Co. Ltd. (Resistors).
BREVILLE—(M.D.) Breville Radio (Radio receivers).
BRITON—(M.) Briton Electrical & Radio Co. (Radio receivers).
B.T.H.—(D.) Australian General Electric Ltd. (Phonograph motors and pick-ups).
BU-RADIO—British General Electric Co. Ltd., Sydney. (Wireless sets).

C

CALSTAN—(M.) Slade's Radio (meters).
CARBONCEL—(D.) Amplion A/sia Ltd. (Air depolarising primary batteries).
CHALLENGE—(M.) Arnold & Beard Ltd. (Radio chassis, coil and I.F. cans, galleries, ceiling flanges, etc.)
CHANEX—(M.) Ducon Condenser Pty. Ltd. (Condensers, metallised & wire-wound resistors).
CLYDE—(M.) Clyde Batteries (Accumulators).
COLVILLECO—Colville Wireless Equipment Co. (Transmitting condensers).
CONCOURSE—(D.) Small, H. G. & Co. (Resistors and rheostats).
CONTINENTAL—(M.D.) Continental Carbon Co. Pty. Ltd. (Electrolytic condensers, carbon resistors, auto-radio suppressors and resistors).
CRAMMOND—(M.) Crammond Radio Mfg. Co. (Radio receivers).
CROWN—(M.) Crown Radio Mfg. Co. (Receivers).
CROYDEN—(M.) Eclipse Radio Pty. Ltd. (Receivers).
C.S.C.—(M.) Condenser Specialty Co. Ltd. (Condensers).

D

DALTON—(M.) H. Dalton & Co. (Moulded products).
DIAMOND—(M.) Widdis Diamond Dry Cells Pty. Ltd. (Batteries).
DIAMOND—(D.) A. H. Gibson (Elec.) Co. Pty. Ltd. (Pilot lamps).
DICKIN—(M.) F. Dickin Ltd. (Cabinets).
DON—(M.) Don Electrical Co. (Battery chargers, rectifiers, rotary converters).
DUCON—(M.) Ducon Condenser Pty. Ltd. (Electrolytic condensers).
DUNCO—M.W.) Wm. J. McLellan & Co. (Relays for all purposes, thermostats and aquastats).
DUPERITE—(M.) Dunlop Perdriau. (Mouldings).

E

EASY—(F.R.) International Radio Co. Ltd. (Washing and ironing machines).
EDISON—(D.) Australian General Electric Ltd. (Lamps).
EDISWAN—(D.) Australian General Electric Ltd. (Lamps).
EFCO—(M.) Efco Mfg. Co. Ltd. (Dials, tuning units, visual tuners, etc.).
EMICOL—(D.) Amplion A/sia Ltd. (Radio meters).
EMMCO—(M.) Electricity Meter Mfg. Co. Ltd. (Receivers).
E.S.M.—(M.) Electrical Specialty Mfg. Co. Ltd. (Receivers).
E.T.C.—(M.) Eastern Trading Co. Ltd. (Mica condensers).
EUREKA—(M.) Huckell Radio. (Receivers).
EVER-READY—(M.) Ever-Ready Co. (Aust.) Ltd. (Dry batts., torches, electrical accessories).
EXIDE—(M.D.) Exide Batteries Aust. Ltd. (Secondary batteries for all purposes).
EXPRESS UNIVERSAL—(M.) Express Electrical Instrument Co. Ltd. (Service equipment).

F

FERRANTI—(D.) Noyes Bros. (Sydney) Ltd. (Transformers and meters).
FERROCART — (M.W.) Ferrocart (A/sia) Pty. Ltd. (Inductances and vibrators for elimination of B & C batts.).
FERRO COIL—(M.) Thom & Smith Ltd. (Radio apparatus, etc.).

G

G.E.—(M.D.) Australian General Electric Ltd. (Lamps, phonograph motors, receivers).
G.E.C.—British General Elec. Co. Ltd. (Wireless instruments, etc.).
GENELEX—(M.) British General Elec. Co. Ltd. (Radio receivers).
GENEMOTOR—(D.) Amplion A/sia Ltd. (B battery eliminators).
GENERAL ELECTRIC—(M.) Australian General Elec. Ltd. (Wireless sets and parts).
GENERAL INDUSTRIES—(F.R.) International Radio Co. Ltd. (Electric motors and record changers, and Magicores).
GENKAY—(M.) Genkay Mfg. Co. (Soldering irons).
GOAT—(F.R.) International Radio Co. Ltd. (Valve shields).
GRAND OPERA—(M.) L. J. Yelland. (Receivers and components).

TRADE NAMES DIRECTORY—(Continued)—

H

HAMMOND—(D.) Amplion A/sia Ltd. (Electric frequency clocks).

HAROLA—(D.) A. E. Harrold. (Receivers and radio components).

HEALING GOLDEN VOICE—(M.) A. G. Healing Ltd. (Receivers).

HENDERSON—(M.) P. A. Henderson & Co. (Power equipment).

HILCO—(M.) Hilco Transformers Pty Ltd. (Transformers).

HIS MASTER'S VOICE — (M.) The Gramophone Co. Ltd. (Radio receivers).

HI-TEST—(D.) Australian General Electric Ltd. (Insulating tape).

HOELLE—(M.) J. J. Hoelle & Co. (Metal work terminals).

HOLANITE—(M.) McKenzie & Holland Pty. Ltd. (Plastic mouldings).

HOLLINGSWORTH—(D.) New System Telephones Pty. Ltd. (Receivers).

HOWARD—(M.) Howard Radio Pty. Ltd. (Receivers).

HYFLUX—(D.) United Radio Distributors Ltd. (Speakers).

HYTRON—(D.) James & Vautin Ltd. (Valves).

I

IMPEX—(M.D.) New Herberholds (A/sia) Ltd. (Batts., mica fixed condensers, valves, fixed resistors, torch cases).

INTERNATIONAL—(D.) International Radio Co. Ltd. (Electrical transcriptions).

I.R.C.—(M.W.) Wm. J. McLellan & Co. (Ceramic and insulated metallised resistors, wire wound resistors).

J

JASPA—J. G. Pritchard & Co. Ltd., Perth. (Radio sets and parts).

JENSEN—(F.R.) International Radio Co. Ltd. (Speakers).

JEWELL—(D.) Warburton Franki Ltd. (Measuring instruments).

K

KELVIN—(W.) Henry G. Small & Co. Pty. Ltd. (Radio and elec. sets, parts and appliances).

KEN-RAD—(D.) Eastern Trading Co. Ltd. (Valves).

KEYSTONE—(M.) C. A. Maddern. (Radio receivers).

KOALA—(W.D.) Mellor Bros. (Radio products).

KRIESLER—(M.) Kriesler A/sia Ltd. (Receivers).

L

LAKE-SETS—Arcadian Radio, Brisbane. (Radio sets).

LEKMEK—(M.) Lekmek Radio Labs. (Quality receivers, superfine kits and Precision high fidelity equipment).

LENZ—(F.R.) International Radio Co. Ltd. (Hook-up wire).

LEONARD—(W.D.) Arthur J. Veall Pty. Ltd. (Refrigerators).

LEWCOS—(M.) Liverpool Electric Cable Co. (Wire).

LION—(M.) Amplion A/sia Ltd. (Land microphones).

M

MAGNAVISION — (M.) Magnavox (Aust.) Ltd. (Dials for radio sets and other instruments).

MAGNAVOX—(M.) Magnavox (Aust.) Ltd. (Speakers).

MAGNUM—(D.) Philips Lamps A/sia Ltd. (Speakers).

MARQUIS — (M.) Commonwealth Moulding Co. Ltd. (Marquis radio components).

MASTER UNIT—Mullard Radio Co. Ltd. (Broadcast receiving sets).

MAZDA—(D.) Australian General Elec. Ltd. (Lamps).

M.I.C.—(D.) Australian General Elec. Ltd. (English insulating materials).

MICKEY MOUSE—(M.) Radio Corporation Pty Ltd. (Auto radio receivers).

MULLARD—(M.D.) Mullard Radio Co. (Valves).

N

NALLY—(M.) Nally Ltd. (Plastic mouldings).

NATIONAL—(W.) National Radio Co. Ltd. (Broadcast and dual wave).

NATIONAL UNION—(F.R.) International Radio Co. Ltd. (Valves, cathode ray tubes, pilot lamps and photo-electric cells).

NESTORITE—(D.) A. S. Harrison & Co. Pty. Ltd. (Moulding powders).

O

OCEANIC—(M.D.) Mick Simmons Ltd. (Receivers).

OHMEG — (M.) Ohmegga Resistors (Aust.) Pty. Ltd. (Metallised carbon resistors).

OHIOHM—(F.R.) International Radio Co. Ltd. (Resistors, suppressors, volume controls).

OSRAM—(M.D.) British General Elec. Co. Ltd. (Valves).

P

PAILLARD—(M.W.) Wm. J. McLellan & Co. (Gramophone motors and pick-ups).

PALEC—(M.) Paton Electrical Instrument Co. (Radio instruments and test equipment).

PANCHROMATIC—(M.D.) Beale & Co. Ltd. (Receivers).

PARAMOUNT—(M.) Paramount Radio Mfg. Co. Ltd. (Resistors, coils, coil kits, dials, etc.).

PERTHANE—(D.) James & Vautin. (Insulating materials).

PHILCO—(M.) Philco Radio & Television Corpn. (Aust.) Ltd. (Radio receivers, testing equipment and valves).

PHILIPS—(M.D.) Philips Lamps A/sia Ltd. (Valves and lamps).

PIGMY—(M.) Hartley's Teleray. (Short wave converters).

PIONEER—(F.R.) International Radio Co. Ltd. (Gen-e-Motors & chargers).

PYROX—(M.) Pyrox Pty. Ltd. (Auto radio).

R

RADELEC—(M.) Amalgamated Wireless A/sia Ltd., Sydney. (Moulded cabinets).

RADIOKES—(M.) Radiokes Ltd. (Coils and kits).

RADIOLA—(M.) Amalgamated Wireless (A/sia) Ltd. (Receivers).

RADIOLETTE — (M.) Amalgamated Wireless A/sia Ltd. (Receivers).

RADIOMOBILE — (M.) Radiomobile Company. (Movable radio receivers).

RADION—(M.) D. Harris & Co. (Radio receivers).

RADIOTRON — (M.) Amalgamated Wireless Valve Co. Ltd. (Valves).

RADIX—(M.) Radix Power Supplies. (Transformers and chokes).

RAYCOPHONE — (M.) Raycophone Ltd. (Sets and components).

RAYTHEON—(D.) Standard Telephones & Cables (Aust.) Ltd. (Valves).

RAYWARE—(M.) Standardised Products. (Bakelite mouldings).

R.C.S.—(M.) Receiver Components Sydney. (Components).

READRITE—(D.) W. G. Watson & Co. Ltd. (Meters and testing equipment).

RELIANCE—(M.) Reliance Radio Co. (Receivers and chassis).

ROAMER — (M.) Stromberg-Carlson A/sia Ltd. (Radio receivers).

ROLA—(M.) Rola Co. (Aust.) Pty. Ltd. (Loud speakers).

ROTETHERM—M.W.) Wm. J. McLellan & Co. (Dial thermometers).

ROTOVISOR — (M.) Amalgamated Wireless A/sia Ltd. (Radio sets, parts, etc.).

S

SANDEL—(M.D.) Otto Sandel Ltd. (A.C. and B.O. sets, auto sets, coil kits, transformers, resistors).

SAXON—(M.D.) Eclipse Radio Pty. Ltd. (Components).

SELECTORLITE — (M.) Stromberg-Carlson A/sia Ltd. (Dials, etc.).

SEYON—(M.D.) Noyes Bros. (Sydney) Ltd. (Receivers, signal generators & oscillators, valve testers, etc.).

SHURE—(F.R.) International Radio Co. Ltd. (Microphones).

SIEMENS-ELLIOT — (F.R.) Siemens (Aust.) Ltd. (Meters).

SIEMENS—(M.) Siemens (Aust.) Pty. Ltd. (Electric lamps, wires and cables, and Neophone).

SILVATONE—(M.) Hartley's Pty. Ltd. (Receivers).

SIMPLEX — (M.D.) Simplex Radio. (Fixed mica condensers and padders, & moulded products).

SIMPSON—(D.) Noyes Bros. (Sydney) Ltd. (Electric record turntables).

SKY-RAIDER—(M.) Reliance Radio Co. Sydney. (Radio sets).

SLADE—(M.D.) Slade's Radio. (Receivers and analysers).

SOLAR—(D.) Eastern Trading Co. Ltd. (Electrolytic condensers).

SPARTON—(F.R.) International Radio Co. Ltd. (Refrigerators).

SPRAGUE—(F.R.) International Radio Co. Ltd. (Condensers).

S.T.C.—(M.D.) Standard Telephones & Cables Ltd. (Receivers).

TRADE NAMES DIRECTORY—(Continued)—

STAN-MOR—(M.) Stan-Mor Batteries. (Dry batteries).

STERLING—(M.) Sterling Radio Ltd. (Radio receivers).

STROMBERG - CARLSON — (M.) Stromberg-Carlson A/sia Ltd. (Receivers).

SUNSHINE RADIO—Carlyle & Co., Perth. (Radio sets and parts).

SWITCHON—(M.) W. G. Watson & Co. Ltd. (Radio apparatus).

SYLVANIA—(D.) Tyme Ltd. (Valves).

SYMFONA—(M.) W. A. Syme & Co. (Chassis).

T

TASMA—(M.D.) Thom & Smith Ltd. (Radio receivers and valve sockets).

TELEFUNKEN—(D.) A. M. Clubb & Co. Ltd. (Radio receivers, valves and accessories).

T.C.C.—(M.) Australasian Engineering Equipt. Co. Pty. Ltd. (Components).

TELA-VERTA—(M.D.) D. W. Radio Co. (Receivers).

TELEFUNKEN—(F.R.) A. M. Clubb & Co. Ltd. (Valves and equipment).

TRAVELTONE—Neals Motors Pty. Ltd. Melbourne. (Radio sets and parts).

TUNGSOL—(D.) Eclipse Radio Pty. Ltd. (Valves).

U

UNIVOX—(M.) Eclipse Radio Pty. Ltd. (Receivers).

URD—(M.) United Radio Distributors Ltd. (Chassis).

UTILITY—(M.W.) Wm. J. McLellan & Co. (Anti-capacity switches and precision dials).

UTILUX—(M.) J. J. Hoelle & Co. (Earthing clips and adaptors).

V

VAN RUYTEN—(M.) Tilbury & Lewis Pty. Ltd. (Receivers).

VASCO—(W.) Duncan & Co. Ltd. (Radio receivers).

VELCO—(D.) A. J. Veall & Co. Ltd. (Receivers).

VESTA—(M.D.) Vesta Battery Co. (Aust.) Ltd. (Plate-lock, Imperial and Defiance Batteries).

VOLMAX—(M.) Standardised Products. (Wire-wound components).

VOLTA—(M.) Volta Dry Batteries Pty. Ltd. (Batteries).

VON ARDENNE—(M.W.) Wm. J. McLellan & Co. (Cathode ray tubes).

VULCOT—(D.) Australian General Elec. Ltd. (Vulcanised cotton sheets).

W

WELDON—(M.) Bloch & Gerber Ltd. (Receivers and components).

WERRING—(M.) Werring Radio Co. (Sets and parts).

WESTINGHOUSE—McKenzie & Holland. (Metal rectifiers).

WESTINGHOUSE—(D.) E. F. Wilks & Co. Ltd. (Electric household utilities).

WESTMINSTER — (M.) Whatmuff's Radio & Electrical Service, Parramatta. (Radio sets).

WESTON—(D.) Warburton Franki Ltd. (Measuring instruments).

WESTRIC—McKenzie & Holland. (Battery chargers).

WETLESS—(M.) Wetless Electric Mfg. Co. (Fixed condensers).

WHITFORD—(F.R.) James & Vautin Ltd. (All wave switches).

WHITING—(D.) Noyes Bros. Ltd. (Pick-ups).

Z

ZENITH—(M.) Zenith Radio Co. Ltd. (Radio receivers).

ZEVA—(D.) Warburton Franki (Melb.) Ltd. (Soldering irons).

Prominent Radio Traders

This list comprises the trading name, address and 'phone of many prominent radio traders throughout Australia who have submitted their particulars for insertion. It is not intended that this list be taken as including all radio traders, and the publishers accept no responsibility for inserting these names, or for any omissions. A fee of 5/- is charged for each insertion.

Ace Amplifiers Ltd. (Udisco), 10 Grosvenor Street, Cremorne, N.S.W. X 3312.
Airsales Broadcasting Co., P.O. Box 123, Newcastle, N.S.W. Waratah 487.
Airzone (1931) Ltd., 16-22 Australia Street, Camperdown, N.S.W. L 2851 (4 lines).
Arcadia Radio, 21 Bass Street, South Kensington, Sydney, N.S.W. FJ 1375.
Australian Radio & Electrical Services, 5 Young Street, Croydon, Sydney, N.S.W. UJ 5168.

Baker & Woods, Hargreaves Street, Bendigo, Vic. Ph. 209.
Baty, C. S. & Co., 782 Hay Street, Perth, W.A. B 5219.
Beck Brothers Ltd., Streaky Bay, S.A. Ph. 2.
Beesley, H., Box 15, P.O., Guyra, N.S.W. Ph. 91.
Bennett & Wood Ltd., Cnr. Pitt & Bathurst Streets, Sydney, N.S.W. M 4405.
Bloxsom, C. F., 60 Denham Street, Rockhampton, Q'ld.
Bolden, L. E., Aitken Avenue, Donald, Vic. Ph. 178.
Burnett, W., Radio Sales & Service, Port Elliot, S.A. Ph. 42.

Cahills, Cnr. Peel & Brisbane Streets, Tamworth, N.S.W. Ph. 5.
Campbell, M. & Co. Ltd., Bridge Street, Muswellbrook, N.S.W. Ph. 24, 118-9.
Clinton's Music Store, 29 Oxide Street, Broken Hill, N.S.W. Ph. 599.
Collier & Beale Ltd., 66 Ghuznee Street, Wellington, N.Z. Ph. 53-395.
Croke, C. M., Koorawatha, N.S.W. Ph. 5.
Crook's Home of Music, 38 Auburn Road, Auburn, N.S.W. UX 7561.
Cymbal Radio Service, 353 Penshurst Street, Willoughby Junction. J 3729.

Davies, F. L., 154 Gaffney Street, Coburg, N.13, Melbourne, Vic. Ph. Brunswick 1463.

Fields, Cycle, Elec & Radio, 142-144 Victoria Street, Mackay, Q'ld. Ph. 118.
Fittell's, Mary Street, Gympie, Queensland. Ph. 264.
Forster, J. C., Korbel, W.A. Ph. 11.
Fultone Radio Co., 110 Jetty Road, Glenelg, S.A. X1474.

Gibson, Les., Radio Sales & Service, Alstonville, N.S.W. Ph. 209.
Gillan, Jas., Denham Street, Rockhampton, Queensland. Ph. 1484.
Gordon's Radio Service, Boggabilla, N.S.W. Ph. 33.
Green, A. A., Morwell, Vic. Ph. 5.
Guille & Co. Ltd., 264-6 King Street to Wilson Street, Newtown, Sydney, N.S.W. L 1227.

Hamilton, L. T., 30 Stanhope Street, Malvern, S.E.3, Vic. U 8455.
Haymes, T. J., 57 Bridge Street, Ballarat, Vic. Ph. 620.
Hindle, A., Carmila, N.C.L., Queensland.
Hinterman, J. R., 32 Arden Street, Clovelly, N.S.W. FX 3062.
Holder, W. P., Post Office, Weemelah, N.S.W.
Hollway, John & Sons, 40 Armstrong Street Nth., Ballarat, Vic. Ph. 89.
Holt, E. A., 747 Stanley Street, South Brisbane, Q'ld. J4379.
Hoskin, C. H. & Sons (Wimmera Radio), 61 Firebrace Street, Horsham, Vic. Ph. Horsham 145.
Howard, J. L., Lyric Building, Charing Cross, Bendigo, Vic. Ph. 397.
Huckell Radio, 285 Military Road, Cremorne Junction. Y 5086.

Ivers, Harvey, Manning Street, Taree, N.S.W. Ph. 137.

Jensen, L. Pty. Ltd., 88-92 Raymond Street, Sale, Vic. Ph. 184.
Johnson, L. J., 32 Templar Street, Forbes, N.S.W. Ph. 38.

Kavanagh, W. W., Dee Why Radio & Electric Supply, Pittwater Road, Dee Why. Y 8275.
King's Radio & Electrical Service, 227 Canterbury Road, Punchbowl, N.S.W. UL 1438.

Leach, L. J., Box 147 P.O., Minyip, Vic. Ph. 135.
Le Cornu, Eric W., Radio Repairs & Service, Yorketown, S.A. Ph. 150.
Lord, H. M., Box 59 P.O., Roma, Queensland. Ph. 188.
Luscombe, L. G., Yandilla Street, Pittsworth, Q'ld. Ph. 188.

Mathews, E. A., Motor & Radio Service, Wirrulla, S.A. Ph. 20.
M.C.T. Radio Pty. Ltd., 56 Langtree Avenue, Mildura, Vic. Ph. Mil. 548.
Mellor Bros., George Street, Burwood, N.S.W. UJ 5906.
Mid States Radio, 610 Dean Street, Albury, N.S.W. Ph. 859.
Miller, P. J., Wagin (also at Katanning) W.A.
Morgan, C. P., Imperial Stores, Bega, N.S.W. Ph. 9.
Mosman Radio Service (Maxwell Cutts), 636 Military Road, Mosman, N.S.W. Y 3792.
McCarthy, Howard J., 110 Gover Street, North Adelaide, S.A.

RADIO TRADERS—(Continued)—

Newton, McLaren Ltd., Leigh Street, Adelaide, S.A C 8341 (6 l.).
Nomchong, Paul C., Albion Buildings, Braidwood, N.S.W. Ph. 89.

Parker Radio Co., 180 Nelson Bay Road, Bronte N.S.W. FW 3523.
P. D. Motors (J. E. Pitman), Pinjarra, W.A. Ph. 58.
Parr, A. K., 206 Pittwater Road, Collaroy Beach, N.S.W. Y 8230.

Radio House, Morgan Street, Mount Morgan, Q'ld. Ph. 78.
Radio Service Club, 42a Armstrong Street, Ballarat, Vic. Ph. 439.
Ratcliffe, W., Catherine Hill Bay, N.S.W.
Rogers & King, Goondiwindi and St. George, Q'land. Ph. Goondiwindi 224.
Rymola Radios, Hibernian Buildings, Adelaide Street, Brisbane, Q'land. B 6341 — J 6864.

Shearer, Charlie, Narrabri, N.S.W. Ph. 83.
Shedder, H., Girilambone, N.S.W.
Sidwell, S. G., 160 Sloane Street, Goulburn, N.S.W. Ph. 240.
Smart, Cecil, Tor Street, Gundagai, N.S.W. Ph. 153.
Smith, A. C., 177 Burwood Road, Burwood, N.S.W. UJ 3816.
Smith, E. J., Harrietville Road, Bright, Vic. Ph. 23.

