RADIO TRADE ANNUAL OF AUSTRALIA 1937

EVERYTHING IN WIRELESS

A.W.A ACTIVITIES . . .

BEAM WIRELESS SERVICE
BEAM WIRELESS PICTUREGRAM SERVICE
OVERSEAS RADIO TELEPHONE SERVICE
PACIFIC ISLANDS WIRELESS SERVICE
COASTAL RADIO SERVICE
MARINE WIRELESS SERVICE
AIRCRAFT RADIO SERVICE
BROADCASTING
RADIO-ELECTRIC WORKS
RADIOLA RECEIVERS
VALVE MANUFACTURE

AUSTRALIA'S NATIONAL WIRELESS ORGANISATION

AMALGAMATED WIRELESS (AUSTRALASIA) LIMITED

LEADERS OF THE AUSTRALIAN WIRELESS INDUSTRY


Two BIG GUNS for 1937
MASTER Mullard VALVES
MASTER Mullard RADIO
COMMONWEALTH NATIONAL LIBRARY
CALIBRE
Veteran valves — tried and proven allies — with the right even to be termed "the old contemptibles" — Mullard are the Master Valves — 1921-1937 — nothing can now disturb the glory and prestige they have won — in the field — in the remotest corners of the Empire. Radio manufacturers, wholesalers, dealers, could choose no better armament to advance their interests for 1937.
RATING
As the swift years of Radio Progress speed by — as competitors' preparations for greater advance are made — so must the vanguards of the fleet — the large force of experienced and dependable radio dealers carefully choose their materials — their weapons. In rating such weapons, names and records mean much — proven leadership and strength to maintain — Mullard arms to aid Radio's Progress.
MASTER VALVES
Mullard
MASTER RADIO
THE MULLARD RADIO CO. (AUST.) LTD., 26-30 Clarence St., Sydney. 'Phone B7446 (2 lines). Telegraphic Address: "Mulvalve."

AUSTRALIAN VALVE MERCHANTS' ASSOCIATION
THIS VALVE HAS BEEN LICENSED UNDER VARIOUS AUSTRALIAN PATENTS FOR USE IN BROADCAST RECEIVERS

The

AUSTRALIAN VALVE MERCHANTS' ASSOCIATION

Established in 1935 for the purpose of bringing about more stable trading conditions in the merchandising of radio valves for use in broadcast receivers, the Australian Valve Merchants' Association has been instrumental in creating uniform sales arrangements and standard trade discounts to the benefit of all those engaged in wholesale or retail radio merchandising. Advisory committees of the Association are established in each Australian State.

Valves marketed by members of the Australian Valve Merchants' Association are licensed under various Australian patents for use and sale in the Commonwealth of Australia.

THE ASSOCIATION'S OFFICE IS AT 1 JAMIESON STREET, SYDNEY
TELEPHONE: B 1046

The Gilded Butterfly......

flutters hither and thither ; never seeming to get anywhere ; bright and glittering, yet never appearing to accomplish anything. The same may be said about a certain class of radio manufacturer who masks his organisation with glittering promises and extravagant terms.

The Stromberg-Carlson franchise agreement, however, holds out no glittering promises ; it is a sound trading policy that has been established and proved correct over a number of years. The Stromberg-Carlson dealer is happy in his knowledge of the organisation behind him, and the quality merchandise he has to sell. Several territories are still available to live dealers ; it may be in your district. Write to-day direct to the Factory.

STROMBERG-CARLSON (A'ASIA) LIMITED
124 BOURKE ROAD, ALEXANDRIA, SYDNEY.

a few reasons why

A.R.C. trained men get the cream of the service business, fill the best jobs, and are always in demand by Radio employers:—

BECAUSE . . .

A.R.C. Lessons are kept completely up-to-date with all Radio developments.

A.R.C. students may train by either Correspondence or night classes.

The A.R.C. system of training is entirely individual—students may commence at any time.