Thompson, N. S., Box 8, P.O., Irymple, Vic. Ph. 56.
Tree Radio-Electric Co., 88 Willoughby Road, Crow's Nest, N.S.W. X 5713.
Tree Radio-Elecrtic Co., 318 Penshurst Street, Willoughby Junction, N.S.W.
Tresilian & Dun (Grenfell) Ltd., Main Street, Grenfell, N.S.W. Ph. 157.
Tucker, K. M., Box 309, P.O., Renmark, S.A. Ph. 73.

Watkins, T. B., Box 57, P.O., Blackall, Queensland. Ph. 16.
Watkins, P. J., Radio Dealer and Elec. Contractor, Cunnamulla, Queensland. Ph. 56.
Watson Radio, Main Street, Lithgow, N.S.W. Ph. 112.
Whatmuff's Radio & Elec. Service Ltd., George Street, Parramatta, N.S.W. UW 9601.
Wilks, E. F. & Co. Ltd., 124 Castlereagh Street, Sydney. M 6361.
Wilson, F .E. ("Snowy"), Tambellup, W.A.
Winstanley, Maurice J., Grey Street, Glen Innes, N.S.W.
Winterburn & Co., 66 Clarence Street, Sydney, N.S.W. B 1196.
Winterburn & Co., 341 Lyons Road, Five Dock, N.S.W. Drumm. 1066.
Wyper Bros. Ltd., Bourbong Street, Bundaberg, Q'ld. Ph. 14 (2 l.).

Company or Firm Registration and Ownership Details

ACORN PRESSED METAL CO. LTD., Head Office, 4-6 Mathieson Street, Camperdown, N.S.W. Governing Director: E. A. E. Parmeter; Director: W. A. Rice; Secretary: D. H. Hinwood. Bankers: Bank of N.S. Wales, Camperdown. Auditor: E. Gordon Hume, F.C.A. (Aust.). Reg. 6th May, 1931.

AIRMASTER RADIO CO., 131 Brunswick Road, Brunswick, Vic. FW 8854-7. Managing Director, L. C. Hargreaves. Directors—F. G. Canning and J. R. Dowling. Secretary, J. R. Dowling. Bankers: Bank of New Zealand. Solicitors: R. H. Cogswell, LL.B., 360 Collins Street, Melbourne. Auditors: Spry Fookes & Co., 339 Collins Street, Melbourne. Commenced 6/1/36.

AIRZONE (1931) LTD., 16-22 Australia St., Camperdown, Sydney, N.S.W. L2851 (6 lines). Managing Director: Claude Plowman. Nominal Capital: £100,000. Subscribed Capital: £54,000. Bankers: English, Scottish & Australian Bank Ltd. Solicitors: Allen, Allen & Hemsley. Auditors: Ewing & Rae. Reg. in Sydney, 1931.

AMALGAMATED WIRELESS (A/sia) LTD., Head Office, 47 York Street, Sydney. Nominal Capital: £1,000,000. Paid up Capital: £744,282. Directors: E. T. Fisk, Esq. (Chairman), C. P. Bartholomew, Esq., The Rt. Hon. W. M. Hughes, P.C., K.C., LL.D., Senator J. D. Millen, T. J. Parker, Esq., Hon. J. F. Coates, M.L.C., F. Strahan, Esq., C.B.E., LL.B. Secretary: J. F. Wilson. Managing Director: E. T. Fisk. Auditors: Yarwood Vane & Co., with Sir G. Mason Allard.

AMPLION (AUST.) LTD., 70 Clarence St., Sydney. Nominal Capital: £20,000. Subscribed Capital: £7,000. Managing Director: P. J. Manley. Director: K. S. Kopsen. Secretary: J. Armstrong. Auditors: Perry & Johnson, Challis House. Martin Place, Sydney. Reg. 19/9/30.

ARNOLD & BEARD LTD., 62-64 Pine St., Chippendale, N.S.W. MA 6609 (2 lines). Directors: J. Arnold, E. H. Beard, A. J. Williams. Secretary: E. H. Beard Com. 1/1/35. Reg. 21/12/34 at Chippendale.

AUSTRALIAN GENERAL ELECTRIC LIMITED, 95 Clarence Street, Sydney. BW2261. Chairman & Managing Director: F. P. Clapp. Deputy Chairman & Assistant Managing Director: A. Maling. Nominal Capital: £1,300,000. Bankers: Bank of Australasia Ltd. Solicitors: Minter Simpson & Co. Auditors: Robert W. Nelson & Co. Directors: F. B. Clapp, A. Maling, S. B. Cox, L. F. Burgess, Sir Felix J. C. Pole, Clark H. Minor.

AUSTRALIAN RADIO COLLEGE LTD., cnr. Broadway and City Rd., Sydney. MA2419. Managing Director & Principal: L. B. Graham. Director: R. Graham. Secretary: Miss E. Pratt. Nominal Capital: £5,000. Subscribed Capital: £1,150. Bankers: Commonwealth Bank of Australia. Auditor: H. B. Hoskins. Reg. firm March, 1931. Formed into a limited company, July, 1935.

AUSTRALIAN SCHOOL OF RADIO ENGINEERING, 1st and 2nd Floors, Wembley House, Railway Square, Sydney, N.S.W. MA4642. Principal: R. T. Andrew. Bankers: N.S.W., Southern Branch. Solicitors: G. W. Connah & Co., Pitt St. Secretary: E. Ledwidge. Reg. in Sydney, 27/11/1930.

BLAND RADIO, Hindmarsh Bldgs., Hindmarsh Sq., Adelaide, S.A. (C5581). Proprietor: W. J. Bland. Sales Manager: J. E. Varden. Secretary: L. H. Linsay. Bankers: Union Bank, Adelaide.

BLOCH & GERBER LTD., 46-48 York St., Sydney. Nominal Capital: £50,000. Subscribed Capital: £26,200. Directors: Eugene Gerber, Otto Raz. Secretary: H. Lederman. Managing Director: Eugene Gerber. Bankers: Bank of N.S.W., Head Office. Auditors: John Stewart & Co. Reg. 1/4/1926.

B.R. (RADIO) LIMITED (Langford, Pickles & Co.), 59-65 Elizabeth St., Melbourne, C.1. Cl. 4480. Managing Director: H. Tatnall. Directors: R. Farquhar, A. K. Wilson, C. A. Morris. Secretary: R. Farquhar. Nominal Capital: £125,000. Subscribed Capital: £70,164. Bankers: The Commercial Bank of Aust. Ltd. Solicitors: Smith & Emmerton. Auditors: Flack & Flack. Reg. at Melbourne, 12/8/33.

BREVILLE RADIO, 486 Elizabeth St., Sydney, N.S.W. M6391. Accountant: N. J. Seatree. Bankers: Bank of N.S.W., Elizabeth St., South Branch, Sydney. Solicitors: J. Stuart Thom & Co., York St., Sydney. Auditors: Blackett & Lewis, O'Connell St., Sydney. Reg. in Sydney, November, 1932. Partners: W. J. O'Brien and Chas. H. Norville.

BRITON ELECTRICAL & RADIO CO., 25-27 Mountain St., Broadway, Sydney, N.S.W. MA6438 (3 lines). Proprietors: James and John Noel Briton. Bankers: Union Bank of Australia Ltd. Reg. 27/8/34.

A. M. CLUBB & CO. LTD., 45 King St., Sydney, N.S.W. M4065. Nominal Capital: £10,000 in £1 shares. Subscribed Capital: £4,000. Bankers: Bank of N.S.W., Head Office. Auditors: Witt & Uther, Kembla Bldgs., Margaret St., Sydney. Directors: A. M. Clubb, T. Tobias, Alex Ingram, C. V. Witt. Secretary: Mr Lyons. Reg. 13/8/34.

CONDENSER SPECIALTY CO. LTD., 112 Rothchild Ave., Rosebery. Nominal Capital: £5000. Manager: Keith D. Davison. Secretary: Keith H. Clayton. Bankers: National Bank (Head Office). Solicitors: C. Thorby Young, 26 O'Connell St., Sydney. Reg. in N.S.W., 24/4/35.

COMMERCIAL INFORMATION—(Continued)—

EFCO MANUFACTURING COMPANY LIMITED, 108 Princess Highway, Arncliffe, Sydney, N.S.W. L2667 (3 lines). Managing Director: Richard Facer, Director: Thomas Facer. Radio Manager: Reginald Facer. Secretary: Miss Ada Facer. Nominal Capital: £15,000. Subscribed Capital: £11,000. Bankers: Commercial Bank of Australia, Arncliffe. Auditors: George Blackett & Lewis. Reg. in Arncliffe, 1929.

EMBELTON, G. P. CO., Head Office, 208-210 Lonsdale Place, Melbourne, Vic. Proprietor: G. P. Embelton.

FINDLAYS PTY. LTD., cnr. George & Brisbane Sts., Launceston, Tasmania. 'Phone 482. Nominal Capital: £100,000. Subscribed Capital: £50,000. Directors: P. A. Findlay, A. P. Findlay and S. H. Findlay. Secretary: P. Frith. Bankers: Bank of Australasia. Solicitors: Martin & Hobkirk, Shields & Heritage. Auditors: Ingles, Gow & Layh. Reg. 11/2/1908 at Launceston.

GENDERS, W. & G. PTY. LTD., Head Office, 53 Cameron Street, Launceston. Nominal Capital: £250,000. Paid up Capital: £110,914. Directors: E. B. Genders (Managing Director), Mr. Claude James, M.H.A., F.F. I.A. Secretary: P. C. Thompson. Auditors: Messrs. Cruickshank, Creasy, Gow and Layh. Bankers, Bank of Australia.

GERARD & GOODMAN LTD., Synagogue Place, Adelaide, S.A. C.5040 (4 lines). Directors: A. E. Gerard, A. H. Gerard, L. D. Sobets. Secretary: B. L. Bertram. Bankers: Commercial Banking Co. of Sydney. Reg. in Adelaide 1807.

A. H. GIBSON (ELECTRICAL) COMPANY PTY. LTD., 23-25 Hardware St., Melbourne, C.1, Vic. F3123. (4 lines). Managing Director: A. H. Gibson. Directors: J. J. Yourelle and C. W. Bryant. Secretary: J. A. Lawrence.

G. J. GRICE LIMITED, 90-92 Queen St., Brisbane, Q'land. B1674. Managing Director: Arthur Baynes. Directors: R. D. Kennedy, H. W. Atkinson. Secretary: A. W. Harlen. Nominal Capital: £200,000. Subscribed Capital: £95,081. Bankers: Bank of N.S.W. Solicitors: Chambers, McNab & Co., Brisbane. Auditors: Troup Harwood & Co., Brisbane. Reg. at Brisbane, 17/1/1903.

D. HARRIS & CO., 140 Rundle St., Adelaide, S.A. C.6122 (2 lines). Proprietors: D. T. Harris and S. D. Harris. Bankers: National Bank Auditors: Taxation Services of Australia. Re-registered 25/10/33.

HARRIS, SCARFE LIMITED, Grenfell St., Adelaide, S.A. Cl. 3300. Directors: P. J. A. Lawrence (Chairman), Harold Law Smith, C. C. Deeley, F. E. Robertson, F. W. Trowse. Secretary (Acting): L. B. Daymond. Nominal Capital: £875,000. Subscribed Capital: £751,606/10/-. Bankers: The Bank of Adelaide. Founded 1851. Reg. at Adelaide 20/10/1920.

A. S. HARRISON & CO. LTD., 85 Clarence Street, Sydney, N.S.W. Managing Director, A. S. Harrison. Secretary, Miss G. N. Wiseman. Bankers: Bank of Australasia, Pitt Street, Sydney.

HARTLEYS PTY. LTD., 270 Flinders Street, Melbourne, C.1. Central 5970. Managing Director: H. W. Joseph. Associate Directors: R. Lyne, T. Stevens, A. Steward. Directors: J. B. Young, F. W. Spry, M. Cohen, H. M. Murphy. Bankers: Commercial Banking Company. Solicitors: Raynes Dickson Kiddle. Auditors: Morton, Watson & Young.

HOMECRAFTS PTY. LTD., 211 Swanston St., Melbourne, Vic. Cl. 8200-1. Bankers: National Bank, Head Office, Melbourne, Vic. Solicitors: Herman & Coltman, 456 Little Collins St., Melbourne. Secretary: Mr. Sexton.

INTERNATIONAL RADIO COMPANY LTD., 254 Castlereagh St., Sydney, N.S.W. M4896 (3 lines). Directors: Charles E. Forrest, Hope B. Gibbons, W. J. Eilbeck, C. G. Salmon. Secretary: William C. Frizelle. Bankers: Bank of New Zealand. Auditors: Lord, Mackay & Co. Reg. in Sydney, 18/10/1924.

INTERNATIONAL RESISTANCE CO. (A/SIA) LTD., 55 Addison Road, Marrickville. BW2385-6. Directors: Wm. J. McLellan and Maxwell Walker. Secretary: G. E. Lucas. Nominal Capital: £5,000. Reg. November, 1934.

KRIESLER (A/SIA) LTD., Head Office, cnr. Pine, Myrtle & Beaumont Streets, Chippendale. Nominal Capital: £10,000. Chairman of Directors: P. G. Tuit.

LEKMEK RADIO LABORATORIES, 75 William St., Technical Director: Rae Weingott. Sydney. FL2626 (3 lines). Proprietor: N. S. Gilmour. Chief Engineer: J. Paton. Factory Supt.: A. V. Bates. Bankers: Union Bank of Australia Ltd. Solicitors: N. C. Oakes and Sagar. Auditors: W. F. Allworth & Sons. Reg. 1931 in Sydney.

McKENZIE & HOLLAND (AUST.) PTY. LTD., Newport, Melbourne, W.15. Chairman of Directors: H. G. Brown. Managing Director: J. B. Jacobson. Directors: W. R. C. Forster and W. H. Craig. Secretary: B. J. Waddick. Registered Office, Newport, Melbourne, W.15. Nominal Capital: £110,000. Paid up Capital: £100,000. Auditors: Troup Harwood & Co. Bankers: Bank of Australasia.

McLELLAN, Wm. J., Bradbury House, 55 York Street, Sydney. Proprietor: Wm. J. McLellan.

JOHN MARTIN LTD., 116-118 Clarence St., Sydney. N.S.W. B 1492. Managing Director: John Martin, Secretary: S. B. Collins. Bankers: Bank of New Zealand. Reg. 1st August, 1934, at Sydney.

MUSGROVE LTD., Head Office, Lyric House, Murray Street, Perth. Directors: M. D'O. Musgrove (Managing Director), H. B. Jackson, K.C., F. C. Kingston. Secretary: R. Peart. Accountant: R. Peart. Auditors: Flack & Flack.

NALLY LIMITED, 15 Castlereagh St., Sydney, N.S.W. B6751-2. Managing Director: Arthur A. Kelly. Directors: T. P. Dowd (Chairman), H. R. Griffiths, F. D. B. MacCullagh, O. Finigan. Secretary: H. R. Griffiths. Nominal Capital: £30,000. Subscribed Capital: £17,500 Bankers: Bank of N.S.W. Solicitors: Biddolph & Salenger, Phillip St., Sydney. Auditors: S. H. Jackson & Co., Elizabeth St., Sydney. Reg. October, 1929.

COMMERCIAL INFORMATION—(Continued)—

NATIONAL RADIO CO. LTD., 96 Pirie St., Adelaide, S.A. 'Phone 2069. Directors: E. R. Smith and Oswald Smith. Secretary: John Scherd.

NEWTON, McLAREN LIMITED, Leigh St., Adelaide, S.A. Cl. 8341 (6 lines). Nominal Capital: £50,000. Subscribed Capital: £27,000. Directors: D. E. McLaren, H. W. Lloyd, B. M. Moulden. Secretary: B. H. Kelsey. Bankers: E. S. & A. Bank Ltd., Adelaide. Solicitors: Baker, McEwin, Ligertwood & Millhouse Auditor: C. J Horrocks. Reg. 14/2/1905.

NORMAN BELL & COY. (PTY.) LIMITED, 403 Adelaide St., Brisbane, Q'land. B3561. Managing Director: Norman McLeod Bell. Directors: L. C. Wilson and H. E. Lintott. Secretary: J. H. Mines. Nominal Capital: £50,000. Bankers: National Bank of A/sia Ltd. Solicitors: Tully & Wilson. Auditors: Thompson & Sharland. Reg. at Brisbane 1/7/1924 (incorporating previous private firm founded 1904).

NOYES BROS. (SYDNEY) LTD., 115 Clarence St., Sydney, N.S.W. B7581. Nominal Capital: £100,000. Subscribed Capital: £99,993. Directors: E. F. Moates, E. R. Mitchell, W. S. Jones, Mrs. C. C. Noyes. General Manager: T. Malcolm Ritchie. Secretary: W. J. Wilson. Bankers: Commercial Bank of Aust. Ltd. Auditors: E. S. Wolfenden. Solicitors: Stephen, Jacques & Stephen. Reg. 3/9/1907.

OHMEGGA RESISTORS (AUST.) PTY. LTD., 21 Station Street, Carlton, N.3, Vic. F2867. Nominal Capital: £2,000. Subscribed Capital: £1,500. Directors: Stanley Price Stroud, Emil Petterson, Raymond Ramelli. Secretary: S. P. Stroud. Bankers: Commonwealth Bank of Aust. Reg. 25/2/35.

OTTO SANDEL LTD., 73 York St., Sydney. BW2028. Managing Director: Otto Sandel. Directors: Jack Sandel, H. B. Phipps, P. L. Grimwood. Manager: H. Kefford. Secretary: Harry E. Davis. Accountant: E. Hewitt. Nominal Capital: £20,000. Subscribed Capital: £10,000. Bankers: Bank of Adelaide. Solicitors: John Hickey & Quinn. Auditors: Neville J. McClung. Reg. 4th April, 1935.

THE PATON ELECTRICAL INSTRUMENT CO., 90 Victoria St., Ashfield, N.S.W. UA1960. Proprietor: Frederick H. Paton. Bankers: Bank of N.S.W., Ashfield. Reg. at Sydney, 23/4/35.

PHILCO RADIO & TELEVISION CORPORATION (AUSTRALIA) LTD., Joynton Ave., Waterloo. Directors: J. I. Carroll, J. McFarlane, R. H. Butler and J. Schartl. Secretary: W. A. Elder.

J. G. PRITCHARD LIMITED, 18 William St., Perth, W.A. B4710, B4711. Managing Director, James G. Pritchard. Sales Manager: H. U. Kendall. Secretary: B. Hartnell. Bankers: Bank of New South Wales. Solicitors: Robinson, Cox & Wheatley. Auditors: S. F. Anderson & Co. Reg. Perth, 1934.

R.C.S. RADIO, Head Office, 21 Ivy Street, Darlington. Proprietor: Ronald A. Bell. Reg. 28/7/32.

RADIO CORPORATION PTY. LTD., 21 Sturt St., South Melbourne, Vic. M4711. Nominal Capital: £100,000. Subscribed Capital: £52,950. Directors: Louis Abrahams, A. G. Warner. Secretary: N. D. Gray. Bankers: National Bank of A/sia Ltd., Melbourne and London. Solicitors: Herman & Coltman. Auditors: G. Wright, Chartered Accountant (Aust.), 440 Little Collins St., Melbourne, Vic. Reg. in Melbourne, 1/7/23.

RADIOMOBILE COMPANY, THE, 56 Hunter St., Sydney, N.S.W. B 5003. Manager, David Campbell. Bankers: Bank of N.S.W., Sydney. Reg. 23/3/1936.

RADIO WHOLESALERS LIMITED, James Place, Adelaide, Cl. 8000 (3 lines). Managing Director: H. R. Pinkerton (Chairman), A. D. Young. Directors: J. A. Hele, Wm. Queale. Secretary: A. J. Carvosso. Nominal Capital: £5,000. Bankers: Bank of New South Wales, Adelaide. Auditors: Counsell Booth & Hunwick. Reg. at Adelaide, 2/8/32.

RADIX POWER SUPPLIES, 64 Lawler St., Subiaco, W.A. B4812. Proprietor: Edgar Albert Dix. Bankers: National Bank of Australasia. Solicitors: Unmack & Unmack, Howard St., Perth. Secretary: H. J. Dix. Reg. 1/10/35.

ROLA CO (AUSTRALIA) PTY. LTD., 81-83 City Road, South Melbourne, S.C.4. M1278 (3 lines). Directors: A. Leonard, C. Webb. Manager & Secretary Raymond H. Yeend. Bankers: Commercial Bank of Australia Ltd. Solicitors: Mallison, Stewart, Stawell & Nankivell. Auditors: Davis & Raven.

SAVERY'S PIANOS LIMITED, 29 Rundle St., Adelaide, S.A. Cl. 8000 (3 lines). Managing Director: H. R. Pinkerton. Directors: A. D. Young (Chairman), J. A. Hele, Wm. Queale. Secretary: A. J. Carvosso. Nominal Capital: £50,000. Subscribed Capital: £40,625. Bankers: Bank of N.S.W., 35 Rundle St., Adelaide, S.A. Auditors: Counsell, Booth & Hunwick. Reg. in Adelaide, 22/9/22.

SCOTT & HOLLADAY LTD., 35 Clarence St., Sydney, N.S.W. BW1278-9. Managing Director: G. L. Murray. Directors: Wm. Arnott and E. A. Richards. Secretary: E. A. Richards. Nominal Capital: £5,000. Bankers: E.S. & A. Bank Ltd. Solicitors: A. J. Taylor, Wm. Arnott & Co., 27 Hunter St., Sydney. Auditors: Milne & Perrett, 56 Hunter St., Sydney. Reg. in Sydney, 25/4/1916.

SIMPLEX RADIO, 716 Parramatta Rd., Petersham. Pet. (L4) 3100. Proprietor: H. H. J. Hankin. Manager: G. Rich. Bankers: E.S. & A. Bank Ltd., Ashfield Branch.

SLADE'S RADIO, Lang Street, Croyden, N.S.W. UJ 5381-2. Proprietor, Charles W. Slade. Secretary, M. Featherstone. Auditors: Klynock & Ligman. Bankers: Commonwealth Bank. Registered 20/5/25.

HENRY G. SMALL & CO. (Also Airdok Radio Valve Co. Pty. Ltd.), 374 Post Office Place, Melbourne, C.1, Vic. Cl. 11455. Managing Director: Henry G. Small. Director: Chas. A. Small. Secretary: C. S. Kirkland. Bankers: Commercial Bank of Australia Ltd., 421 Bourke St., Melbourne, Vic. Reg. April, 1923.

COMMERCIAL INFORMATION—(Continued)—

STANTON INDICATOR COMPANY, 140 Elizabeth St., Sydney, N.S.W. M6058. Proprietor: V. E. Stanton.

STERLING RADIO LTD., 539 Elizabeth Street, Sydney. M 3261. Directors: J. M. Tait and N. H. Buchanan. Secretary, F. Howe Talbot. Nominal Capital, £5,000. Bankers: Bank of N.S.W. Auditors: Ludowici & Caldwell. Solicitors: Boyle & Co. Registered in Sydney 11/5/34.

W. A. SYME & COMPANY, Braefield Bldg., cnr. Bourke & Liverpool Sts., Sydney, N.S.W. Proprietor: W. A.Syme. FL2463-F2730. Secretary: R. Syme. Bankers: Bank of N.S.W., William St., Sydney. Auditors: Walter H. Williams, 33 Macquarie Place, Sydney. Reg. in Sydney, November, 1930.

TELEVISION (AUSTRALIA) LIMITED, Barrack House, 16 Barrack St., Sydney. B4649. Directors: R. M. Ross, J. O. S. Cordell, G. H. Corringham, C. C. Grimley. Secretary: J. E. W. Wright. Nominal Capital: £100,000. Bankers: Bank of N.S.W. and Commercial Banking Co. of Sydney Ltd. Solicitors: Jennings & Jennings, Sydney. Auditors: Trist & Stranger, Sydney. Reg. in Sydney, 25/9/29, and Brisbane 10/7/34.

THOM & SMITH LTD., Head Office, 55 Dowling St., East Sydney. Directors: J. E. Smith and F. W. P. Thom. Secretary: S. T. Lindsay.

THOMSONS LTD., Head Office, 674 Hay St., Perth, W.A. B9571-2. Managing Director: A. L. Thomson. Directors: J. C. Mysonski and T. F. Hantke. Secretary: A. L. Forsyth, A.I.C.A. Nominal Capital: £30,000. Bankers: E.S. & A. Bank Ltd. Auditors: McLaren, Coulton and Meagher. Reg. 1909.

UNITED RADIO DISTRIBUTORS LTD., 234 Clarence St., Sydney, N.S.W. MA2382. Director: H. C. Long. Secretary: W. J. Mawer. Nominal Capital: £5,000. Bankers: Bank of N.S.W. Auditors: Robert Mitchell & Bailey. Reg. in Sydney 15/11/35 to take over Goodwill of United Radio Distributors. Reg. 27/9/32.

A J. VEALL (AGENCIES) LTD., 127 York St., Sydney, N.S.W. MA3524. Directors: A. J. Veall, H. V. Prior, R. K. McDougall, S. G. Homberg. Secretary: W. Blackmore. Bankers: Commercial Bank of Australia. Solicitors: Hill, Thomson & Sullivan. Auditors: Stuckey & Colvin. Reg. Sydney, 3/7/35.

VESTA BATTERY COMPANY (AUSTRALIA) LIMITED, 14 George St., Leichhardt, N.S.W. Pet. 1844-5-6. Nominal Capital: £20,000. Directors: A. R. Allen, S. Airens, E. S. Kelynack, L. E. Easy. Secretary: P. Lovett. Bankers: E.S. & A. Bank Ltd. Solicitors: Clayton, Utz & Co., 136 Liverpool St., Sydney. Auditors: Eric S. Kelynack & Higman, 7 Wynyard Street, Sydney. Reg. 19/3/28.

WARBURTON FRANKI LTD., Head Office, 307-315 Kent Street, Sydney. Nominal Capital: £200,000. Paid up Capital: £100,000. Directors: F. J. Carrick (Chairman), G. S. Warburton, R. J. N. Franki. Secretary: H. J. Rodgers. Auditors: Allard, Way and Hardie Bankers: Commercial Banking Co. of Sydney Ltd.

WERRING RADIO COMPANY, 213-215 Queensberry St., Carlton, N.3, Vic. F5483. Proprietor: O. C. Werring. Bankers: National Bank of Aust. Ltd., North Melbourne. Solicitors: Gillot, Moir & Ahern. Auditors: M. A. Davenport. Reg. 6/4/1926.

WESTMINSTER RADIO TELEVISION CO. LTD., 26 George St., Parramatta. UW 9601. Managing Director: C. Whatmuff. Nominal capital: £10,000. Solicitors: R. E. Coleman, Parramatta. Bankers: National Bank of Aust., Parramatta Branch. Auditors: Rowan & Co., Parramatta. Other Directors: Daphne Whatmuff and Dr. Cedric Whiting.

WILLIAM BEGG & SONS, 343 Little Collins St., Melbourne, Vic. M 1835. Proprietor: Reginald H. Begg. Bankers: National Bank of A/sia Ltd. Reg. in Melbourne, 1928.

WETLESS ELECTRIC MFG. CO., 281 Princes Highway, St. Peters, N.S.W. L2824 (2 lines). Proprietor: A. P. J. Wetless. Secretary: M. C. Parry. Bankers: New South Wales, Rockdale. Reg. in Sydney, 24/4/29.

WIDDIS DIAMOND DRY CELLS, 119 Hawke St., West Melbourne, Vic. F1175 (2 lines). General Manager & Director: Clive Evans. Secretary: H. O. Byrne. Bankers: E.S. & A., Collins St., Melbourne.

E. F. WILKS & CO. LTD., 124 Castlereagh St., Sydney. M6361 (8 lines). Telegrams and Cables: "Factors," Sydney. Directors: H. J. Howes (Chairman), E. F Wilks and G. H. Horton. Secretary: E. O'Bree. Paid up Capital: £300,000. Auditors: Deane Vick & Co. Bankers: Bank of N.S.W. Reg. 13/2/1917.

ZENITH RADIO CO. LTD., 37 Oxford St., Paddington, N.S.W. FL2248-FL2143. Managing Director: Jose Alberti. Nominal Capital: £5,000. Bankers: Union Bank of Australia Ltd. Solicitors: J. W. Joyce, Sydney Auditors: G. Powell, Bondi.

Australian Broadcasting Commission

General and State Managers






MOSES, C. J. A. HORNER, H. G. BEARUP, T. W. LEWIS, E. J. THOMAS, L. R. HOSKING, C. M.

Mr. Charles Joseph Alfred Moses, born January 21, 1900, at Atherton, Lancashire, England. Was educated at Oswestry Grammar School and Royal Military College, Sandhurst. He held a commission in the British Regular Army (The Border Regiment) from 1918 to 1922 serving in France, Germany and Ireland. Owing to slowness of promotion in British Army, he took advantage of "Geddes Scheme" and retired in October, 1922, coming to Australia in December, 1922, to join his parents, who had been in Australia for some years previously. Was fruit-growing in the Bendigo district from December, 1922 to June, 1924.

In motor business in Melbourne from July, 1924 to August 1930, first as salesman, then as executive. Joined Melbourne staff of the Australian Broadcasting Company in August, 1930, as announcer, later taking on wider responsibilities as sporting and news commentator. Was transferred to Sydney in January, 1933 as Sporting and News Editor. Shortly afterwards, in addition to those duties, was appointed Talks Controller and organised the school broadcasts. In May, 1934, was appointed Federal Talks Controller, and also supervised the Commission's sporting activities, from a Federal point of view. On September 1st, 1935, appointed Federal Liaison Officer, and on November 1st, 1935, appointed General Manager of Australian Broadcasting Commission.

Passed Oxford Junior Local Examination at 13, passed Oxford Senior Local Examination at 15, passed London Matriculation Examination at 16, passed Army Entrance Examination at 17 (passing in 27th out of 3,000 entrants). Represented Regiment in every sport — Athletics, Boxing, Cross-country running, Cricket, Hockey, Rugby and Soccer. Won Irish Command Boxing and Shot-putting Championships, 1920, 21, 22, won Victorian Amateur Heavyweight Boxing Championship in 1925, won Victorian Discus Throwing Championship in 1927-28. Represented Victoria at Rugby Union Football in 1926—32 inclusive.

Has broadcast no less than twenty different forms of sport including, athletics, boxing, cricket, cross-country running, soccer, Rugby League, Rugby Union, cycling, speedway racing, rowing, wrestling, ice hockey, trotting, baseball, tennis, swimming, Australian Rules football, golf, flying, sheepdog trials.

Horner, H. G., Manager for N.S.W. Educated at King's College, Canterbury; thereafter for a period of approximately three years travelled extensively, visiting every British Colony and many other parts of the world. He finally settled in Canada for a period of four years, came to Australia in 1914, and has been in this country ever since. A qualified accountant and secretary, and has held the following positions: Secretary William Atkins Ltd., Secretary Palmolive Company, Assistant Secretary Sun Newspapers Ltd., Manager Broadcasters (Sydney) Ltd., Secretary Australian Broadcasting Co. Ltd., Manager N.S.W. Branch Australian Broadcasting Commission.

Bearup, Thomas William, Manager for Victoria. Joined Amalgamated Wireless (A/sia) Ltd., in 1916. Visited England to investigate, inter alia, developments in broadcasting. December, 1923: Joined 2FC at its opening. October 1924—July, 1929: Studio Manager 3LO/3AR, Melbourne. July, 1929—June, 1932: Victorian Manager Australian Broadcasting Commission. March, 1936—visited overseas on behalf of the Commission.

Hosking, Charles Martin. Manager for South Australia. Prior to the advent of broadcasting most of his career was spent in the legal profession in Victoria. As interesting interludes, he journeyed to the Nor'-west with Explorer Carr-Boyd and later explored the one-time waste and unsurveyed mallee.

Between times he was General Organising Secretary of the last big Federal Referenda Campaign, and did a course in art. He wrote several plays, one of which was produced in London by Charles Arnold, and was for some years a musical and dramatic critic and freelance journalist. Mr. Hosking became associated with 3LO, Melbourne, in 1925, and has served at various "A" class stations in a managerial capacity.

Lewis, E. J., Manager for Queensland. Saw service at Gallipoli and was invalided back to Australia. Joined the Broadcasting Company of Australia Ltd., at 3LO, in 1924. In 1929 joined 3DB, Melbourne. Appointed Manager of 7ZL Hobart, in April, 1930. Later appointed Manager under the Australian Broadcasting Company in December, 1930, and remained in that position until the station was taken over by the Australian Broadcasting Commission in 1932. Was transferred to Brisbane in January, 1934.

Kirke, Basil, Manager for Western Australia. Mr. Kirke was born in Australia, served in the A.I.F. and later was engaged in the planting industry in the Pacific Islands. He first became associated with broadcasting through 2BL Sydney, and was appointed Manager of 6WF in 1930.

Lieut.-Colonel L. R. Thomas—Manager for Tasmania. Born England, educated Mill Hill School and Middle Temple, London, Barrister-at-Law. Military Service-Auxiliary Forces since 1903. Served in Gallipoli, Suvla Bay and Mesopotamia. Staff Officer Army Headquarters, Baghdad, 1917-1919 — Awarded D.S.O. 1917. Headquarters Staff—Southern and Northern Commands, England. Registrar University of Tasmania, 1922-1933. Controller of Talks and Educational Broadcasts, Australian Broadcasting Commission, Victorian Division of 1933-1934.

WHO'S WHO

IN THE AUSTRALIAN RADIO INDUSTRY

AARONS, Albert: Director Eclipse Radio Pty. Ltd., Melbourne. Founded Eclipse Radio Pty. Ltd., with nephew Saul, 1926.

AARONS, Saul C.: Director Eclipse Radio Pty. Ltd., Melbourne. Sales Manager, Corbett Derham Pty. Ltd., 1924. Sales Manager, Tunafone Wireless Pty. Ltd., 1925. Formed Eclipse Radio with uncle, May, 1926. Born January, 1900.

ABRAHAMS, Louis: Joint Managing Director Radio Corporation Pty. Ltd., 11 Sturt St., South Melbourne. Took interest in wireless in 1923 as a hobby and later same year, started Louis Coen Wireless in the basement of Louis Coen Tobacconists at 63 Swanston St. Upon purchase by Louis Coen Wireless of Radio Corporation of Australia, the manufacturing business of Radio Corporation and the trading business of Louis Coen Wireless were merged into the Radio Corporation Pty. Ltd. Private address, Toorak Road, Toorak. Recreations: Aviation and motoring.

ADAMSON, William Kenneth: Managing Director Radio Services Ltd., 74a Pirie Street, Adelaide. Amateur License 1922. Commenced commercial radio career 1923. Manager Radio Dept., Duncan & Fraser Ltd., 2 years. Manager A. G. Healing Ltd., Service Department, 4 years. Established Radio Services Ltd., 1932. Owner operator amateur Station VK5WA. Recreations: Tennis and music. Born 30/7/05.

AHRENDT, Eric Albert: Manager Radio & Electrical Department Charles Birks & Co. Ltd., Rundle St., Adelaide. Finished education Melbourne University. Previously Manager Cox Bros., Musical Dept., Adelaide, three years; Manager Eddys Ltd., Radio Dept., six months; Manager Charles Birks Radio Dept., 2 years; own business 2 years in Melbourne. Private address, Woolsley Terrace, Woodlands, S.A. Recreations: Golf, yachting. Born 5/12/1905.

ALBERTI, J.: Director Zenith Radio Co. Ltd., 37½ Oxford Street, Paddington, N.S.W. Spanish nationality, resident in Australia 15 years. Formerly Managing Director of Acorn Pressed Metal Co. Clubs: S.A.S., R.A.C.A. and W.R.C.

ALLSOP, Raymond Cottam: Director and Chief Engineer, Raycophone Ltd., Trafalgar St., Annandale. Fellow Society of Motor Engineers, America, Member Institution of Radio Engineers (Aust.). One of the first radio experimenters in Australia, commencing in 1911. Served in Naval Transport Service as radio operator during Great War, also as laboratory assistant in Naval Wireless Works at Randwick. One of the first two to transmit short wave radiophone to England and America. In 1913 was apprenticed to Shaw Wireless Co. Commenced experiments with sound motion pictures in 1920. From beginning of broadcasting in Australia to 1929 constructed and operated 2BL—1929 founded Raycophone Ltd. Private address: "Nalova," Chelmsford Avenue, Lindfield, N.S.W. Married. Born March 11th, 1898, at Randwick, N.S.W. Recreation: Golf.

ANDREW, Reginald Thomas: Principal Australian School of Radio Engineering, Wembley House, Sydney. Assoc. I.W.T. (London). Principal Australian School of Radio Engineering since establishment. Private address: 21 Medusa Street, Mosman. Married. Recreations: General sporting.

APPERLEY, Geo. (M.Inst. R.E., Aust.): Traffic Manager, Beam Wireless, Amalgamated Wireless (A'sia) Ltd., Melbourne. Early training and experience telegraphy, telephony and wireless with N.Z. Govt. Telegraphs. 1910-1912 Wireless Service of British Colonial Government. 1913 joined A.W.A. 1914-1916 Chief of Marconi Wireless School. 1916-1919 A.W.A. Works Manager. 1919-1923 A.W.A. Technical Superintendent and i/c Patent Dept. 1924, i/c Beam Wireless Service. Visited England and the Continent of Europe in 1924 and again in 1933 on

Apperley, G.

Beam Wireless investigation. Private address: 409 Glen Eira Rd., Caulfield, Victoria. Born, 24th March, 1887.

ARMSTRONG, Oscar Reginald: Secretary The Ever-Ready Co. (Aust.) Ltd., Marshall St., Sydney. Educated Sydney Grammar School. Joined Ever-Ready Co. 7/1/33. Private address: Murriverie Rd., Bondi. Recreations: Wrestling, walking and swimming. Born, 30/1/04.

ARNOLD, J.: Managing Director Arnold and Beard Ltd., 62 Pine St., Chippendale, N.S. Wales. Born May 13, 1900. Came to Australia 1926 after

being Production Manager for Williams & Co. Ltd., England. Founded Arnold & Nunn, Metal Spinners, in 1930 and converted the firm into limited company (Arnold & Beard Ltd.) in January, 1935. Recreations: Motoring and surfing. Private address: 35 Daintry St., Manly.

AUSTIN, Ernest A.: Director, Essanay Pty. Ltd., Melbourne. Four years A.I.F. Entered Radio 1921. Works Manager, Radio Corporation, 1925-1928. Born June, 1880.

BAILEY, E. Gordon, M.Inst. R.E. Aust., Assoc. I.R.E. America: Works Superintendent Amalgamated Wireless Valve Co., Ltd. Apprenticed to A.W.A. in 1918. Visited U.S.A. on behalf of A.W.A. in 1931 to study valve manufacture and following year supervised the installation of valve plant, Amalgamated Wireless Valve Co. Ltd., Ashfield. Visited U.S.A. again 1935-36, returning May, 1936. Private address: 11 Ocean Street, Kogarah.

BAIN, J. W. Duncan: Radio Sales Country Refrigeration Manager, Melbourne branch New System Telephones Pty. Ltd. Formerly with B.G.E. in N.S.W. and Victoria.

BAKER, William George B.Sc., B.Eng., D.Sc. Eng.: Superintendent Technical Engineering Section of Marconi School of Wireless. Gained Deas-Thomson Scholarship for Physics, 1920. Graduated Bachelor of Science 1921 with University Medal for Mathematics and Honours in Mathematics and Physics. Graduated Bachelor of Engineering 1923 with first class Honours and University Medal. Became demonstrator in Physics in 1923, and science research scholar 1923-4. Gained the Walter and Eliza Hall Engineering Travelling Fellowship 1924-27. Entered General Electric Co., U.S.A. Research Laboratory, and B.T.H. Coy.'s Research Laboratory, Rugby, England. Hon. Lecturer, Electrical Engineering, University of Sydney, 1927. Research Fellow, broadcasting station 2FC, 1927-8. Radio Research Officer, Council of Science and Industrial Research, 1928-31. Joined Amalgamated Wireless 1931. Graduated Doctor of Science and Engineering, Sydney University, 1932. Born 27th May, 1902, South Australia.

BATES, Arthur V.: Factory Superintendent. Commenced career at L. P. R. Bean & Co. Ltd., in 1924 which was later incorporated into Stromberg-Carlson. Joined Thom & Smith 1932. Joined Lekmek Laboratories March 1936. Private address: 68 Clyde Street, Bondi. Recreations: Fishing, tennis and swimming. Born 21/1/08.

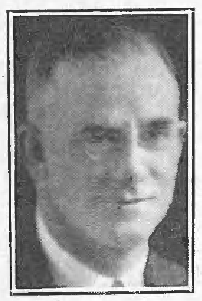
WHO'S WHO—(Continued)—

BATY, C. S.—Managing Director, C. S. Baty & Co., 782 Hay Street, Perth, W.A. One of the oldest radio manufacturers in W.A. Connected with

radio since its inception in W.A. Manufacturer of Batyphone radio receivers. Recreations — Fishing and golf.

BEAMES, Eric. — Manager, Philips Lamps A/sia Ltd., Newcastle Branch. Was interested in insurance, but in 1930 was influenced to sell Radiolas in Newcastle. Joined Philips end of 1930 and went to Noyes Bros. in 1932, returning to Philips in 1934. Educated Petersham School. Born 1903. Recreation—gardening.

BEAN, L. P. R.—Managing Director, Stromberg - Carlson A/sia Ltd., 118-124 Bourke Rd., Alexandria, N.S.W. M.I.E.E., Mem. I.E.E. (U.S.A.), M.Inst. R.E. Aust. 1904-1919, Electrical Engineer on staff of P.M.G.'s Dept. 1919, resigned from public service; visited America, returned 1920; founded L. P. R. Bean & Co. Ltd. Visited overseas 1922-23, and again in 1926-27. Returned Australia 1927, formed Stromberg-Carlson A/sia Ltd. (incorporating L. P. R.



Bean & Co. Ltd.). Re-visited overseas 1935. Removed complete organisation into own factory premises at above address. Vice-President, Institution of Radio Engineers (Aust.). President, A.R.M.P.A.L. Born 1884.

BEARD, Ernest Gordon: Director Ace Amplifiers Ltd., M. Inst.R.E., Aust. Served in wireless in Royal Navy. Private address: Tunk St., Northbridge, N.S.W. Born 1897.

BEARD, Edwin, F.I.I.A., A.A.I.S., F.C.I.: Director and Secretary, Arnold & Beard Ltd., 62 Pine Street, Chippendale, Sydney. 14 years Manager, W. G. Huthwaite & Co., Wagga Wagga. In January, 1935, joined Mr. Arnold and formed the limited company of Arnold & Beard. Private address: 13 James Street, Manly. Recreations: Bowls and photography. Born July 23, 1885.

BEGG, Reginald H.: Proprietor William Begg & Sons, 479 Little Collins St., Melbourne. B.E., Diploma of Electrical Engineering; Associate Member, Institute of Engineers; Fellow S.A. School of Mines; Diploma of Applied Science, Adelaide University. Educated St. Peter's College and Adelaide University. Private address: 7 Henderson Ave., Maloeru, S.E.4, Victoria. Recreations: Golf and swimming. Born 31st March, 1889. Private address: 7 Henderson Avenue, Malvern, Victoria.

BELL, Ronald Albert, A.Inst. R.E., Aust.; Proprietor R.C.S. Radio, 12 City Rd., Sydney. Member of Royal Motor Yacht Club. Licensed Electrician, engaged in radio elec. eng. since

1919. Founded R.C.S. Radio in 1932. Private address: "Birralee," Walsham Parade, North Bondi. Born 13/1/1902. Recreations: Angling, fish breeding and speed boat racing.

BOTTEN, Herbert William: Radio Manager Mick Simmons Ltd., Sydney. Electrical testroom Adelaide Tramways, 1915. Served A.I.F., Palestine, Signals, 1915-1919. Joined wireless industry 1922, appointed present position 1924. Born 9/1/1895.

BOWDEN, Norman James: Radio Manager, the Lawrence & Hanson Electric Co. Ltd., Sydney. Member Radio Society. Lieutenant Sigs. 1st Div. Has

been connected with Lawrence & Hanson since 1928. Private address: "Warringah," Awaba Street, Mosman. Born April 23rd, 1909. Recreations: Military operations and swimming. Single. Clubs.

BOX, Arthur Kingston: Technical Editor "The Listener-In," of Flinders Street, Melbourne. Associated with radio journalism since 1925. Born January 8th, 1905.

BRASH, Alfred F.: Managing Director M. Brash & Co. Pty. Ltd., 108-110 Elizabeth St., Melbourne, C.1. Chairman Victorian Radio Association. Clubs: Naval and Military, Victoria Golf, Sorrento Golf. Educated Cumloden College & Melbourne University. Amateur Welterweight Boxing Champion of Victoria, 1906. Served with B.E.F., Italy, 1916-1919. Rank, Captain. Private address: "Lindfield," Mandeville Cr., Toorak. Born 2/8/81. Recreation: Golf.

BROWN, Basil F. A.: Engineer, D.W. Radio Co., 210 Willoughby Rd., Crow's Nest. W/T Cpl. 2nd Divisional Sigs. Educated North Sydney High School. Five years in Sydney, Lismore and Brisbane motor trade as mechanic and later in sales department. Two years as lessee of an irrigation block at Yenda, N.S.W. Joined D.W. Radio Co., 1932. Private address, 12 Bellevue Ave., Greenwich. Born 18/10/09, W.A. Recreations: Swimming, tennis, fishing, riding, golf, amateur radio.