Twice weekly, lectures are held in the College lecture hall, which is capable of seating up to 300 persons. An efficient Radio Service-work department is maintained for the use of A.R.C. students.

Students may use our Employment Service, Buying Service, Consultation Service, free of charge.

A special technical magazine is produced free for the benefit of A.R.C. students.

DO YOU

Wish to get ahead in Radio?
Require a competent employee?
Just communicate with the A.R.C.

AN ILLUSTRATED PROSPECTUS IS AVAILABLE UPON REQUEST.

Australian Radio College Students handle modern apparatus under the personal supervision of fully qualified instructors. All branches of service work are taught, even how a student should conduct himself in the home.

Note the photographs of the College itself, and the splendid lecture hall, which has a seating accomodation for 300 persons.

At the top left, is a facsimile of "Opportunity," the free College magazine.

AUSTRALIAN RADIO COLLEGE LTD.

Broadway (Opposite Grace Bros.) Sydney.

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.	RETAIL PRICES. £ s. d.	CODE WORD.
CLYDE SUPER RADIO BATTERIES.				
6CR11	6	100	3 15 0	Universal
6CR13	6	120	4 7 6	Valet
6CR15	6	140	4 16 6	Pulse
6CR17	6	160	5 10 6	West
CLYDE RADIO BATTERIES.				
2VS5	2	25	0 17 6	Voyage
2VS7	2	40	0 18 9	Zone
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	2 15 0	Renew
6CR9	6	80	3 0 0	Ocean

Freight, Packing and Sales Tax Extra.

CLYDE
RADIO BATTERIES

The Batteries with a background of great achievements

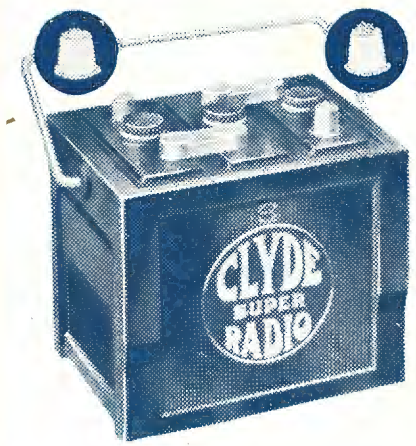
PRODUCT OF

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; Wills & Co. Pty. Ltd., 7 Quadrant, Launceston.



Clyde Super Radio Batteries for Vibrator Sets.

THREE YEARS' GUARANTEE.

Type 4SR7

Type 2VC11

TWO YEARS' GUARANTEE.

WORLD LEADER

. . . for Seven Successive Years!

EACH year since 1930 Philco has consistently sold more radio receivers than any other manufacturer in the world . . . Why?

Mainly because the results of Philco's research and experiment have been *real* contributions to radio achievement . . . contributions that have given the radio buyer something of tangible and practical benefit . . . as, for instance . . .

"Socket Power", which eliminated dry batteries from wired homes; Hazeltine Neutrodyne A.C. Sets with built-in power supply instead of separate units; The first practical application of A.V.C. (in 1929); In 1930 tuning condensers floated on soft rubber; and valves so rugged they could be shipped mounted in the chassis; In 1931 the first satisfactory low-priced Auto Radio; In 1932 the 6.3 Volt Valve—the first hum-free valve of its voltage——

——And so on down to the present day . . . with further features that mean better performance and better value.

Philco's policy is sound. Its success is founded on RESEARCH . . . and with the greatest laboratories of their kind in the world behind it, Philco says with the conviction of certain knowledge—"You cannot buy a better radio!"

. . . and again this year PHILCO leads with . . .

GENUINE S.W. BAND-SPREAD • • • •

which spreads overseas stations from 6 to 8 times farther apart, names and locates them on the dial and makes S.W. tuning as simple as tuning for local broadcast.

UNITISED CHASSIS CONSTRUCTION • •

which floats the whole of the tuning circuit as one unit, while it anchors rigidly those circuits which should be immovable; which results in simplified and standardised chassis layout and, therefore, easier service, and which eliminates flexing of grid leads and switch wires and thus ensures far better performance on short wave.