BRISBANE, Ronald Wallace: Proprietor Brisbane's Radio & Electrical Stores, Adelaide. Connected with radio trade sixteen years. Private address: 24 Te Anau Avenue, Prospect, S.A. Born 27/10/1910. Recreations: Tennis.

BRITON, John Noel: Partner and Chief Engr. Briton Elect. Radio Co., 25-27 Mountain St., Broadway, Sydney.

Graduate of Sydney University. B.E. (first class honours in Electrical Engineering), B.Sc., Councillor and M.Inst.R.E., Aust., A.M.I.E.Aust. Born 1907. Private address: 5 Brand St., Artarmon.

BROOKER, Vivian M.: Manager Broadcasting Department, Amalgamated Wireless, M.Inst. R.E. (Aust.), M.Inst. Wireless Technology (London), M.I.R.E.

(America). Joined staff Amalgamated Wireless, 1917. Manager and Chief Engineer, 7LA, Launceston, 1931 to July, 1933. Transferred present position, July, 1933. Private address: 257 Maroubra Bay Road, Maroubra, N.S.W. Recreation: Reading. Born 11th Feb., 1899.

BROAD, Archibald Du Bourg: Secretary Victorian Radio Association and Manager Electrical Federation (Victoria) since 1928. Recreations: Sport and golf.

BROWN, Andrew F. O.: Secretary, Electrical and Radio Association, N.S.W. Grace Bldg., Sydney. Assistant Secretary, Electrical Association, 1923. Appointed Secretary, 1928. Recreations: Tennis, golf. Born 25/6/1903.

WHO'S WHO—(Continued)—

BROWN, Harold Percival, C.M.G., M.B.E., M.I.E.E.: Director-General, Postmaster-General's Dept., Commonwealth of Australia, Treasury Gardens, Melbourne. As a youth on the staff of the superintending engineer, Newcastle, England (Post Office Department). Later he was attached to the engineer-in-chief's staff, London, in charge of cable designs and the undergrounding of telephone lines. In 1922 selected by the Commonwealth to act in an advisory capacity in carrying out a large works programme of the Postmaster-General's Department. Appointed present position, December 1923. Born 28/12/1878.

BROWN, Stafford Meredith: Sales Manager, Amalgamated Wireless (A'sia) Ltd., Melbourne. Graduated Marconi School of Wireless, Sydney, and joined A.W.A. 1915. Born 20th January, 1896, Narrabri, N.S.W.

BUCHANAN, N. H.: Director and Chief Engineer, Sterling

Radio Ltd., 539 Elizabeth Street, Sydney. Previously Chief Engineer, Zenith Radio, and Chief Engineer, Sydney Branch Eclipse Radio Pty. Ltd. Born 21/11/04.

BUCKLAND, William L.: Managing Director Wm. L. Buckland Pty. Ltd., 139-141 Franklin St., Melbourne, C.1.; Hobart and Launceston. Became associated with radio trade 1930. Private address: 34 Head St., Elwood. Recreations: Skiing, yachting and farming.

BUIK, Harold E.: Superintendent Marine Section Marconi School of Wireless. Joined Sydney branch of the M.I.M.C. Co. Ltd., in October, 1911, and appointed wireless officer on inter-State vessels. Transferred A.W.A. marine service in 1913. Joined R.A. Navy in 1915. 1918 appointed instructor at Marconi

Buik, H. E.

School of Wireless. 1921 Chief Instructor and 1926 Superintendent. Born 22nd February, 1889, Rose Park, Adelaide, S.A.

BUILDER, Geoffrey, B.Sc., Ph.D., F.Inst.P., A.M.I.E. (Aust.), Officer-in-charge of A.W.A. Research Laboratories, Ashfield. Educated at Guildford Grammar School, W.A., University of W.A., University of London. One time Observer at the Watheroo Observatory of

the Carnegie Institution of Washington. There carried out experiments with low power radio equipment and maintained a service route from the Observatory to headquarters in Washington. From there went to London and two years later obtained doctorate for Radio Investigations of the Ionosphere. Then in charge of the British Polar Year expedition work in Norway. Returned to Australia and carried out investigations for the Australian Radio Research Board until joining A.W.A. in 1934. Has published a number of papers on various aspects of radio research. Recreations: Tennis and swimming. Born, 21/6/06.

BULL, John Alfred: Manager Electrical Supplies Section (Radio, Lamps and Electrical Accessories), Noyes Bros. (Sydney) Ltd. Recreations: Tennis, and rifle shooting.

BURBIDGE, Philip A.: Assistant Sales Manager New System Telephones Pty. Ltd., 276 Flinders Street, Melbourne. Formerly with Warburton, Franki Ltd. and Hartley's Radio Department. Recreations: Lacrosse and tennis.

BURBURY, Eric Alfred: Engineer, Patents Department, Amalgamated Wireless (A/sia) Ltd., Sydney. M.Inst.R.E. (Aust.). Joined A.W.A., 1914. 178 South Head Road, Vaucluse. Born 20/4/94. Recreation: Tennis and swimming.

BURCHELL, Reginald John: Australian Radio Technical Services & Patents Co. Ltd., Sydney. 16 years with West Australian Government Railways. 10 years member Commonwealth Parliament. Two years active service A.I.F. 13 years commercial pursuits. Private address: 24 Wolseley Road, Mosman. Recreation: Golf. Born 20/5/1883.

BYERS, Geoffrey A.: Sales and Advertising Department, Lekmek Radio Laboratories, 75 William Street, Sydney. Private address: 6 Wallaringa Avenue, Neutral Bay. Recreation: Tennis.

BUSHBY, T. R. W.: M.Inst. R.E. (Aust.), A.M.I.R.E. (U.S.A.). Born 1900, at Littlehampton, Eng. Educated East Hove School, St. George's College, London, and Regent Polytechnic, London. 1919-1930 Dept. of Scientific Research, Radio Research Board, London. 1930-31, President W.I.A., N.S.W. Division. 1932, Member and Councillor Institution of Radio Engineers (Aust.). 1932-1935, Radio Engineer Raycophone Ltd. 1935, Joined A.W.A.

BYRNE, Valentine Gerard: Advertising representative "The Listener-In," 62 Flinders Street, Melbourne. Connected with publicity section of radio trade for last ten years. Joined "The Listener-In" in 1931. Private address: 30 Forster Avenue, East Malvern, Melbourne. Recreations: Tennis, motoring and fishing.

CANNING, Frederick Gerald: M.Inst.R.E. Aust. Chief Radio Eng. Targan Elec. Pty. Ltd., 131 Brunswick Rd. Brunswick, Vic. 1921-24 Marine Operator Amalgamated Wireless A/sia Ltd. 1930-31, Chief Radio Eng. Targan Electric Co., now Radiokraft Pty. Ltd., Melbourne. Born, England, 16/3/1900.

CAREY, A. J.: Manager Alisons Pty. Ltd., George St. Connected with Radio trade for past ten years. Australian Sales Manager for Eclipse Radio Pty.

Carey, A. J.

Ltd. 1929-30, Manager Sydney Branch of that Company 1931-33; Sales Manager, Radio Division, New System Telephones Pty. Ltd. 1932 to early 1934; joined Tyme Ltd. as Manager, until 1936.

CARROLL, J. I.: General Manager New System Telephones Pty. Ltd., 276 Castlereagh Street, Sydney.

CHANDLER, John Beals: Born Norfolk, England, in 1887, and arrived in Australia in 1907. In 1913 established the firm of J. B. Chandler & Co., of Brisbane. Prominent Radio and Electrical Wholesaler; also Proprietor of several Broadcasting Stations.

CHAPMAN, Aubrey A.: In charge of radio sales and production sections at Bloch & Ger-

ber Ltd. 13 years radio and electrical experience, Australian and American. Private address: 16 Rangers Rd., Croydon. Married. Born 17/1/1908, Echuca, Vic. Recreations: Home and the surf.

CHEONG, Clifford H.: Member of Editorial Staff "The Listener-In," Melbourne. Joined Victorian Railways 1924, graduated to advertising division and later to the Betterment and Publicity Board. Was a free lance journalist for many years; joined "The Listener-In" Editorial Staff July, 1933. Born Shepparton, Victoria, Nov. 11, 1907.

WHO'S WHO—(Continued)—

CHILTON, Robert Ralph: Technical Dept., Mullard Radio Co. (Aust.) Ltd., 26-30 Clarence St., Sydney. A.Inst.R.E. (Aust.), Ph.C., M.P.S., Dip.

W.I.A. Member R.S.G.B. Apprenticed to electrical trade. Graduated in pharmacy Sydney University. Practised two years in pharmacy taking up television experiment in 1930. Chief Instructor Australian Radio College 1931 and Superintendent of same 1933. Inaugurated Broadway Radio Laboratory 1933, Mullard Radio Company 1934 to date. Private address: Chilton Av., Warrawee, N.S.W.

CHILTON, George F., M. Inst.R.E.Aust. — Engineer in charge A.W.A. Beam Receiving Station, Rockbank, Vic. 1911-12 Marine Wireless Officer. 1912-15, Engineer - Operator, Radio Centre, Sydney. 1915-1918, O.I.C., Port Moresby Radio. 1918-22 O.I.C. Brisbane Radio. 1922-24 O.I.C. Sydney Radio. 1924-25 O.I.C. Townsville Radio. 1925-26 entered Marconi College, Chelmsford. 1926 to date Engineer in charge Beam Station, Rockbank. Born 5/7/1891.

CLARKE, Alick Ryle: Manager, Radio Department, A. G. Healing Ltd., Adelaide, since 1933. Seven years manager of Harris Scarfe's Ltd., Radio Department. Private address: 6 Staunton Avenue, Rosefield, Fullarton, S.A. Born Adelaide, 9/5/1904. Married. Recreations: Astronomy and kindred subjects.

CLARKE, George R.: Radio Sales Manager Tilbury & Lewis Pty. Ltd. Previously managed Homecrafts. In business on own account distributing Van Ruyten for two years. Joined Courtland's and in 1934, appointed Radio Sales Manager at Tilbury & Lewis Pty. Ltd. Private address: 43 Stewart Street, Ormond. 'Phone X5996. Recreation: Golf.

CLARKE, Fred W.: Managing Director Continental Carbon Co. Pty. Ltd., Melbourne. Commenced manufacturing "Advance" radio products in 1922. Business became Radio Corporation (Aust.) Pty. Ltd., in 1926. Manager of Radio parts department and Director of Tilbury & Lewis Pty. Ltd., 1927-33. Commenced Continental Carbon Co. Pty. Ltd. on return from America in 1934. Private address: 286 Heidelberg Road, Ivanhoe. Phone: Ivanhoe 135. Recreation: Flying.

CLARKE, William G.: Supt. Coastal & Island Radio Services, Amalgamated Wireless (A/sia) Ltd., Sydney. Served O.I.C. Brisbane, Townsville and Perth Radio telegraph stations, 1912-1920. 1927, transferred to A.W.A. Head Office, Sydney, as Superintendent Radio Services. Private address: "Delmonte," 146 Carrington Road, Randwick. Born 5/6/84. Recreations: Motoring and surfing.

COLLOCOTT, Harold: Branch Manager, Adelaide Dept., Eclipse Radio Pty. Ltd. Entered radio industry, 1923. 1926, joined Eclipse Radio Pty. Ltd. 1928, apptd. Sydney Mgr. 1930, apptd. Adelaide Manager.

COLVILLE, Sydney: M.Inst. R.E. (Aust.). Proprietor Colville Wireless Supplies, Rowe Street, Sydney. Entered Radio field experimentally in 1911 and

commercially in 1921. Founder of Queensland Wireless Institute, 1914-19. Colville-Moore Wireless Supplies Ltd., 1921. Commissions: Technical Adviser to Siamese Government 1923. Lieut. Instructor Navy League. Radio Engineer Royal Aero Club of N.S.W. Designer of Broadcast Stations 4AY, 4IP, 4BU. Specialty Aircraft Radio. Conducted numerous tests over past eight years; particularly interested in its development. Recreations: Flying and golf.

CONRY, William Henry, M. Inst.R.E.Aust.—Radio Inspector, P.M.G.'s Dept., Melbourne. 1910 appointed Engineers' Branch, P.M.G.'s Dept. 1915-1918 Wireless Operator R.A.N. Radio Service (Transport). 1920-1923 special radio duties, Wireless Branch, P.M.G.'s Dept. 1924 appointed Radio Inspector, Grade 1, 1922, Radio Inspector, Grade 2. Born 3/6/1892.

COOK, Samuel Gordon: Manager Radio Electrical & Refrigeration Dept., David Jones Ltd., Post Office Stores, George

Street, Sydney. Mem. United Service Institute, Lieut. in Royal Aust. Naval Volunteer Reserve. Lieut. R.N.A.S. & R.A.F. during war. Mem. Australian Flying Corps Assn., also Master Mariner Cert. Born January, 1895.

COOKSON, Joseph George, M.Inst.R.E.Aust. — Engineer-in-charge, Radio Centre, Pennant Hills, A.W.A. Ltd. 1917-24 Radio Mechanic, Townsville, Cooktown and Sydney. 1924-26 Maintenance of Station 2FC Sydney. Visited Marconi College, Chelmsford, England. 1926 appointed Engineer-in-charge Radio Centre, Pennant Hills. Born 1888.

COOPER, Stanley A. B., M.Inst.R.E.Aust.—Beam Wireless Technician, Rockbank, Vic. Joined A.W.A. staff 1924. 1925-26 completed special course of instruction in radio engineering, Marconi College, Chelmsford. 1927-32 Technician at Beam Transmitting Station, Fiskville. 1932 to date Rockbank. Born 27/4/1897.

COURT, T. P.: Councillor and Member I.R.E. (Aust.). President, Society of Radio Technicians, Australia. Design Engineer, Standard Telephones and Cables (A/sia) Ltd., Sydney. Joined S.T.C. 1925. Private address: 14 Boyle Street, Cremorne. Educated Prahran College and Melbourne Technical College. Born 2/12/1894.

COX, Edmund S. ("Ted"): Sales Manager, Amplion (Aust.) Ltd. Born 12th March, 1904. Educated at Trinity Grammar

School, Sydney. Active interest in radio since inception of broadcasting. Appointed first Metropolitan representative Philips Lamps (Aust.) Ltd., 1927—associated 5 years. Joined Amplion (Aust.) Ltd., 1933.

COXON, W. E., A.Inst.R.E. (U.S.A.), Consulting Radio and Sound Engineer, A.M.P. Chambers, Perth, W.A. In 1907 conducted wireless experimental station at Perth until out-

break of war. During which was engaged on electrical work in England with A. C. Reyrolle. Gained Certificate of Proficiency in Radio with North Eastern Schools of Wireless, and continued as instructor. Returning to W.A. after war, was Instructor in Electrical trade classes of Repatriation Department. Then commenced business on own account as electrical and radio engineer. 1924 appointed engineer and Manager of 6WF. 1929 conducted first duplex telephony between Australia and Java, and Singapore. December, 1933 built and installed transmitter for Station 6AM, Northam. September 1934 was made Station Manager and Supervising Engineer. October, 1935, resigned to commence business as Radio and Sound Engineer. Has been on several occasions President of the Wireless Institute of Australia (W.A. Division).

WHO'S WHO—(Continued)—

CRAVEN, Norman Thomas John: Proprietor and General Manager, Reliance Radio Co. (A/sia), 14 Barrack Street, Sydney. Received early training in electrical engineering and

in experimental radio since 1912. Served with Searchlight Engineers and 2nd Division Signallers during War. Established Reliance Radio Co., 6th May, 1932. Private address: 138 Brighton Boulevarde, Bondi North, N.S.W. Born June 6, 1895. Recreations: Surfing and golf.

CRAWFORD, W. T. S.: Councillor and M.Inst.R.E. Aust. Senior Radio Inspector, Sydney

CUTTS, Gregory Maxwell: Member Council of Society of Radio Technicians, Australia. Vice-President, R.R.A. Proprietor, Mosman Radio Service. Chief Radio Engineer and Radio Manager, Burgin's Electric Co. Ltd. for 9 years. Educated at The Hutchins School, Hobart, Tas. Clubs: R.A.C.A. full member; Hon. Secretary of Rotary Club of North Sydney. Private address: 8 Burton Street, Mosman. Married. Born 28/6/1903, Brewarrina, N.S.W. Recreations: Fishing, estuary and deep sea.

DARE, Eric: General manager, the Mullard Radio Company (Aust.) Limited, Head Office, 26-30 Clarence Street, Sydney. Educated Napier Boys High School. Amateur radio transmitter, 1912-13. With Philips, 1926 to June, 1930, as Technical-Commercial and advertising Manager, taking over

Mullard in August, 1930. Private address: 17 Streatfield Rd., Bellevue Hill. Married. Born N.Z., 17th February, 1897. Recreations: Swimming and amateur wrestling.

DAVIDSON, George Robert. —Radioplayer Sales Manager, Philips Lamps (A/sia) Ltd. Educated at North Sydney High

School. Joined radio industry 1928. Country traveller for Philips Lamps 1930-1932. Sales Manager, Ducon Condenser Pty. Ltd., 1932-1935. Rejoined Philips Lamps, 1935. Private address: 37 Wycombe Road, Neutral Bay. Born 7/7/03. Recreations: Tennis and swimming.

DAVIES, R. M.—New South Wales Manager New Systems Telephones Pty. Ltd., 276 Castlereagh Street, Sydney.

DAVIS, Albert George.—Proprietor A. G. Davis & Co., Wembley House, George Street, Sydney. Fellow Australian Institute of Secretaries. Associate—Chartered Institute of Secretaries (London). Associate—Association of Accountants of Australia. Justice of the Peace, N.S.W., Queensland, South Australia. Recreations: Motoring, literature and music.

DAVIS, Russell.—Metropolitan Manager, Beale & Co. Ltd. Joined piano technical staff of company 1920. After four years' factory experience, transferred, in 1924, to metropolitan and country sales staff. 1927 in control of Company's suburban agents. Interstate representative in 1930. Metropolitan Manager present position in 1932. Recreations: Motoring, golf, tennis and music.

DAVISON, Keith Douglas. —Managing Director, Condenser Specialty Co. Ltd., 112 Rothchild Avenue, Rosebery, N.S.W. Educated Kyre College and St. Peter's College, Adelaide. Studied mechanical and electrical engineering Adelaide

School of Mines and University. Two years drafting Port Pirie Smelting Works. Three years motor business on own account. Commenced radio experimenting 1913. Joined Raycophone 1929: Radio service division. Joined Wetless Electric Mfg. Co. Ltd. latter end 1930 and remained four years as outside representative resigning early 1935 to found own company. Private address: 23 Willis Street, South Kensington, N.S.W. Recreations: Speedboating. Born at Pt. Pirie, S.A., 1900.

DEARMAN, Reginald Vincent. — Chief Accountant Amalgamated Wireless (A'sia) Ltd., Sydney. Associate member, Commonwealth Institute of Accountants. Educated Fort Street High School. Accountancy, 1st place N.S.W. Institute, June, 1924, Final Accounts. Joined Amalgamated Wireless (A/sia) Ltd., January, 1924. Private address: 20 Selwyn Street, Artarmon. Born 2/8/'97. Recreations: Tennis, fishing, swimming, gardening.

DE COURCY BROWN, A. W.—A.Inst. R.E. Educated at Petersham Inter. High School. From 1935 Radio Sales Engineer

De Courcy Brown, A.

with Noyes Bros. (Sydney) Ltd. Private address: "Santa Barbara," Edward Street, Bondi. Born 27/8/1909. Recreations: Surfing and fishing.

DENING,, Alex.—Manager Philips Lamps A/sia Ltd., Perth Branch. Was radio operator for A.W.A. Travelled world in this capacity. Then Manager Philips Lamps Newcastle Branch for two years. Transferred to Sydney in capacity of city traveller. Recreations—surfing and gardening.

DONNER, W. A., Managing Director, Columbia Graphophone A/sia Ltd., Homebush, N.S.W. Following the amalgamation overseas of Columbia, H.M.V. and Marconiphone, appointed General Manager in Australia for His Master's

Voice, Manager in Australia for Parlophone. Previously Export Manager, Columbia Graphophone Co. Ltd., Clerkenwell Rd., London. Came to Australia as Managing Director Columbia Graphophone A/sia Ltd. in 1929. Married. Private address: Olphert Avenue, Vaucluse. FU 7113.

DOBBYN, Joseph McMullen, M.Inst.R.E.Aust.—Radio Inspector, P.M.G.'s Dept., Melbourne. 1908-1911 apprentice electrical engineering. 1911-1925 Electrical Engineers' Branch, P.M.G.'s Dept., Melbourne. During the Great War, served as Wireless Operator, R.A.N. Transport Service. 1925, Radio Inspector. Born 20/7/1892.

WHO'S WHO—(Continued)—

DRAFFIN, James Charles, M.Inst.R.E.Aust. — Engineer, Broadcasting Dept., Amalgamated Wireless A/sia Ltd., Sydney. Commenced in radio as Telegraphist with the Australian Forces in New Guinea 1916-21. 1922-25 Officer in charge, Bitapapa Radio, New Guinea. 1927-35, Engineer in Charge, Beam Station, Fiskville, Victoria. 1935, transferred to head office, A.W.A., Sydney. Born 23/5/1893.

DUDMAN, Victor H., M.Inst.R.E.Aust. — Manager Transmitting Department Philips Lamps (A/sia) Ltd., 69-73

Clarence Street, Sydney. Engaged with Royal Navy and Royal Australian Navy from 1919-1928. Has been with Philips Lamps since September, 1928. Private address: 52 Portland Street, Rose Bay. Born London, 2nd July, 1903.

DUFFY, John, A.M.I.R.E. (U.S.A.).—Manager, Radio Department, Marcus Clark & Co. Ltd., Sydney. In 1926 commenced service with Royal Australian Naval Forces. 1927 with Home Recreations (Aust.) Ltd., Sydney. 1928 joined Harringtons Ltd., Sydney. 1930 formed Harrington's Radio Club and elected President. Built and operated radio and television station VK2HR for club. 1932 resigned from Harringtons Ltd. and formed Duffy Radio Co. Ltd. 1935 qualified for Broadcast Engineer's Ticket. October 1935 sold out interest in Company and accepted present position. Private address: 1 Wilfield Avenue, Vaucluse. Born 3/6/1907, Sydney. Married. Recreations: Golf and swimming.

DUKE, Alan S.—Proprietor Alan S. Duke Pty. Ltd., 48 Bourke Street, Melbourne, R.A. C.V. Commenced in electrical industry, 1912. Formed own Company March, 1931. Chairman Wholesale Radio Association, 1929-30. First President Victorian Radio Association in October, 1931 and '32. Chairman Exhibition Committee, 1930-31-32. Born January 1897. Recreations: Tennis swimming.

DUNN, John T.: Sales Manager, E.S.M. Co. Ltd., Glebe. 8 years with Bennett & Wood Ltd., 3 years of which Radio

Sales Manager. 4 years Active Service, A.I.F., Egypt and France. Private address: "Wyoming," Mitchell Street, North Bondi. Married. Born 2/10/1896. Recreations: Motoring and golf.

DUNNE, Peter Edmund Langton, M.Inst.R.E.Aust. — Radio Inspector, P.M.G.'s Dept., Melbourne. 1914-1919 P.M.G.'s Dept. 1919-1925 served in Coastal Wireless Service as Radio Telegraphist. 1925-28 P.M.G.'s Dept., Radio Station. 1928 to date, Radio Inspector. Born 19/12/1892.

DWYER, Stanley G.: Secretary Australian Valve Mer-

chants Association, Sydney. Secretary, Stromberg - Carlson (A/sia) Ltd. 1929-1934. Trained in Accountancy, 1915. Born 3/6/96.

EGLON, George: Director and Factory Manager, Stromberg-Carlson (A/sia) Ltd., Syd-

Eglon, G.

ney. Born March 18th, 1885, Leicester, England. Educated at Ald. Newton's School, Leicester, and Leicester Technical School. Joined L. P. R. Bean & Co. in 1924. Appointed Factory Manager, Stromberg - Carlson (A/sia) Ltd., 1931. Appointed Director 1935. Private address: 17 Baroona Road, Northbridge. Reading, gardening and surfing.

EILBECK, George Edward: Director of Eilbeck & Co. Ltd., 5 years with Airzone (1931) Ltd. First buying department

and in later years, sales department. Left October, 1935, to join brother in own business. Private address: 27 Cremorne Road, Cremorne. Born 15/3/1908, at Sydney. Single. Clubs: Royal Sydney Golf Club and G.P.S. Old Boys' Club. Recreation: Golf.

EILBECK, Walter Blake: Managing Director of Eilbeck & Co. Ltd. Associated with Arkell & Douglas Inc. in Sydney, New Zealand and New York, until 1932, when present company was formed. Private address: 27 Cremorne Road, Cremorne. Born 11/6/04, Sydney. Club: Australian Golf Club. Recreations: Golf and yachting.

ELLIOTT, Albert Arthur: Proprietor Wendel Electric Co., St. Francis Street, Melbourne. Born 18/11/98. Recreations: Shooting and fishing.

ELLIOT, Samuel: Educated at Melbourne Technical College. Member M. Inst.R.E. Victorian Manager of Western Electric Co. (Aust.) Ltd. 5 years with Victorian Railways, Sea-going Wireless Operator for 1 year, and with Western Electric Co. for 7 years. Private address: "Grendow," Bristol Street, Canterbury, Vic. Born Kensington, Vic., 13/4/1906. Recreations: Golf and tennis.

EMBELTON, George Pearson—B.A. Proprietor G. P. Embelton & Co. Educated Wesley College, and Melbourne University. Graduated B.A. (Melb.). Recreations: Golf, and swimming.

EVANS, Clive Walter: Director and General Manager, Widdis Diamond Dry Cells Pty. Ltd. 119 Hawke Street, West Melbourne, since 1922. Treasurer, Victorian Division I.R.E., Aust.

ELLIS, Alfred William Leslie: Manager Merchandise and Warehouse Departments of Noyes Bros. (Sydney) Ltd. Born Steiglitz, Victoria, October 1894. Educated Scotch College,

Melbourne. Major, Commanding No. 4 Squadron, Australian Flying Corps. Joined Studebaker Corporation of America, 1920. Representative South America, Canada, Europe, Sth. Africa and Australia. Managing Director Studebaker (Sydney) Ltd. Manager Masse Battery Sales Co., Sydney, 1931-1934. President Australian Flying Corps Association. Recreation: Golf.

EVERITT, Arthur Raymond: Partner, Borthwick Everitt & Co., 33 Mountain St., Sydney. A.Inst.R.E.Aust. Private address: "Merlan," Dunois Street, Longueville. Recreations: Golf and tennis. Born 20/3/1908.

FACER, Thomas: Director and Supervisor of hardware manufacturing side of Efco Mfg. Co. Ltd., Princes Highway, Arncliffe. Private address: 12 Westminster Street, Bexley. Born 12/1/1886. Recreations: Gardening, motoring and golf.

WHO'S WHO—(Continued)—

FACER, Reginald: Director Efco Manufacturing Co. Ltd., Princes Highway, Arncliffe. Su-

perintendent radio side of business. Born 12/4/1898. Recreations: Golf and motoring.

FACER, Richard: Managing Director Efco Mfg. Co. Ltd., Princes Highway, Arncliffe. In business in England for many years. Came to Australia, and

in company with two sons, Thomas and Reginald, founded the Efco Mfg. Co. Ltd., in 1920. Just completed 60 years in active business. Private address: 30 Clarence Road, Rockdale. Born 2/5/1860. Recreation: Gardening.

FISK, Ernest Thomas: Chairman and Managing Director, Amalgamated Wireless (A/sia)

Ltd., 47 York Street, Sydney. F.Inst.R.E., A.M.I.E. (Aust.), F.Inst.R.E., Aust. Born at Sunbury-on-Thames, near London, 1886, joined Marconi Co., 1905. Trained and worked in all branches wireless engineering operating in England, America, and other countries. 1909 went to Arctic icefields, demonstrated possibilities of wireless with Newfoundland Sealing Fleet. 1910, on board s.s. "Otranto," exchanged messages with H.M.S. "Powerful," in Sydney Harbour, when "Otranto" was 200 miles north-west of Fremantle, a distance of 1800 miles—a record in those days. Came to Australia, 1911, as representative of Marconi Wireless Telegraph Co. Amalgamated Wireless incorporated, 1913, appointed General Manager with a seat on the Board, three years later became Managing Director. In September, 1918, received first direct wireless telegraphic messages transmitted from England at his station at Wahroonga, N.S.W. August, 1920, gave first public demonstration of broadcasting at Royal Society of N.S.W., Sydney. The establishment of the Beam Wireless Service between Australia and England was largely due to his experimental work and his consistent advocacy with both British and Australian Governments for the adoption of his plans for the service. Wireless Telephone Service between Australia and Homeland mainly due to his experimental work. The prestige of Amalgamated Wireless as one of the foremost wireless companies of the world is due to the broad vision and high executive ability of Mr. Fisk who, during the past 20 years, has developed wireless in Australia and in the Pacific from a national point of view. Mr. Fisk is considered the foremost wireless authority in Australia. Visited England, U.S.A., and the Continent of Europe in 1933 investigating latest developments in wireless. Made a Chevalier of the Order of the Crown of Italy by the King of Italy. President, Institution of Radio Engineers (Aust.), since 1932.

FITZGERALD, R. — Born October, 1899, Petersham,

N.S.W. Educated at Petersham Commercial High School, first entered radio trade as manager of Harringtons Ltd., Sydney, wholesale radio dept., in 1924. Joined staff of Philips Lamps, January, 1925, as radio representative and has continued as such to date. Recreations: Swimming, fishing and tennis.

FORREST, Charles Eckersley: Managing Director International Radio Co. Ltd., 254 Castlereagh Street, Sydney. Active in radio since and prior to inception of broadcasting. Established International Radio Co. Ltd, Sydney,

in June, 1923. Private address: 79 Drumalbyn Road, Bellevue Hill. Born September 27th, 1898.

FREEDMAN, Allan Harris. —Director and Sales Manager, Stromberg-Carlson A/sia Ltd.,

Sydney. Yale University, B.Sc. Pilot Radio & Tube Mfg. Co. (U.S.A.) 5 years. 1929, present position. Born 23rd March, 1902. Recreation: Fishing.

FREEMAN, A.C.—In charge of laboratory, Amalgamated Wireless Valve Co. Ltd. Educated Toowoomba Grammar School. B.E. Queensland University, 1931. Employed on Engineering construction to 1934, following radio as hobby. Joined Amalgamated Wireless Valve Co. Ltd., May 1934. Born at Toowoomba, Queensland in 1910.

FRYER, Frederick Fenwick, R.A.F., F.R.P.S., M.I.T. Manager, Radio & Refrigeration

Fryer, F. F.

Dept., Bennett & Wood Ltd., Pitt and Bathurst Sts., Sydney. Educated Sydney Grammar School, Sydney Technical College, I.C.S. and Marconi School. Holder of Wireless Operator's First Class Certificate. Served as signaller 1st Batt. Infantry Signallers, A.M.F.; Flt.-Lt. Royal Air Force Reserve. First Class Certificate St. John Ambulance. Commencing electrical engineering with Electricity Meter Mfg. —4½ years—later Breville Radio as Assistant Engineer and David Jones Ltd. Recreations: Photography, music, physical culture, chemistry and general athletics. Private address: 9 Arthur St., Edgecliffe.

GARTH, Alfred Henry.—A. Inst. R.E.Aust. F. Inst. of Commerce, England. Sales and Service Manager of New System Telephones Pty. Ltd., Adelaide. Educated at Riverton High School and Adelaide University. Commenced radio retailing 1925. Appointed superintendent Industrial School, Edwardstown, 1929. Joined staff of New System Telephones Pty. Ltd., 1932. Private address: 148 North East Road, Walkerville, S.A. Born at Robertstown, S.A., on 28/9/05. Single. Recreations: Tennis and motoring.

GENDERS, E. B.—Managing Director W. & G. Genders Pty. Ltd., Hobart and Launceston. Address: "Glenwood," Relbia. Hobby: Farming and stock breeding.

GERBER, Eugene. — Chairman of Directors, Bloch & Gerber Ltd., 46-48 York Street, Sydney. Private address: 22 Eastbourne Avenue, Clovelly. Born July 10th, 1880.

GIBSON, Aubrey H. L.— Governing Director A. H. Gibson (Elec.) Pty. Ltd., Melbourne. Formerly agent for Hoover Cleaners for Victoria. Nephew of the late Sir Robert Gibson. Private address: Orrong Road, Toorak. Sport: Polo.

WHO'S WHO—(Continued)—

GIBSON, Sladen. —Manager Homecrafts Pty. Ltd., Melbourne. Entered Victorian Radio trade in 1926 on the sales side of Louis Coen Wireless. Soon after appointed to junior executive position and later as technical commercial representative. Left for England and Continent in 1928, on return rejoined Louis Coen Wireless and afterwards appointed Manager Homecrafts Pty. Ltd. Recreation: Golf.

GIDLOW, C.—Radio Parts Manager, Efco Mfg. Co. Ltd., Princes Highway, Arncliffe, N.S.W. Connected with Efco

Company for 8 years. Private address: Port Hacking Road, Sylvania. Born 31/12/1895. Recreation: Poultry raising.

GILMOUR, Norman Stanley. —Proprietor, Lekmek Radio Laboratories, 75 William Street, Sydney. M.Inst.R.E.Aust., and Vice-President of the Institution since 1932. Millions Club. Amateur Experimenting 1910.

Telegraph Branch P.M.G.'s Dept., till 1915, Engineer Postmaster-General's Department (N.S.W.) 1915-1922. 1922-1927 Director L. P. R. Bean & Co. Ltd.; 1927-31, Director Stromberg-Carlson A/sia Ltd.; 1931, founded Lekmek Radio Laboratories. Born 25/9/1890. Recreations: Swimming and tennis.

GITTOES, Clifford Searle.—Sales Manager Ducon Condenser Pty. Ltd., 73-83 Bourke St.,

Waterloo, N.S.W. Joined Ducon 1933 as Chanex Production Manager—Commenced experimental Radio, 1925. Student Marconi School. 4 years Motor Trade. 1929 Country Representative Amplion (A/sia) Ltd. Private address: 33 Beresford Road, Strathfield. Recreations: Surfing and tennis. Born 1906.

GODLEY, William.—Airzone (1931) Ltd., Sydney. On leaving school, entered Admiralty Hydrographic Survey Branch, and as a cadet served four years surveying service in British Columbia. Followed by three years in North Queensland and two years in N.W. Australia. Later, a year was spent on Photographic Survey of countries around Mediterranean. Joined Harringtons Ltd., 1912, and had considerable executive experience. Following on country representation, was branch manager Adelaide four years, Brisbane two years and General Manager New Zealand, five years. Returned to Head Office as Sydney Manager in 1928. Resigned Feb., 1933. Joined B.G.E. Ltd. in N.Z. Returned Australia early 1934. Joined Airzone (1931) Ltd. Private address: 49 Tunstall Ave., Kensington. Born, January, 1882. Recreations: Photography, gardening, golf. Educated Tottenham Grammar School, London.

GORDON, F. A.—Manager Electrical Supply Dept. Noyes Bros., Melbourne. President of Victorian Electrical Federation, 1935. Private address: 17 Denman Avenue, East St. Kilda, S.2. Phone L 1335. Recreation: Golf.

GOW, Donald N., Metropolitan (Sydney) Representative, Airzone (1931) Ltd. for 4 years to date. Joined A.I.F. 16 Corps Signals in last year of war. Became associated with radio almost immediately after War and has been in it ever since. Has had practical and executive ex-

Gow, D. N.

perience in all branches including engineering and tool making, technical engineering, factory management, publicity and general management. Married. Private address: 4 Belmore St., Burwood. UJ 4610. Born 1900. Recreation: Golf.

GRAHAM, Lancelot Beaven. —Director and Principal Australian Radio College, Broadway, Sydney. Commenced radio 1925, actively concerned in the industry since that date. Joined Amplion (A/sia) Ltd., at the commencement of that Company. Later with Philips Lamps (A/sia) Ltd. Joined A.R.C., 1933, and appointed Principal, August, 1934. Private address: 20 Inglethorpe Avenue, Kensington. Studies: Radio Research. Born 23rd October, 1907.

GREEN, Alfred Leonard, Dr., M.Inst.R.E.Aust. B.Sc. & Dip. Ed. 1925, M.Sc. 1929, Ph.D. 1934 (London) Member Royal Soc. Teachers 1928, Ass. Mem-

ber I.R.E. (U.S.A.) 1928.—Physicist, Amalgamated Wireless Research Laboratories, Ashfield, Sydney. 1926-27 Post-graduate research in radio at King's College, London. 1928-29 Scientific Assistant, Radio Research Board, England; Senior Assistant Prof. E. V. Appleton, F.R.S. 1929 to 1935 Research Physicist Radio Research Board, Australia. 1935 joined Amalgamated Wireless A/sia Ltd. Born 3/2/05.

GREEN, H. J.—Manager A. P. Sutherland, South Melbourne. Grew up with this firm. Visited England for special training in the Exide Battery Works. Is expert in all forms of battery power and lighting. Private address: 7 Kilmartin Street, Essendon, Vic. FU 7134.

GREENWOOD, J. Russell.—Electrical Manager, Anthony Hordern & Son, Limited, Sydney. Chairman, Electrical and Radio Development Association, N.S.W.

GUTHRIE, James Henry Frencham.—Manager, Radio & Valve Departments, British Gen-

eral Electric Co. Ltd., 104 Clarence St., Sydney. Jackerooing in Queensland 3 years—joined Australian Paper Mfrs. in Melbourne 2½ years; with Philips Lamps Aust. Ltd., Melbourne, 4 years, leaving to take over management of the Valve Dept., of B.G.E. Co. Ltd., head office, Sydney, early 1933; early in 1934 took over joint management of Radio and Valve Departments. Educated at Melbourne Church of England Grammar School. Recreations: Tennis and golf. Private address: "Lymington," Cooper St., Double Bay (FM 5559).

HALE, John Palmer.—Manager Radio Department, Newton, McLaren Limited, 17 Leigh Street, Adelaide. Associated with Company since early part of 1917. Inaugurated Radio Section and in charge of same from 1922. Private address: Elderslie Avenue, Fitzroy. Born October, 1900.

HALL, Bernard M. ("Van"). —A.Inst.R.E. Aust. (by exam.). Educated Sydney Grammar School, 1925-29; joint Proprietor Radio & Television Supply Co., 1932-33; staff of Rowe St. Radio 1932; David Jones, Sales & Service, 1933-36. At present Service Manager, Bennett & Wood Ltd. Recreations: Football and radio. Private address: 6 Billong Ave., Vaucluse.

WHO'S WHO—(Continued)—

HANKIN, H. H. J. — Proprietor, Simplex Radio, 716 Parramatta Rd., Petersham. Private

address: Old Castlehill Rd., Castlehill, N.S.W. Born 13/6/1901. Recreations: Tennis, motoring, gardening.

HARCOURT, Victor John. —Secretary Radio Finance Company Ltd., 11 Sturt Street, Sth. Melbourne, Vic. Private address: 20 Melrose Street, Mordialloc, Vic. Recreations: Fishing and duck shooting. Born 1901.

HARGRAVE, Dan W. — Radio Sales Manager, Noyes Bros., Melbourne. Private address: 20 Rosedale Road, Glen Iris, S.E.6. Born 3/7/1904.

HARRIS, David Thomas.—Manager D. Harris & Co., 140 Rundle Street, Adelaide. Commenced on own account in Radio, July, 1929. Entered into partnership, with brother S. D. Harris, 1930. Private address: 6 Fortrose Street, Dunbath, Glenelg. Recreations: Yachting, swimming, golf.

HARRIS, Samuel D.—Partner, D. Harris & Co., Adelaide. In charge of Technical & Manufacturing Section. Previously with Elec. Eng. Lab. S.A. School of Mines. 6 years engineering draftsman, S.A. Railways. Entered existing partnership 1930. Private address: 25 Ramsgate Street, Glenelg, S.A. Recreations: Golf, tennis, swimming.

HARROLD, Arthur Elliotts. —Commenced business in Brisbane, 1910 as Wholesale Importer of Musical Instruments, was one of pioneers of Gramophone Trade in Queensland. Private address: Clayfield, Brisbane. Born in Sydney, N.S.W.

HART, Chas. H.—Branch Manager The Ever-Ready Co. (Aust.) Ltd., Perry House, Elizabeth Street, Brisbane. Arrived in Melbourne from England 1924. Joined Ever-Ready as Vic. Country Rep. in 1932. Appointed Brisbane Manager, December, 1935. Private address: Walker Avenue, Teneriffe, Brisbane. Born 29/10/02. Recreations: gardening and motoring.

HARTLEY, Harold. — Proprietor, Hartley's Teleray, Sandringham, Vic., S8. Opened first radio store in Melbourne, 1919. Radio Manager Leviathan Ltd., 1924. Opened a radio factory for same firm 1925. Hobbies: Golf, yachting, fishing and billiards. Private address: 5 Daley Road, Sandringham, S8.

HAWORTH, Stanley R. E. —Sales Representative, Amalgamated Wireless Valve Co. Ltd.

Joined A.W.A. in 1921. Joined Amalgamated Wireless Valve Co., in 1932. Recreations: Tennis, bridge.

HENDERSON, Frederick J. —M.Inst.R.E. (Aust.). Director and Manager, Howard Radio Pty. Ltd., Vere Street, Richmond, Vic. Educated at All Hallows Grammar School, England. Commenced radio 1908 with British Marconi Co. Later in charge Macquarie Island radio station for Mawson Expedition. During War was Officer of R.A.N.R.S. in charge of erecting and testing radio stations throughout Australia. 1928, appointed Director Howard Radio Pty. Ltd. Born 26/6/91. Private address: South Lodge, Were Street, Brighton Beach, S.5, Victoria.

HENRY, Basil Roger.—Publicity Dept., Philips (A/sia)

Ltd. Educated: Sandgate College, Queensland. Fifteen years in general publicity, seven years at Anthony Horderns', four years "Sun" Newspaper and late Advertising Manager of "The Advocate," Burnie, Tasmania. Private address: 108 Kurraba Road, Neutral Bay. Born 10/10/1900. Recreations: Captain of North Sydney Hockey team 3 years, represented N.S.W. Hockey 1931, captained Tasmania Hockey 1934. Golf, Tennis and Cricket.

HERRING, George Ken. — Sales Manager, The Ever Ready Co. (Aust.) Ltd., Marshall St.,

Sydney. Educated Sydney Grammar School. Private address: 2 George's Road, Vaucluse (FU 8755). Born 16/12/99. Recreations: Golf and surfing.

HERTOG, A. den.—Managing Director, Philips Lamps

(A/sia) Ltd., 69 Clarence St., Sydney. Director Electric Lamp Manufacturers (Australia) Ltd., Clyde Street, Hamilton, N.S.W.

HILLS, A. H.—Queensland Representative of Philips Lamps (A/sia) Ltd. Company address: Perry House, Elizabeth Street, Brisbane. Has represented Philips Lamps (A/sia) Ltd., in Queensland since 1927.

HILL, William C. — 191 Queen Street, Melbourne. Connected with radio since the War,

prior to which he served in the Army, having been invalided back to Australia. After several years at sea as a Wireless Operator, joined the Commercial staff of A.W.A. in Melbourne. Organised and managed 7LA, Launceston. Was appointed Noyes Bros. (Melb.) Pty. Ltd., left 1933 to start own business as Stromberg-Carlson Factory Representative for Victoria and Tasmania.

HOBDEN, Hillstead Inigo. —Radio Manager, Eastern Trading Co. Ltd., 155 Clarence St., Sydney. Served with B.E.F. in France during war. Member Millions Club. Private address: Lindfield. Born 1893. Recreations: Golf, motoring.

HOMEWOOD, Walter, B.—Director and Sales Manager, Airzone (1931) Ltd., 16 Australia Street, Camperdown, Sydney.

HOMBERG, S. G.—Born in Gippsland. Early in life interested in experimental wireless. Director and Staff Supt. of A. J. Veall's Pty. Ltd. Recreations: Psychology, ancient history, golf.

HOOKE, Lionel Alfred.—Deputy General Manager, Amalgamated Wireless (A/sia) Ltd., 47 York Street, Sydney.

M.I.R.E. (America), M.Inst. R.E. (Aust.). Joined Amalgamated Wireless, 1913, and in 1914 joined Shackleton's Polar Expedition. During war commissioned in New Zealand Royal Naval Volunteer Reserve, served as commissioned officer in submarine chasers. Transferred as pilot to Air Force,

WHO'S WHO—(Continued)—

Hooke, L. A.—(Contd.)—subsequently commanding Air Station at Bude. On return to Australia appointed Melbourne Office, A.W.A., and later became Melbourne Manager. Transferred to Sydney as Assistant Manager and became Deputy General-Manager A.W.A. 1925. 1930-32 travelled Europe and America for A.W.A. investigating world's development in radio. Councillor Institution Radio Engineers, Australia. Born 31/12/1894.

HORNER, Ernest Albert.—Manager Radio-Electric Works, Amalgamated Wireless (A/sia) Ltd., Parramatta Road, Ashfield. Born Auburn, N.S.W. Commenced Electrical Training N.S.W. Tramways, 1908. Joined A.W.A. 1918, later Assistant Manager of Works. Appointed Works Manager, 1923. Visited England and United States in 1926, to study manufacture and again visited England in 1932-3 on A.W.A.'s behalf.

HULL, Allan Galbraith.—M.Inst.R.E. (Aust.). 1930 Technical Editor "Wireless Weekly," Wireless Newspapers Ltd., 60 Elizabeth Street, Sydney. During 1936 made world tour on behalf of paper investigating radio and television. Private address: 69 Baroona Road, Northbridge. Born 5/4/05.

HOSKING, A. P. — Sales Manager, Amalgamated Wireless Valve Co. Ltd., 47 York

Street, Sydney. M.Inst.R.E. (Aust.). Served with South African Forces during War. Recreations: Golf, fishing, motoring.

HUCKELL, Edward Dean.—Proprietor Huckell Radio, 285 Military Road, Cremorne, N.S.W. M.Inst.R.E., Aust. Vice-President Radio Retailers' Association, N.S.W. Established "Huckell Radio," Cre-

Huckell, E. D.

morne, 1928. Private address: 285 Military Road, Cremorne, N.S.W. Born November 24th, 1897. Recreations: Literature, travel.

HUNT, George. — General Manager E.S.M. Co. Ltd. Joined Radio Industry, 1932.

Private address: 4 Mitchell St., Marrickville. Born 15/10/04. Recreations: Tennis and motoring.

IRVINE, Charles J. — Tasmanian Representative, A. G. Healing Ltd., 167 Franklin St., Melbourne. Commenced in Radio 1927. Appointed Sales Manager, 1929. Born 26/7/04.

JAMES, Claude E. W. — M.H.A. Director W. & G. Genders Pty. Ltd., Tasmania. Address: Frankland St., Launceston. Fellow Federal Institute Accountants.

JEACOCKE, Norman Reginald.—Advertising representative of Wireless Newspapers Ltd., of 60 Elizabeth Street, Sydney. Recreations: Golf and swimming.

JENNINGS, R. H. J.—Sales Manager, Thom & Smith, 55 Dowling Street, East Sydney. Joined Thom & Smith, November, 1932. Private address: No.

Jennings, R. H. J.

8 Kenya, Streatfield Road, Bellevue Hill. Recreations: Golf, tennis and yachting. Born 27/7/03.

JEWELL, Albert. — Director and Manager, The Ever-Ready Co. (Great Britain) Ltd., Marshall Street, Sydney. Appointed Melbourne Manager in November, 1931; present position, June, 1933. Private address: Burrabirra Avenue, Vaucluse. Born 21/8/93. Recreations: Fishing and art.

JOHANSSON, Nils Alfred—Radio Engineer and Radio Mgr. Beale & Co. Ltd., Trafalgar Street, Annandale. Bachelor Science, A.Inst.R.E. (America),

M. Swedish Inventors Society. M. Radio Technical Society (Sweden). Formerly of Western Electric Radio Research Department (Bell Telephone Laboratories), Swedish Telefunken Co., and allied organisations. Born 25/9/1895.

JOHNS, Frederick W. W.—Director and Secretary of P. & L. Wireless Supplies Pty. Ltd., which he joined in 1927. Born 26/2/05.

JOHNSON, J. Murray. — Eng.-in-charge Beam Wireless Picturegram Service, Amalgamated Wireless (A/sia) Ltd., 167-9 Queen Street, Melbourne. M.Inst.R.E. (Aust.). 1911 joined Australasian Wireless Company. 1912, joined Commonwealth Radio Service. 1923, transferred to Engineering Department, A.W.A., Sydney. 1932, appointed present position. Visited England on behalf of A.W.A. 1931, and again in 1934. Appointed present position 1934. Born 24/11/89.

KEFFORD, Harold. — Sales Manager, Otto Sandel Ltd., Sydney. Foundation Member Institute of Sales and Business

Management (Aust.), Associate, Australasian Institute of Secretaries, Associate, Commonwealth Institute of Accountants. Born 18th December, 1898, at Bathurst, N.S.W.

KENNELL, Richard J. W.—Superintendent Philco Radio & Television Corp. (Aust.) Ltd., 12 years Electrical Engineers Branch P.M.G.'s Dept. 11 years Chief Engineers, New Systems Telephones. Member Institute of Radio Engineers, U.S.A., Member and Councillor Institute of Radio Engineers (Aust.) Address: 1 Greycliffe Avenue, Vaucluse. Born Melbourne, 29/10/1892. Recreations: Various. Married.

KERIN, J. J. — Managing Director American Steel Export Co. Ltd. and Tyme Ltd. Connected with motor trade. Well-known as a keen debater. Considerable political interests.

KERR, William. — Factory Manager, Eclipse Radio Pty. Ltd. Company address: 216-222 City Road, South Melbourne, Vic. Hon. Secretary, Brighton Radio Club. Private address: 211 North Road, Caulfield. Born 23rd January, 1904.

KINGSTON, Fredk. Charles.—Director Musgrove's Ltd., in charge Radio, Phonographs and Electrical Depts., also Director W.A. Broadcasters' Ltd. Born in England Feb., 1892. Entered Music Trade in Australia, 1912. Served four years with A.I.F. Signals. In March, 1930, established 6ML, W.A.'s first class "B" station. 1933 supervised building and establishing of Station 6IX. Now holds position as Station Director of 6ML and 6IX. President, 6ML Cheerio Club. Private address: 19 Suburban Road, South Perth.

WHO'S WHO—(Continued)—

KNOCK, Donald Brader. — Radio Editor, Bulletin Newspaper Co. Ltd., 252 George St., Sydney. Member Flying Corps Assn. of Australia. 4th Russian Order St. George. Deniken's White Army, 1919. Born Manchester, England, 10/10/99. Educated Wigan Grammar School. Apprenticed Mechanical Engineer and studied radio as hobby. Served with Royal Naval Air Service. Owner-operator exp. radio station VK2NO. Private address: 102 Nelson Bay Road, Bronte. Recreations: Swimming and motoring.

LACKEY, R., A. Inst. R.E. (Aust.), Dip. W.I.A. Born at Burwood, N.S.W. Educated at Central Technical School. Em-

ployed by Home Recreations, 1930. Foreman of Radio Department 1931. With Airzone Ltd., 1932. Joined the Australian Radio College during 1932. 1933 to date, Chief Instructor of the Australian Radio College.

LARCHER, Ernest John — Sales Manager of "Limberts," Adelaide. Commenced business London, 1910, with Stirling Record Co., The Zonophone Co., and H.M.V. Co. Many years with London Factors travelling British Isles. Arrived Adelaide, 1923, joined Aeolian Co., remaining until closed down. Sales Manager, Service Music Co. Radio Sales supervisor for New Systems Telephones Pty. Ltd., Adelaide. Now Sales Manager of Limberts. Private address: Kentish Hotel, Stanley Street, North Adelaide. Date and place of birth: April, 1893, London. Single. Recreations: Work, Political Economy.

LARKIN, Frederick William.—Publicity Manager, Amalgamated Wireless (A/sia) Ltd., 47 York Street, Sydney. Associate of Commonwealth Institute of Accountants. Associate of the Chartered Institute of Secretaries, Holder of Diploma in Economics & Commerce (Sydney University). Joined Australasian Wireless Co. Ltd., as

Larkin, F. W.

Accountant July, 1912, appointed Accountant to Amalgamated Wireless (A/sia) Ltd., on formation, July, 1913, until 1923, when he took over duties of Publicity and Advertising Manager on the creation of that section of A.W.A. activities. Private address: 61 Wolseley Road, Mosman.

LARKINS, Albert John. — Radio Sales Manager, Efco Mfg. Co. Ltd., Princes Highway, Arn-

cliffe. With United Distributors 1922-27, then in business on own account for 5 years. Joined Efco early 1932. Private address: 50 Gray Street, Kogarah. Born 19/10/1898. Recreations: Fishing and motoring.

LEEMAN, John. — Branch Manager, The Ever Ready Co. (Great Britain) Ltd., 360 Collins Street, Melbourne. Joined organisation as country representative March, 1932; appointed present position June, 1933. Born 2/7/1901. Recreations: Tennis and swimming. Private address: "Carngham," 38 Frederick Street, West Brunswick, Victoria.

LEVENSON, Joseph. — Proprietor Levenson's Radio, Pitt Street, Sydney. 28 years in business in Pitt Street. Private address: 36 Allison Road, Kensington. Born April, 1882. Recreations: Business literature.

LIMBERT, Charles Cameron.—Proprietor of "Limberts," 49a Grenfell Street, Adelaide, S.A. Started manufacturing radio in 1925. Considerable experience in design and manufacture of quality radio gramophones, talking and public address equipment. Private address: 126 Park terrace, Wayville, S.A. Born September 28th, 1905. Narracoorte, S.A. Single. Recreations: Radio research, motoring, swimming, reading.

LINDBERG, Elaf Richard.—Manager & Engineer, National Radio Corp. Ltd. Two years S.A. Electric Supplies. Four years on own account. Four years National Radio Corp. Private address: "Seafield Tower," Glenelg. Date and place of birth: 22nd August, 1894. Copenhagen, Denmark. Clubs: Glenelg Yacht Club. Recreations: Tennis and yachting.

LINDSAY, George William.—Queensland Manager, International Radio Company, C.T.A. Buildings, Elizabeth Street, Brisbane. Electrical Engineer by profession. Completed Westinghouse graduate student courses in Pittsburg and New York.

For some years was a Sales Engineer with Westinghouse International Co. in New York and travelled extensively in America, Europe, and the Far East. Returned to Australia in 1930 representing American interests including Freid-Eismann and C. A. Earl Radio. Joined International Radio in Sydney early in 1935.

LOVETT, Hubert Frank.—M.Inst.R.E.Aust. District Superintendent Western Electric Co., Aust. Ltd., Hobart, Tasmania. First Class Commercial Operator's Certificate October, 1926. June 24 to July 26, Draftsman, Engineers' Branch, P.M.G.'s Dept. Hobart. Since sound equipment engineering. Born 8/10/1905.

LOVETT, Leonard. — Proprietor and manager Radio and Electric Department, L. Lovett, 81 Bathurst Street, Hobart. Served apprenticeship with Hutchinson & Co., Hobart. Private address: "Birkroyd," Alexander Street, Hobart. Born 1894. Recreations: Tennis, fishing.

MACDOUGALL, R. K. — Managing Director A. J. Veall Pty. Ltd., Swanston Street, Melbourne. Entered electrical business in 1920. Joined A. J. Veall as traveller 1923. Promoted to Directorship 1930. Promoted to present position, December, 1935. Private address: Langham Pl., Hawthorne East. Recreations: Golf, bridge.

MacGRATH, J. — Specialty radio division Tilbury & Lewis Pty. Ltd., 45 Wangaratta St.,

Richmond. Formed Regent Radio in 1933, of which he was Managing Director till 1934 when he resigned to join Tilbury & Lewis Pty. Ltd. Private address: 4 The Ridge, Canterbury, E7, Vic. Recreations: Golf.

MADDERN, Clarence Arthur—Proprietor own business manufacturing Keystone Radio. Wireless operator, 2nd Div. Sig. Co., A.I.F. Employee Adelaide Observatory until 1922. Radio Manager, Bullock Clyde & Radio Stores seven years. Radio Manager, Harringtons, Adelaide Branch one year. Private address: 25 Dixon St., Clarence Park. Born 21/3/1896. Rose Park, S.A. Married. Recreations: Tennis, golf, fishing.

MALONE, James J.—M.Inst. R.E. Aust. Chief Inspector Wireless Postmaster-General's Department, Treasury Gardens

Melbourne. Chairman, Victorian Division, Institution Radio Engineers Australia. Served as Wireless Officer R.A.A.F. in France.

MANLEY, Patrick Joseph.—Managing Director, Amplion (A/sia) Ltd., 70 Clarence St., Sydney. Member Institution of Radio Engineers, Australia. Councillor of United Service (Army, Navy, Air Force) Institute. Commenced Victorian

WHO'S WHO—(Continued)—

Manley, P. J.—(Contd.)—

Railways, Telegraph and Telephone Division. 2nd Lieut. Signal Engineers, 1912-14. A.I.F. Signals 1915-19, Captain commanding Divisional Artillery Signals. 1919, Marine Wireless Officer. At present attached 1st Cavalry Divisional Signals. 1923, Sales Department Amalgamated Wireless. General Manager and Director, Amplion (Australasia) Limited, 1927. Formed Speakers (Australasia) Limited 1930, with position of Managing Director. Made careful study of Radio Manufacturing and merchandising abroad on several occasions. Private address: "Altona," Petrarch Avenue, Vaucluse. Born Melbourne, Vic., 11th September, 1894. Member Legacy Club, Imperial Service and Royal Sydney Yacht Squadron. Recreation: Army Signals (Captain 1st Cav. Signals).

MARKS, T. E. D. — The Southport School, Queensland, St. Paul's College. Sydney University, B.E., A.M.I.E. (Aust.) Southern Railway Company Electrification England, 1924. Joined McKenzie & Holland (Aust.) Pty. Ltd., Chief Engineer, Melbourne, in 1924; in England with Westinghouse Brake & Saxby Signal Co., returned as Assistant Engineer. Appointed Chief Engineer in 1933.

MARTIN, Albert Frederick.—B.E.E. Radio Receiver Development Engineer, A.W.A. Radio-Electric Works, Ashfield. Entered Wesley College, Melbourne, 1916, attended University of Melbourne, 1920-23. Associated with Melbourne Electric Supply Co., 1924, and later with Westinghouse Electric & Manufacturing Co., East Pittsburg, Pa., U.S.A. Joined A.W.A. in 1928. Born Ballarat, Victoria, 30th June, 1902. Recreations: Gardening and surfing.

MARTIN, Charles J.—Managing Director, Radio Maintenance Pty. Ltd., Swanston Street, Melbourne. Recreation: Golf.

MARTIN, John.—Managing Director Martin Ltd., 116-118 Clarence Street, Sydney. Engaged in accountancy as private secretary to the late Philip Henry Morton (ex M.L.A.) for 20 years. Formed Rogers Majestic Ltd. in August, 1934, and acquired a complete interest in February, 1935, and changed the name to John Martin Ltd. Private address: Hillcrest Ave., Hurstville, N.S.W. Recreations: Tennis and surfing. Born Aug. 19th, 1889.

MASHFORD, Rupert Leslie.—Liverpool Electric Cable Co. Ltd., Sydney. Technical, Publicity & Sales. Received early training in Electrical Engineering under late Professor Oxlade, of Sydney Technical College and Federal Electric Works, Sydney. Engaged in electrical activities until outbreak of war. In 1928 joined The Liverpool Electric Cable Co. Ltd.

MASKALL, Donald. — Managing Director Paramount Radio Manufacturing Co. Ltd., 301 Castlereagh Street, Sydney. Founded "Paramount Radio Mfg. Co.," May, 1932. Formed into Limited Company, April, 1934. Private address: Carlingford. Born 16/4/11. Recreations: Tennis, motoring, flying.

MATTHEWS, Thomas John, Manager, Specialty Dept., Radio Hall, David Jones Ltd., Sydney. Supervising Radio, Refrigerator,

Sewing Machine, Vacum Cleaner, Washing Machine & Ironer, Electrical Specialty and Radio Accessories Divisions. Previously N.S.W. Manager Firth Bros. Pty. Ltd.; Manager Radio & Television Mfrs. Ltd. Recreations: Fishing, swimming, golf. Born 14/11/1903.

McDONALD, Arthur Stephen.—Chief Engineer & Assistant Manager, Amalgamated Wireless (A/sia) Ltd., 47 York Street, Sydney. M.Inst.R.E. (America) and M.Inst.R.E.

McDonald, A. S.

(Aust.). Councillor of I.R.E. Aust. Born Castle Donnington, now Swan Hill, Vic. Educated at Public School and Melbourne Technical College.

McLEAN, Eric Archibald.—Sales Manager Radio Dept., Smith Sons & Rees. Ltd. Com-

pany address: 30-32 Wentworth Avenue, Sydney. Educated Public Schools, South Australia. Entered Postal Department, 1912. Address: Cambridge Avenue, Vaucluse. Born 4th February, 1897. Recreations: Literature, gardening, tennis.

McPHEE, Stuart Duncan.—Works Manager, Standard Telephones & Cables (A/sia) Ltd., 71 York Street, Sydney. Born and educated in Melbourne. M.Inst.R.E. (Aust.). Born 1899.

McQUILLAN, Cecil John.—Chief Radio Systems Engineer Standard Telephones & Cables Ltd., 71 York Street, Sydney. B.Sc. (Engineering) Honors London University. D.I.C. (Diploma of the Imperial College, London), Whitworth Exhibition. M.I.R.E. (America). Private address: "Cheddington," Elizabeth Bay Road, Sydney. 1923, joined Standard Telephones & Cables Ltd., London. 1933, visited England and the Continent to study latest technique and returned to Australia to carry out contract with Postmaster General's Department for the manufacture, supply and installation of seven new Regional Stations to be erected at Launceston, Townsville, Grafton, Sale, Dubbo, Murtoa and Katanning.

MILLINGEN, Arthur Clarence. — Managing Director, Eastern Trading Company Ltd., Keep House, 155 Clarence St., Sydney.

MINGAY, Oswald Francis.—M.Inst.R.E. Aust. M.Inst.R.E. (U.S.A.). Managing Director Australian Radio Publications Ltd. Managing Editor and Proprietor, "Radio Retailer of

Australia," "Radio Trade Annual," "Radio Review of Aust.," "Broadcasting Business," 30 Carrington Street, Sydney. Honorary Secretary Institution Radio Engineers, Australia. Hon. Sec. Radio Industry Annual Ball. Served in Signals A.I.F. 1915-1919. Millions Club. Founded Australian Radio Publications, 1930. Principal Australian Radio College, 1930-1933. Private address: 4 Woodside Ave., Lindfield, N.S.W. Born 1/7/95.

MITCHELL, George.—Manager Radio Section Martin de Launay Ltd., Sydney and Newcastle. Marconi School of Wireless. Associated with Martin de Launay Ltd., fourteen years. Private address: Hall Street, Bondi.

MITCHELL, Stanley Cyril.—Managing Director Commonwealth Moulding Company Ltd., 240 Princes Highway, Arncliffe, N.S.W. Alderman of Rockdale Municipal Council. Electrical Engineer by profession. 12 years master builder. Alderman, Rockdale Municipal Council. Private address: 240 Princes Highway, Arncliffe, N.S.W. Born 1892. Recreation: Fishing.

MITCHELL, V. F.—General Sales Manager of J. B. Chandler and Co., Brisbane. Director of 4BH.

MOORE, Eric J. T.—Consulting Radio Engineer. M.Inst. R.E. Aust. Education at Armidale College and Sydney High School. Qualified Royal Naval Examination Electrical Engineering, 1917. 1910, 1911, with Telefunken Company, erecting station AAA. 1911-14, P.M.G.

WHO'S WHO— Continued —

Moore, E. J. T.—Contd.

Telephone Department. 1914-16, Wireless Operator, Australian Transport 1916-19, Lieutenant, Royal Naval Air Service, 1923-26, Manager Farmer and Company Ltd., Radio Section, 1926-32, Stromberg-Carlson & Company, Rochester, U.S.A., 1932, Dec. 1934, Chief Engr. Stromberg-Carlson (A/sia) Ltd. In 1935 established own consulting business. Born 12/7/94.

MORGAN, Ivor. — Director and Engineer Regent Radio Pty. Ltd., 288 Burke Road, Camberwell, E6. With Leviathan Radio Department as technical expert in Radio and sound pictures, and also 18 months with Radiovision (Aust.) Ltd., on technical and laboratory staff. Jointed Regent Radio July, 1933. Became Director, November 20, 1934. Councillor of W.I.A. (3DH) 9/3/09.

MOSEL, Lawrence E.—Proprietor Western Radio Co., Torrensville, S. Australia. Private address: Stirling West, S. Aust. Single. Recreations: Tennis and cricket.

MOYLE, John Murray. — A.Inst.R.E. Aust. Technical Staff, "Wireless Weekly." Private address: 882 Pacific Highway, Chatswood. Born Feb. 28th, 1908. Married. Recreations: Motoring, and operating Amateur Station VK2JU.

MULHOLLAND, John Leonard.—Asst. Manager, Amalgamated Wireless (A/sia) Ltd.,

Sydney. President Victorian Radio Association (1932-33). M.Inst.R.E. (Aust.), Wireless Officer s.s. "Koombana," 28th August, 1911. N.Z. Manager, July, 1915. Traffic Manager, Marine Dept., 1920-22. Assistant Manager, A.W.A. Head Office, 1922. Melbourne Manager, 1928-34. Private address: Wallaroy Road, Woollahra. Born, 19/4/91. Recreations: Golf, motoring, bridge.

MURRAY, Gilbert Lang.—Managing Director, The Mullard Radio Company (Aust.) Ltd., 35 Clarence Street, Sydney. Royal Automobile Club. Tattersall's Club. Australian Golf Club. Appointed Managing Director Mullard Radio Company (Aust.) Ltd., at inception of company, May, 1931. Managing Director of Scott & Holladay Ltd., 35 Clarence St., Sydney. Private address: Royal Automobile Club of Australia, 89 Macquarie Street, Sydney. Born 13th April, 1889. Recreations: Golf and tennis.

MUTTON, Arthur Henry, B. E.—Student M.I.E. (Aust.), Hon. Sec. Communication Engineers section Institute of En-

gineers (Aust.). Engineer with Paton Electrical Instrument Co., 90 Victoria Street, Ashfield, N.S.W. since 1935. Educated Sydney Technical High School. Attended Sydney University 1925, graduating B.E. in 1932. From 1932 to September, 1935, Engineer in charge Radio Research Station, Sydney University. Private address: 31 Stafford Street, Stanmore. N.S.W. Born Stanmore, N.S.W. 27/9/1908. Single. Recreations: Baseball.

NEWMAN, Sydney Moreton.—Radio Engineer, Amalgamated Wireless (A/sia) Ltd., Sydney. M.Inst.R.E. (Aust.). Joined A.W.A. Engineering and Research Staff, 1920. Private address: 11 Kissing Point Rd., Turramurra, Sydney. Born, 1898. Recreations: Golf, tennis, motor competitions.

NEWMAN, S. W. H. — Director and Works Manager, The Ever-Ready Co. (Aust.) Ltd., Marshall Street, Sydney. Joined organisation 1916; appointed present position, 1930. Private address: "Wilga," Forsyth Street, Sth. Kensington. Born 13/7/1900. Recreations: Cricket, golf and fishing.

NICHOLLS, Keith Trewhella. — Branch Manager of Philips Lamps (A/sia) Ltd. Company address: 590 Bourke Street, Melbourne. Sales staff of Philips Lamps (A/sia) Ltd., Sydney. In 1930 transferred to Philips, Melbourne, as Sales Manager, appointed Manager of that Branch in 1932. Private address: 29 New Street, Hampton, S.7.

NORVILLE, Charles Henry.—Partner and Chief Engineer, Breville Radio, 486 Elizabeth Street, Sydney. M.Inst.R.E. (Aust.). A.I.R.E. (America). Testing Engineer, N.S.W. Railways' Laboratories, 1922-1931. Radio Engineer, Philips Lamps (A/sia) Ltd., 1931-32. Copartner Breville Radio, 1932-33. Hon. Treasurer Institution of Radio Engineers, Australia. Private address: 22 Shaw Avenue, Kensington. Born 20th February, 1902.

O'BRIEN, William J.—Partner and Sales Manager Breville Radio, 486 Elizabeth Street,

Sydney. Commenced study of Wireless at Marconi School, Melbourne, in 1918. Spent 9 years in America. Sales Manager for wholesale Radio houses. Returned Australia, 1929. Manager, Radio Dept., Suttons Ltd., and later Sales Manager for Thom & Smith. Commenced above business in November, 1932. Vice-President and Councillor of Aust. Radio Mfrs. Patents' Assn. Ltd. Recreations: Golf and swimming. Private address: "Talofa," Ravenswood Avenue, Randwick. Born 2nd August, 1899.

OPIE, Ernst Jack. — Radio Manager, Harris, Scarfe Ltd., Adelaide. Radio Manager A. W. Dobbie & Co. Ltd. since 1929. Joined present Company in Feb., 1934. Private address: 26 George Street, Parkside, S.A. Date and place of birth: Born 27/12/1908, Adelaide. Married. Masonic Club, Holdfast Bay Yacht Club. Recreations: Swimmin, tennis and cricket.

OVERDIEP, J. A.—Assistant General Manager of Philips Lamps (A/sia) Ltd. Company address: 69-73 Clarence Street,

Sydney. Awarded D. H. (Rotterdam). Associated with Philips Company for many years. Two years in Holland and Czechoslovakia; 4 years in British India, Ceylon, Burma, Siam and Java, and Straits Settlements. Has been connected with the Australian organisation of Philips since 1930. Private address: "Ashcroft," Bogota Avenue, Cremorne. Born 17th October, 1901.

PARCELL, W. R. Allan.—Sales Manager, A. J. Veall Pty. Ltd., Melbourne. Arrived in Australia early in 1934 and appointed Sales Manager Radiokes Ltd. After 12 months resigned

and joined Crown Radio, but very shortly was attracted to Vealls Pty. Ltd. Prior to coming to Australia was Radio Manager for F. J. W. Fear & Co., Wellington, N.Z.

PARKER, Philip S.—Works Manager, Airzone (1931) Ltd., Australia Street, Camperdown, N.S.W. Ashfield Technical School and private tutorship. Member and Councillor Institution Radio Engineers, Aust. Member Society Automotive Engineers, U.S.A. Manufacture of

WHO'S WHO—(Continued)—

Parker, P. S.—(Contd.)—radio 1925-27. Visited U.S.A. and England and had experience in various factories manufacturing automotive electric equipment and radio apparatus 1927-28. Joined Philips (A/sia) Ltd., Service Manager, 1928. Appointed Factory Manager to Philips, laid down new plans, and in charge of all manufacturing activities 1930-32. Joined Airzone as Works Manager, 1932. Born 22/9/03.

PARKINSON, Ernest Collins.—Works Production Superintendent, Amalgamated Wireless (A/sia) Ltd. Born Dec. 28th, 1898, Keighley, Yorkshire, England. Educated Salt High Schools, Saltair. Yorkshire, England. & Son, machine tool makers, Shipley. 1929, joined A.W.A. as Works Production Superintendent. Private address: 28 Birnam Grove, Strathfield. Born 28/12/1898. Recreation: Cricket.

PARMITER, Ernest Albert.—Governing Director, Acorn Pressed Metal Co. Ltd., 46 Mathieson Street, Camperdown,

N.S.W. Arrived in Australia, 1909. Founded present company, September, 1930. Private address: 27 Thorn Street, Ryde. Recreations: Motoring, shooting, surfing. Born 27/1/1891.

PARRAMORE, Harold Arthur.—Director of Regent Radio Pty. Ltd., 288 Burke Road, Camberwell, E.6, Vic. Private address: 4 The Ridge, Canterbury, E.7., Vic. Recreation: Tennis. Born 1913.

PATON, Frederick Henry.—Proprietor Paton Electrical Instrument Co., 90 Victoria Street, Ashfield, N.S.W. In 1910 joined Maritime Wireless Co., Randwick, N.S.W., and served four years apprenticeship. At outbreak of war joined Field Engineers and served at Gallipoli and in France, being severely wounded and eventually invalided home in 1917.

Paton, F. H.

Interested in radio experimental until taking it up commercially in 1929, making radio receivers and test equipment. Founded present company in May, 1935. Private address: 90 Victoria St., Ashfield. Born at Sydney, 3/10/1895. Married. Club: Amateur Fisherman's Association. Recreation: Angling.

PATON, John Alston—Chief Engineer, Lekmek Radio, 75 William Street, Sydney. Private address: 103 Essex Street, Epping. Recreations: Swimming and fishing. Born 18th March, 1907.

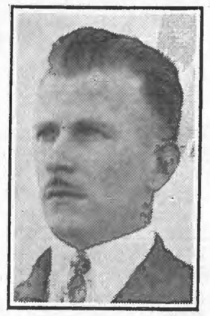
PATTERSON, Raymond W.—Sales Manager D.W. Radio Co., 210 Willoughby Road, Crow's Nest, Sydney. Joined

D.W. Radio Co., September, 1935. Educated Sydney Boy's High School and left 1923 to join The Radio Co. Ltd., Sydney. Manager Smith's Radio Store 1925-6, Manager Radio Distributors Ltd., 1926-7. Conducted own business, Service and Sales, Sydney, 1927-30. Joined Harringtons Ltd. in 1930 as Suburban Representative Wholesale Radio Dept. Then joined Sydney Branch Eclipse Radio Pty. Ltd., 1931, outdoor service staff. Next on outdoor sales staff Bebarfalds Ltd., until September, 1935. Five years in R.A. Naval Reserve, Wireless Section, leaving as leading Telegraphist. Born in Sydney, 10/12/1906. Recreations: Swimming, sailing, fishing, motoring, gardening and tennis.

PEARCE, Harry Frank. — Radio Manager, Standard Telephone & Cables (A/sia) Ltd.,

Sydney. Organised Radio Dept. for S.T.C. in 1923 when the Company was then Western Electric Co. Ltd. Recreation: Fshing. Born December, 1898.

PENNY, Langford W.—Manager of Sales Division 2TM Broadcasting Station, Tamworth. Commenced Radio Activities



with David Jones Ltd. (Radio Dept.) in 1923. From 1925 to 1927 served as sea-going operator on staff of A.W.A. Ltd., 1927-28 A.G.E. Co. Ltd., Queensland Country Sales, 1928-29 Manager of Radio Dept., Aeolian Co., Newcastle; 1931-33 Manager Radio Dept., J. A. Booth & Co. Ltd., Sydney; 1934-35 own Radio business Northbridge. Joined staff of 2TM February, 1935. Born 4th January, 1906.

PERSSON, O. — Factory Manager, Ducon Condenser Pty. Ltd., 73 Bourke Street, Waterloo, Sydney.

PERSSON, Andrew Rudolf. —A.Inst.R.E. (Aust.). Manag-

ing Director Ducon Condenser Pty. Ltd., and Manager H. Hecht & Co., 73 Bourke St., Waterloo. Vice-President Radio & Telephone Mfrs. Assn. Born 1892.

PETERSON, Rupert C.—Factory Manager, Tilbury & Lewis Pty. Ltd., Wangaratta St., Richmond. Formerly Sales Engineer, Warburton Franki Ltd. Experience also with L. J. Yelland and Noyes Bros. (Melb.)

PHILLIPS, J. B.—Proprietor Crown Radio Mfg. Co., 55

Bourke Street, Sydney. Private address: "The Garden," Carr Street, Coogee.

PHILLIPS, William H. C.—Marine Superintendent, Amalgamated Wireless (A/sia) Ltd., Sydney. M.Inst.R.E. (Aust.) Joined A.W.A., December, 1911. Appointed Marine Superintendent, 1924. Private address: 9 Ocean Street, Kogarah. Born Cairns, N.Q., 12/3/92.

PINKERTON, Harold Richard, Managing Director Savery's Pianos Ltd., Managing Director, Radio Wholesalers Ltd., General Manager, Hume Broadcasters Ltd. (5DN). Music and radio business twenty-six years. Broadcasting for past two years.

PLOWMAN, Claude.—Managing Director Airzone (1931) Ltd., 16 Australia St., Camperdown, Sydney. President Radio & Telephone Mfrs. Assn. of N.S.W.; Director, Radio Interests Ltd. Recreation: Yachting.

PLUMMER, David.—Designing engineer and technical adviser for A. G. Healing Ltd., Melbourne. For 5 years with Electrical Equipment Manufacturing Co., which later became Metropolitan Vickers. Joined H. J. Holst, radio engineers, in June, 1926, and went to Healing's in 1928. Until retirement of Mr. Cecil White, was factory manager.

WHO'S WHO—(Continued)—

POGONOWSKI, Louis Alexander.—Radio Sales Manager, British General Electric Co. Ltd., Melbourne. 1934, Sales Promotion Philips Lamps Ltd. Appointed Manager of Elec. & Radio Dept. of Wm. Adams Ltd., 1934. Joined Firth Bros., Radio Sales Manager, 1935. Born Feb. 5th, 1906. Recreation: Golf and swimming.

PRIOR, Herbert. — General Managing Director, A. J. Veall Pty. Ltd. Left engineer's office of City Council to become accountant for A. J. Veall. Later appointed Manager. In 1931 appointed Managing Director and present position December, 1935. Recreations: Football, tennis and golf.

PRITCHARD, Norman John. —Educated in England. Apprenticed Wolseley Tool and Motor Car Company, Birmingham. Attached 1st Royal Warwickshire Regiment. Hydraulic & structural Engineering with Sydney Hydraulic & General Engineering Co. and Elliott McLean & Co. Electrical experience with F. T. S. O'Donnell & Griffin. Three years trading in Solomon Islands. War service with 1st A.F.A./A.I.F. and Intelligence. Factory Representative Klein Mfg. Co., Cleveland, Ohio, U.S.A. North Shore Representative Adastra Flying School. Radio dealer 5 years. Established "Australian Radio News." Wholesale radio selling with Briton Electrical and Radio Co., and now N.S.W. Sales Representative Lekmek Radio Laboratories. Private address: Raglan Street, Mosman. Born Melbourne, 1891. Recreations: Fishing and Experimental Engineering.

PURVES, Bartholomew. — Manager Brisbane Branch Eclipse Radio Pty. Ltd., 15 Creek Street, Brisbane. Joined W. H. Eutrope and Sons, Mel-

bourne, in 1921, as City and Suburban representative. Transferred to Radio Corporation 1931. Joined Eclipse Radio Pty. Ltd., Melbourne, 1932. Opened Brisbane branch in September, 1933. Private address: "Retherway" Hotel, North Quay, Brisbane. Born 3/10/1898. Recreations: Tennis and swimming.

RANKIN, V. S., L.I.C.A., A.A.I.S. — Accountant, New Herberholds (A/sia) Ltd., 431 Hoddle Street, Abbotsford, N.9.

RAZ, Otto.—Director, Bloch & Gerber Ltd., 46-48 York St., Sydney. Private address: 14 Russell Avenue, Lindfield.

REED, Joseph Griffiths, A.M. I.E. (Aust.).—Design Engineer, Amalgamated Wireless (A/sia) Ltd. Transferred from Professional Division, P.M.G. Radio Service, 1912. Carried out experimental radio telegraph transmissions in association with R.A.N. Reserve at Newcastle, in 1914. Recreations: Model making and photography. Born 30th June, 1897.

REES, M. W. — Managing Director Smith Sons & Rees, 30-32 Wentworth Avenue, Sydney. Royal Automobile of Aust. C.T.A. Founded own business under name of M. W. Rees Ltd., 1917. August, 1920, a fusion of interests with S. Smith & Sons (M.A.) London, was effected and Mr. Rees became Managing Director of the combined concern. Private address: 37 Bundarra Road, Bellevue Hill, Sydney. Recreations: Motoring and golf.

RICHARDSON, Alan Kensington, A.O.C.P., L.O.C.P., W.A.A., A.R.R.L., Managing Director of Wireless and Electrical Services Ltd., 47 King William Street, Adelaide. Manufacturing and Servicing 7 years. Private address: 11 South Road, Everard Park. Born Kensington, S. Aust., 17/8/1914. Single. Recreations: Flying.

RICH, Gordon.—Sales Manager, Simplex Radio, 716 Parramatta Road, Petersham. Office

Manager, Biden & Roberts during 1924-1929, Radio Sales Bebarfalds, Sydney, 1929-31. Joined Simplex Radio as Sales Manager 1931. Private address: 6 Fitzroy Street, Croydon. Born 12/4/02. Recreations: Tennis and motoring.

RISELY, Edwin John.—Educated Scotch College, Adelaide. M.Inst.R.E. (Aust.). South Australian Manager Western Electric Co. (Aust.) Ltd., 1925-26 Engineer Broadcast Station 5DN Adelaide. 1927-29 Marine Radio Operator. 1929-36 Engineer, Western Electric Co. (Aust.) Ltd. Private address: 9 Day Road, Glenunga, S.A. Born November 25th, 1906, Semaphore, S.A. Married.

RITCHIE, Thomas Malcolm. —General Manager, Noyes Bros. (Sydney) Ltd. Director, Crompton Parkinson Australia Ltd. Director, Godfrey Ltd. Director, H. P. Gregory & Co. Ltd. Director, Southern Portland Cement Ltd. Member Institute Engineers Australia. Member Executive Council Chambers of Manufacturers, N.S.W. Vice-President, Metal Trades Employees Ass., N.S.W. Member Electricity Advisory Committee to the Government of N.S.W.

ROSE, Cecil John.—Manager, Reg. Rose & Co. Ltd., 58 Margaret Street, Sydney. Member Western Suburbs Hard Court Tennis Association. Sales Manager since inception, 1924. Private address: 12 Forest St., Haberfield. Born 4/9/1888. Recreations: Tennis, cricket, football, motoring.

ROSE, Reginald James. — Governing Director, Reg. Rose & Co. Ltd., Kembla Buildings, 58 Margaret Street, Sydney. Member N.S.W. Aero Club, Royal Automobile Club, Bowral Golf Club, National Ice Skating Club. Educated Fort Street High School. Joined Amalgamated Wireless 1915. Appointed Departmental Manager, 1920. Started in business on own account 1923. Born, December, 1897. Recreations: Flying, golf, motoring, ice skating and gardening.

SALMON, Clifford Grist.—Sales Manager, International Radio Company Ltd., 254 Castlereagh Street, Sydney. Extensive organising experience merchandising electrical specialties in Australia and New Zealand. Became associated with International Radio Company Ltd., in 1934. Previously Sales Manager of New Systems Telephones Pty. Ltd., Sydney, and Sales Organiser, A. & T. Burt Ltd., of New Zealand. Educated, Fort Street High School, Sydney. Private address: "Glendaruel," Findlay Avenue, Roseville.

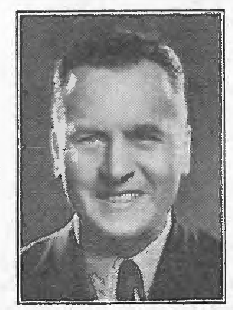
SANDEL, Otto, Managing Director of Otto Sandel Ltd., Radio Wholesale House, 73 York Street, Sydney. Designed and built original Broadcasting Station 2UW in 1922, a "B"

class license for which was issued in 1925. Been engaged in the manufacture of radio and retailing of same since 1925. In October, 1935, founded the wholesale house which bears his name in York Street, Sydney, and in February, 1936, founded the factory at 101 William St. Born at Brisbane, 2nd October, 1905. Owns and operates amateur station VK2HH. Married, and belongs to the following Clubs: R.A.C.A., N.S.W. Light Car Club, Sydney Bicycle and Motor Club. Private address: 8 St. Helens, Victoria Road, Bellevue Hill, N.S.W. Chief recreation is motoring.

SCHLIESMAN, George. — Director and Chief Radio Engineer E.S.M. Co. Ltd. In radio since 1913. Joined staff Electricity Meter Mfg. Co. Ltd., in 1922. Private address: 91 Arthur Street, Moore Park. Born 11/4/85. Recreations: Fishing, motoring and E.S.M.

SCOTT, Allen Wilson.—M. Inst.R.E.Aust. Chief Engineer, Stromberg-Carlson A/sia Ltd., Sydney. Graduated Sydney Technical High School and Sydney Technical College. Diploma of Sydney Technical College, Electrical Engineering. Appointed Chief Engineer, Stromberg-Carlson A/sia Ltd., 1934. Born 17/11/1906.

SCOTT, Harry Edward. — Secretary Philips Lamps (A/sia) Ltd., 69-73 Clarence Street,



WHO'S WHO—(Continued)—

Scott, H. E.—(Contd.)—Sydney. Educated at Latimer School, London. War Service from 1914-1918—Gallipoli, 29th Division, France, 56th, 58th and 47th Divisions; achieved the rank of Captain. Formerly an international soccer player. Previous commercial activities embraced banking in London and Africa, and auditing in London. Joined Philips Lamps (A/sia) Ltd., in November, 1927. Private address: 15 Eastern Road, Turramurra. Born London, 17th January, 1899. Recreations: Golf, tennis, billiards.

SEABRIDGE, Ernest E. — Radio Manager, A. H. Gibson (Elec.) Pty. Ltd., Melbourne. Formerly with Noyes Bros. (Melb.) Ltd., for 4 years, and in business on his own account for 3 years. Joined present firm at inception of radio department. Private address: Booran Road, Caulfield.

SEARLE, Geoff D.—Managing Director Regent Radio Pty. Ltd., 288 Burke Road, Camberwell, E.6. Experimental Engineer with Radiovision (Aust.) Ltd. in connection with picture transmission and radio. Joined Regent Radio, April, 1934. Became Managing Director November 20, 1934. Private address: 22 Bradford Avenue, Kew. Recreation: Motoring Born 22/8/10.

SEARSEN, Edward Michael. —Sales Manager, Radio Industries Ltd., Waterloo. Graduated from marine service to radio sales. Private address: 63 Henrietta Street, Waverley. Born, 16/2/1901.

SIMPSON, Walter G., Radio Sales Manager, "His Master's Voice" Radio, Columbia Graphophone Co. Ltd., Homebush, N.S.W. Entered music business in 1919 with Nicholson's Ltd., Perth. Manager Gramophone Dept. for 8 years,

then joined Columbia Graphophone A/sia Ltd., as Sales Manager. Held that position for 7 years until the advent of "H.M.V." radio, when transferred to that division as Radio Sales Manager. Married. Private address: "Burnside," O'Sullivan Rd., Woollahra. FM2278. Born 1901. Recreation: Golf.

SLADE, Charles William.—M.I.R.E. America. Sole owner of Slade's Radio and Slade's Precision Test Equipment, Lang Street, Croydon, N.S.W. Born Birmingham, Eng., 22/5/1893. Joined Royal Navy as Wireless Boy in February, 1909. Served in H.M.S. "Powerful" as leading telegraphist in 1912. Throughout the War served in H.M. Submarines with Capt Boyle, V.C. Left Royal Navy

with rank of Petty Officer Telegraphist in September, 1922, after serving 3 years in Australia on H.M.A. Submarine J7. Returned to Australia 1923. Radio Engineer to W. H. Wiles, 1924. Two years Technical Editor "Wireless Weekly" and "Daily Telegraph Radio Supplement," 1925-26. Commenced business as Slade's Radio at end of 1926. 1931 commenced manufacturing Precision Test Equipment. May 1935 world tour to study latest test equipment and television.

SMALL, Henry Giles. — A.S.T.C., A.M.I.E.A., Lic. S.E.C., Vic., Managing Director, Henry G. Small & Co., Airdok Radio Valve Co. Pty. Ltd. Trained at West Australian School of Mines, Kalgoorlie, Municipal & Light Station, Kalgoorlie, Elec. Light & Power Co., Melbourne Elec. Supply Co., Metro Vickers, British Insulated & Shelby Cells. Victorian Railways. Private address: 16 Rathnines Road, Auburn, Victoria. Date and place of birth: Kalgoorlie, W.A. Single. Clubs: C.T.A. and City and Overseas Club, Melbourne. Recreations: Swimming, Tennis, Golf, Shooting, Motoring.

SMITH, Colin W.—B.A., A. Inst.R.E. (Aust.). Sales Manager, New Herberholds (A/sia)

Ltd., 431 Hoddle Street, Abbotsford, N.9. Australian Radio Publications Ltd., July, 1933 to 1935. Recreations: Golf and photography.

SMITH, F. Langford, B.Sc., B.E. (First Class Honours), A.M.I.E. (Aust.), A.M.I.E.E. (London), M.Inst.R.E. (Aust.), Chartered Electrical Engineer, N.S.W. Development Engineer

and Unified Sales Engineering Service, Amalgamated Wireless Valve Co. Ltd., Sydney. 1928-1929 Metropolitan Vickers, Manchester, England. 1929-1932 Cosmos Lamp Works England (Factory Engineer and Development Engineer for Valves). Joined A.W. Valve Co., 1932. Visited U.S.A. and Canada, 1934-35.

SMITH, John Edwin. — Thom & Smith Ltd. (Tasma), 55 Dowling Street, East Sydney. 1912-16, 1924-29, foreman toolroom, Stromberg-Carlson (Sydney). 17/12/29, founded Thom

& Smith with Mr. Fred Thom. Private address: 62 Boyle Street, Manly. Club: Tattersalls. Recreations: Golf, fishing and surfing.

SMITH, Roy Victor Townsend.—General Manager, Sydney branch, Eclipse Radio Pty. Ltd., 137 Clarence Street, Sydney. Born 3/4/1894. Private address: "Gwyder Court," 235 Raglan Street, Balmoral, N.S.W. Recreations: Tennis, bridge, literature.

SOLOMON, Cecil C. H.—Managing Director, Traveltone Radio Pty. Ltd. Captain in Australian Corps of Signals. Radio experience since 1920. With Hartleys for 4 years, Eclipse 3 years. Joined Radio Maintenance Pty. Ltd. as Chief Engineer in 1932, becoming Managing Director, 1934. Recreations: Motoring and military activities. Born 26/3/02.

SOLOMONS, Leopold M.—N.S.W. representative for Radio Corporation Pty. Ltd. Joined

present firm 1927. Born 2/11/03. Recreations: Tennis, golf and fishing.

SOUTHEY, Reginald V., M.Inst.R.E.Aust.—Radio & Recording Engineer, Columbia Graphophone Aust. Ltd., Homebush. 1919-1923 with General Electric Company of London. 1923 to date with Columbia Graphophone Co., London and Sydney. Also with Standard Telephones, London and Bell Telephone Labs., New York. Educated Alleyn's College, Dulwich, London. Born 4/8/1903.

SOUTHWELL, Clifford Lindsay.—Radio Manager, Radio Dept. Associated General Electric Industries Ltd., 93 Clarence Street, Sydney. Member United Service Institute. Private address: 21 Narooma Road, Northbridge. Served with A.I.F. in Palestine. Recreations: Military activities; Captain-Signals. Born 1897.

WHO'S WHO—(Continued)—

STANTON, Victor Edward. —Manager Stanton Indicator Co., 140 Elizabeth St., Sydney. Associated with the first radio broadcasts and receiving in South Australia, his home State. Later in New Zealand and Queensland as Science Lecturer. Private address: 55 Homer St., Undercliffe. Born: Adelaide, 20/6/1887. Married. Recreations: Gardening and swimming.

STEPHEN, Alexander Ernest. —Assistant Manager Radio Wholesalers Ltd., James Place, Adelaide. Left Public Accountant's Office to join Harrington's Ltd., Adelaide, 1926, as Radio Salesman, and later as Country Representative. Joined Savery's Pianos Ltd., 1933, as Country Radio Sales Manager and present position. Private address: 1 Jellicoe St., Linden. Born: Adelaide, 15th January, 1910. Married. Recreations: Tennis, lacrosse, badminton.

STEVENSON, Keith.—Melbourne Manager, Eastern Trading Co. Ltd., Peacock House, Bourke Street, Melbourne. Has been identified with firm for many years in various capacities. Appointed Melbourne Manager when radio section was developed.

STROUD, Stanley Price. — Manager Ohmegga Resistors (Aust.) Pty. Ltd., also Secretary & Sales Manager Southern Cross Electric Lamps Manufacturing Pty. Ltd. 1925-33 Director Langford Pickles Co. Pty. Ltd. 1933-35 Sales Manager B. R (Radio) Ltd. 1935-36 as above (Resistor Lamps). Private address: 125 Disraeil Street, Kew. Date and place of birth: Southall, Middlesex, England, 24/10/1901. Married with son and daughter. Recreations: Soccer and tennis.

STOKES, Robert Keith. — Managing Director, Radiokes Ltd., formerly Metropolitan

Electric Co. Ltd., George and Cleveland Streets, Redfern. Established in 1923. Visited overseas during 1935. Recreations: Golf and surfing. Born 1893.

STUART, Alan, A.Inst.R.E. Aust.—Technician, Beam Transmitting Station, Ballan, Vic. Joined A.W.A. Ltd., Sydney 1915. First Class P.M.G.'s Certificate August, 1918. Joined Marine Staff A.W.A. 1919-26. January, 1927 to April 1927, Technician Radio Centre Pennant Hills. April, 1927 to August, 1932, Technician Beam Receiving Station, Rockbank, Vic. August, 1932 to date, Technician Beam Transmitting Station, Ballan, Vic. Born 11/11/1909.

SUTHERLAND, A. P. — Proprietor A. P. Sutherland, Maffra St., Sth. Melbourne, Vic. Has been in business for 30 odd years and is widely known in the electric and motor trades. Private address: 39 Black St., Nth. Brighton, Vic. X 3576.

SWANN, Norman W.—Melbourne Manager, International Radio Ltd., 415 Bourke Street, Melbourne. Educated Scotch College, Melbourne. Noyes Bros. (Melb.) Ltd., joined 1925. Subsequently resigned and visited several American and European radio factories. Joined International Radio Ltd., 1933. Hobbies: Fishing, golf and swimming.

SWEENEY, Walter.—Director, Essanay Pty. Ltd., Melbourne, M.I.R.E., U.S.A. Engineer Marconi Co., 1907-1912. Wireless Inspector P.M.G.'s Dept., 1912-1916. Formed Essanay, 1928. Born Jan., 1887.

TAIT, John Mitchell. Director, Sterling Radio Ltd., 539 Elizabeth Street, Sydney. Formed present Company with co-

Director Buchanan, 11/5/34. Formerly with British General Electric Co. Ltd. for 14 years. Visited England on behalf of B.G.E. 1925. Appointed Manager, Radio and Telephone Dept., B.G.E., 1931. Born 11/12/1899.

TAYLOR, John Peebles. — Sales Manager, Commonwealth Moulding Company Ltd., 240 Princes Highway, Arncliffe,

N.S.W. Served in A.I.F. Engaged in radio since 1922. Private address: 7 Poate Road, Centennial Park, Sydney, N.S.W. (Major, Army Signals). Born, 1895. Recreations: Tennis and surfing.

THOM, Frederick William Parkes.—Partner Thom & Smith Ltd. (Tasma), 55 Dowling Street, East Sydney. Mem. Inst. R.E. (Aust.), M.Inst.R.E. (U.S.A.). Councillor Institution Radio Engineers, Australia.

1925-1929, production and radio engineer Stromberg - Carlson, Aust., Ltd. 17/12/29, founded with Mr. J. E. Smith, the firm Thom & Smith. Club: Tattersalls. Private address: 9 Bancroft Avenue, Roseville. Recreations: Golf, surfing, fishing. Born 11/7/1904.

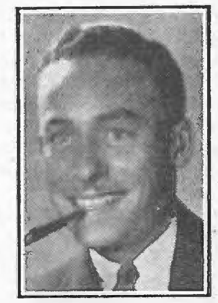
THOMAS, Alfred.—Manager for Philips Lamps (A/sia) Ltd.,

Adelaide branch. G.E.C. England before and after war, three years Ireland wholesale radio early days. Came to Aust. 1935, joined Siemen's then Amplion—Philips 7th year. Private address: Glenburnie Avenue, Mitchem, Adelaide, S.A. Born: Manchester, England, 3/12/82. Married. Recreations: Swimming, gardening, chess.

THOMAS, Captain Herbert, 27th Battalion A.M.F.—Manager Electrical & Radio Depts., Coltom Palmer & Preston Ltd., Currie St., Adelaide. Inaugurated Radio & Elec. Depts., Harris Scarfe & Sandover Ltd., Perth, W.A. Operated amateur station 6DY. W.A. Manufactured first Console Receiver in W.A. Relinquished above to take similar position with Colton, Palmer & Preston, of Adelaide, 9 years Manager, Electrical & Radio Dept., Colton, Palmer, & Preston Ltd. Married. Clubs: Naval and Military Club. Recreations: Tennis.

TISBURY, Frederick H. — Publicity Manager, The Ever-Ready Co. (Aust.) Ltd., Marshall Street. Sydney. Private address: 34 Beaumont St., Rosebery. Born 25/12/1895. Recreations: Tennis and motoring.

TOPP, George Forbes.—Manager Radio Section, Noyes Bros. (Sydney) Ltd. Educated Petersham Inter. High School



and Sydney Technical College. Recreation: Cricket. Private address: 24 Narooma Rd., Northbridge.

TRACKSON, Philange S. — Managing Director, Trackson Bros. Ltd., 157-159 Elizabeth Street, Brisbane. Assoc.M.I.R.E. (Aust.), Assoc.M.I.E.E., London. Private address: "Norvie," 102 Racecourse Road, Ascot, Brisbane.

TREE, Ernest E.—Proprietor, Tree Radio-Electric Co., 128 Willoughby Road, Crow's Nest. Councillor and Associate I.R.E. Aust. Captain Singer Car Club, N.S.W. President Radio Retailers' Association of N.S.W.

WHO'S WHO—(Continued)—

Tree, E. E.—(Contd.)

Associate of Illuminating Engineering Society. Born 1904.

TURNER, Oliver Clive. — I.R.E. of Aust., A.M.I.R.E. of U.S.A. Consulting Engineer, 14 Spring St., Sydney. Joined staff Electricity Meter Mfg. Co. Ltd. in 1926 as Foreman, later was Chief Engineer until 1933. Private address: "Clynel," Rectory Ave., Ashfield. Born 29/9/01. Recreation: Tennis, swimming.

TRENAM, Harold C. — Managing Director, Standard Telephones & Cables (A/sia) Ltd., 71 York Street, Sydney. Educated Manchester Technical College, M.Inst.R.E. (Aust.). Qualified City and Guilds, London. Up to 1906, Engineer British Post Office. To 1926 Superintendent of Installations, Western Electric Co. Ltd. 1925-28, General Sales Manager, Western Electric Co. Ltd. 1928-

30, Deputy Manager, Standard Telephones & Cables Ltd., London. To 1932, Managing Director Creed & Co. Ltd., Telegraph Engineers, London. Director Standard Telephones & Cables Ltd., London. Director International Telephone & Telegraph Co. Ltd. 1933, came to Australia in present position.

TUIT, Percy George. — Chairman of Directors of Kriesler (Australasia) Ltd., Myrtle Street, Chippendale. Member of Millions Club and City Tattersalls Club. Born 1896. Re-

constructed the old Kriesler Radio Co. in October, 1933. Home address: Latimer Road, Bellevue Hill. Born 1896.

TYLER, C. F.—In charge of sales promotion and dealer welfare of the Gramophone Co. Ltd., 2 Parramatta Rd., Homebush. 3 years with the Gramophone Co. in England; 7 years in Australia.

TYLER, Herbert Murray.—Sales Engineer Stromberg-Carlson (Aust.) Ltd. Member of I.R.E. (Aust.). Diploma Trade Certificate, W.I.A. Educated at

Technical High School. Service Engineer Anthony Horderns many years. Private address: Rosedale Road, Gordon. Born 18/4/06.

TYRELL, Charles W. — Engineer Philips Lamps (A/sia) Ltd., Sydney. Assoc. M.Inst. R.E., Aust. Assist. Hon. Treasurer, I.R.E. Aust. Joined Philips, 1930. 1933 to date, Technical and Commercial Dept. Private address: "Mentone," Beach Street, Coogee. Born 8/11/1905. Captain Cav-

alry Signals. Member of United Service Institution.

VAUGHAN, Clifford Walter.—Factory Manager, Eastern Trading Co. Ltd. Joined O'Donnell, Griffin & Co., 1921, apprenticed as electrical fitter in 1922, Technical representative from 1927 to 1928, assistant to Works Manager, 1928 till 1930, transferred to Don Electrical Co. in 1930 as Manager. Private address: 182 Queen Street, Ashfield. Born 21/7/07. Recreations: Tennis and billiards.

VEALL, Arthur J.—Governing Director, A. J. Veall & Co., Swanston Street, Melbourne. Entered retail electrical business in Chapel Street, Prahran, opening business in city ; 1923. In 1928 bought Robotham's radio business and inaugurated purely cash trading basis. Now owns five retail houses. Recreations: Racing and shooting.

VORDON, Joseph Edwin.—Sales Manager Bland Radio, Adelaide. Sales Staff D. & W. Murray Ltd., A. G. Healing Ltd., Duncan & Co. Council W.I.A., 1924-1930. Treasurer W.I.A., 1926-1930. Private address: 8 Alma Rd., Fullarton. Married. Born Unley, 30/4/05. Adelaide Rowing Club. Recreations: Rowing and tennis.

WADHAM, Kevin. — Manager National Radio Corporation Ltd., 96 Pirie St., Adelaide. Member W.I.A., VK5KW. Civil Service (three years). Production department Paroso Ltd., radio manufacturers and dealers, Adelaide. Joined A. G. Healing Ltd., Adelaide. March, 1927, Manager Radio Dept. Born : October, 1904.

WALKER, Ross M. — Manager Radio & Refrigeration Dept., A. G. Healing Ltd., Melbourne. Started in radio department of Brown's Motors, Geelong. Joined A. G. Healing 1924. Appointed present position 1929. Recreations: Speed boating, gardening, pedigree dog-breeding and showing. 5/10/09.

WALTER, Reginald P. — Managing Director, the Ever-Ready Co. (Australia) Ltd. Arrived in Australia from head office, London, in 1930, to re-

organise both the factory and sales end of the business. Private address: 18 Dalley Avenue, Vaucluse. Recreations: Fishing, riding, cricket.

WALTERS, Gerald, M.Inst. R.E.Aust. — Officer in charge Townsville Radio Station. Joined Marconi Co., Liverpool England in August, 1906. January, 1913 resigned Marconi Co., joined Commonwealth Government as Engineer-Operator, over 30 years' unbroken radio service. Born 27/3/1886.

WARBY, Francis M.—Partner, D. W. Radio Co., 210 Willoughby Road, Crow's Nest. Joined D.W. Super Short-Wave Converters in 1932 and as partner, August, 1933. Private address: "Brindabella," Lennox Street, Croydon. Born 15/3/13. Recreations: Tennis, swimming, fishing and reading.

WARBY, Herbert A., Ph.C. —Partner, General Manager, D. W. Radio Co., 210 Willoughby Rd., Crow's Nest. Took up radio as a hobby at age of 14. Took degree in chemistry but left that profession to go into sound equipment at Amplion. Assistant Sound Engineer for Harrington's and Manager of retail radio dept. Installation and service engineer at Raycophone. Commenced present business under the name of D. W. Super Short-Wave Converters, February, 1929, specialising in short-wave equipment. Private address: 32 Alexander Avenue, Willoughby. Born 15/3/1905. Recreations: Tennis and surfing.

WARNER, Arthur G.—Joint Managing Director, Radio Corporation Pty. Ltd., Sturt Street, South Melbourne. First associated with the radio trade as factory representative, Brunet headphones and Ormona parts. Later merged with Louis Coen Wireless, which in turn became Radio Corporation Pty. Ltd. Recreations: Tennis, golf and

WHO'S WHO—(Continued)—

Warner, A. G.—(Contd.)—

aviation. Private address: North Road, Brighton.

WEDGNER, Norman T. — M.Inst.R.E. (Aust), M.S.R.T., early licensed experimenter before advent of broadcasting. Late signals instructor R.A.F.A., reserve corps. Established in radio business North Shore since 1929. Marconi School Training and Diploma. Associated Motor and Publishing trade two years in Sales capacity. Born 1906.

WEBB, A. L. C.—Managing Director Rola Co. Aust. Pty. Ltd., 81-3 City Road, Sth. Mel-

bourne, Vic. Private address: Berkley Court, Toorak Rd., Toorak. Phone U 1130. Recreations: Flying. Married. Born St. Kilda.

WEINGOTT, Rae.—Technical Director of Sales and Technical Depts. of Kriesler (Australasia) Ltd., Myrtle Street, Chippendale. Home address: 15

Nelson Bay Road, Bronte. Date of birth: 12th December, 1904. Recreations: Movie picture photography.

WELSH, Charles O.—Director since 1931, Eclipse Radio Pty. Ltd. Born March 1892.

WERRING, Oscar Carl. — Proprietor, Radio Dept., Werring Radio Co., 213-215 Queensberry Street, Carlton, N3. Private address: 285 High Street, Prahran, S.1. Born 13/8/1906, Sydney. Clubs: Royal Brighton Yacht Club, Elsternwick Club. Recreations : Yachting, billiards.

WETLESS, A. P. J. — Proprietor, Wetless Electric Manufacturing Co., 281 King Street, St. Peters. Electrical Engineer, specialised in condenser manufacture since 1923.

WILKINSON, Bruce, B.E., A.M.I.E. (Aust.). — Research Engineer, Amalgamated Wireless (A/sia) Ltd., Graduated Bachelor of Mechanical and Electrical Engineering, University of Sydney, 1928. Joined A.W.A. Engineering Department. 1930. Captain 1st Medium Artillery Brigade, A.G.A. Born 8th November, 1903. Recreations : Cricket, tennis, swimming.

WILLIAMS, George F., M.Inst.R.E.Aust.—Chief Engineer, Eclipse Radio Pty. Ltd., Melbourne. Educated Leipzig University, B.Sc. Actively commenced in radio in 1922 with Radio Corporation of Australia. Joined Eclipse Radio 1928. Born 13/5/1932.

WILSON, John Francis. — Secretary and Assistant Manager, Amalgamated Wireless (A/sia) Ltd., 47 York Street, Sydney. A.C.I.S., Member Inst.R.E., Aust. Educated St. James College and Sydney University. Joined M.W.T. Co. in 1909 as marine-engineer-operator. Engaged on construction work and ship-fitting in Brazil, South Africa and Canada. Joined Australian branch in 1911, and been with A.W.A. since inception of company. Appointed Secretary A.W.A. in 1917 and Assistant-Manager in 1918. Recreations: Tennis, swimming.

WING, William J. J.—General Sales Manager Amalgamated Wireless (A/sia) Ltd., 47 York Street, Sydney. Born and edu-

cated in England. Joined Marconi School, England, 1911. Joined Commonwealth Radio Service, 1913. Joined commercial side of A.W.A. 1923, and appointed sales manager, 1924. Has been prominently associated with radio trade organisations.

WINTER, William Francis.—Managing Director New Herberholds (A/asia) Ltd., 431 Hoddle St., Abbotsford, N.9, Vic. Entered radio in 1922. 1932, formed Herberholds. Born 1903.

WOOLLETT, Norman H. — Publicity Manager, Philips Lamps (A/sia) Ltd., 69-73 Clarence Street, Sydney. Educated at Sydney Church of England Grammar School, North Sydney. Commenced business activities in 1923. Spent three years in shipping, and one year retail. Joined Philips Lamps, 1927. Private address: "Torquay," Darling Point Road, Darling Point. Born 1908. Recreations: Golf, tennis.

WYLES, David G.—M.Inst. R.E. (Aust.). Manager Technical and Commercial Dept., Philips Lamps (A/sia) Ltd., 69 Clarence Street. Vice President

Institution Radio Engineers Australia, Member I.R.E. (U.S.A.). Joined Amalgamated Wireless 1914. Visited Europe, Great Britain 1922-23, investigating radio on behalf A.W.A. Appointed Chief Engineer, Station 2BL, 1925. Later appointed engineer National Electric Co., N.Z. Joined Philips Lamps (A/sia) Ltd., Melbourne, as technical and commercial manager, 1929, 1932 transferred to Philips head office, Sydney. Visited England, Europe and the U.S.A. on behalf of Messrs. Philips Lamps. Private address: 36 Burra Road, Artarmon. Born 20/7/94.

YEEND, R. H. — Manager Rola Co. (Aust.) Pty. Ltd., 81-83 City Road, South Melbourne, Victoria.

YELLAND, Francis Edward. —Sales Manager of Grand Opera Radio, Glen Eira Road, Ripponlea. Born 26/7/06. Recreation: Cricket.

YELLAND, Leslie J. — Proprietor, Grand Opera Radio, Glen Eira Road, Ripponlea. Certified electrical engineer (Australia). Entered business in 1927 as Grand Opera Radio. Born 24/8/03.

YOUNG, Frederick Cavin.—Sales Manager, Battery Section, Clyde Engineering Co. Ltd., Wentworth Ave., Sydney. Member Australian Institute Marine Engineers. Served apprenticeship general engineering at Clyde Engineering Works, Granville, N.S.W., and took full engineering course at Granville

Technical College. 1910-1914, had 4 years service as Marine Engineer. At outbreak of war enlisted in Field Engineers and transferred to A.N. & M.F. eventually rising to rank of 1st Lieutenant. Rejoined Clyde Co. 1923, in General Engineering Section and became foreman engineer-fitter in steel car construction dept. Feb., 1929, appointed Production Manager, Battery Dept., and Sales Manager in Oct., 1935. Interested in Masonic and returned soldier movements. Private address : "Looee," Kuroki St., Penshurst, N.S.W.

YOURELLE, F. J.—Director A. H. Gibson (Elec.) Pty. Ltd., Melbourne. Formerly Assistant Manager of the Electrical Department of Noyes Bros., Melbourne. Sport: Cricket and golf. Private address: Sireway, Caulfield.

RAY, Reginald John, Proprietor, Standardised Products. Holder of Electrical Engineering Diploma. Technical College

education. Apprenticeship with Francis Belle Co. Ltd.; Production Foreman to H. R. James, Summer Hill; Production Manager to James Manufacturing Co. Started Standardised Products in 1930. Private address: 14 Hedger Ave., Ashfield. Born at Junee (N.S.W.), February, 1905. Recreations: Tennis and technical research.

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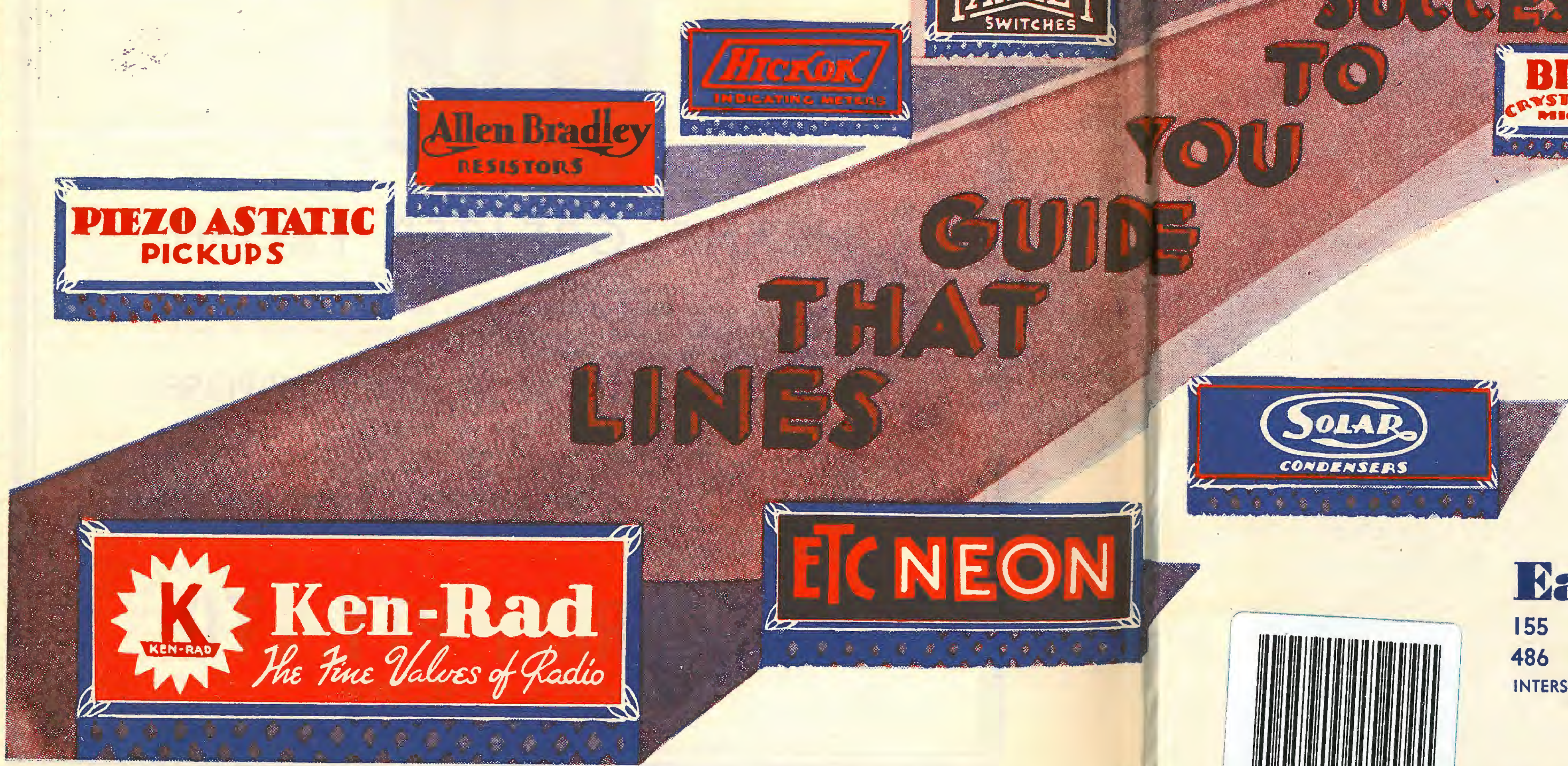

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