WIDE-ANGLE SOUND DIFFUSION • • •

which spreads the full tonal range evenly throughout the room so that, no matter where you sit within audible range of a Philco, you get the full beauty of Philco's "Balanced Unit" reproduction.

PHILCO

The Greatest Name in Radio

PHILCO RADIO & TELEVISION CORP. (AUSTRALIA) PTY. LTD. - - WATERLOO, N.S.W.

WE have ventured, in past editions of this Annual, to indulge in prophesies concerning the future for radio in general and TASMA in particular.

It seems that we were right. In the case of TASMA, our leadership has not only been maintained, but vastly increased. We have had to complete a new and much larger factory with vastly increased facilities. We have had to multiply our output to a surprising extent to meet ever-growing demand. Our dealers have reached record figures — and we have carefully built our range of receivers until it meets every possible type of prospect in city or country.

Powerful, consistent, carefully achieved advertising has backed up the invaluable quality of TASMA receivers and we can justly claim that TASMA receivers to-day embody every important development in radio science together with more truly exclusive features than any other sets offered.

We conscientiously believe that the Tasma De Luxe Series of Radio Receivers outstrips all competition. It is to that end that we have laboured. The success achieved by the Tasma organisation is reflected in the sales figures of every Tasma dealer—and in the complete satisfaction of thousands of TASMA dealers in all States of the Commonwealth.

THOM and SMITH LIMITED
29-39 Botany Road, Mascot
'Phone Mas. 1080

. . . The . . .
RADIO TRADE ANNUAL OF AUSTRALIA

●

FIFTH EDITION 1937

PRICE, 10/-
POST FREE IN AUSTRALIA
OVERSEAS PRICE, 15/-.

●

Whilst every care has been exercised in the compilation of this Annual, the publishers cannot accept any responsibility for any errors or omissions.

●

Publishers
Australian Radio Publications Ltd.

O. F. MINGAY, Managing Editor

Head Office: 30 Carrington Street, Sydney.
'Phone B 7188 (3 lines); G.P.O. Box 3765

Branch Office: 422 Little Collins Street, Melbourne.
'Phone M 5438; G.P.O. Box 1774

Also Publishers of . . .

"RADIO RETAILER OF AUSTRALIA" (the weekly trade journal circulating throughout Australia. Subscription 15/- p.a.

"RADIO REVIEW" (technical monthly). Subscription 10/- p.a.

"BROADCASTING BUSINESS" (the weekly trade publication covering the activities of Commercial Broadcasting in Australia). Subscription 15/- p.a.

"BROADCASTING BUSINESS YEAR BOOK" (an annual publication covering the business of broadcasting). Price 10/-.

Preface . . .

THIS fifth edition of the RADIO TRADE ANNUAL OF AUSTRALIA is presented again for the general use of the trade. This Annual has achieved a world-wide reputation, and is accepted overseas and in Australia by all those interested in Australian radio development as a most comprehensive publication, containing practically everything necessary as a reference to the radio industry of Australia.

This year we have decided on a few changes, as, for instance, the Act of Parliament constituting the Australian Broadcasting Commission is omitted, as it has been published on several occasions in our previous Trade Annuals. Likewise, the agreement between the Commonwealth Government and Amalgamated Wireless (A/sia) Ltd., and one or two other matters that need not be repeated every year.

The review of radio in Australia for the past year of 1936 will be found on the following pages. In every way it was one of the most satisfactory years ever experienced in Australian radio circles.

Of course, ever since 1930, when the Federal Labour Government then in office introduced a protective tariff schedule on radio apparatus, the radio industry has gone from success to success every year, despite the world-wide depression. Whilst 1936 was a good year, it is anticipated that 1937 will be even better, and, providing no calamity occurs, 1938 will be better to a marked degree. That is because next year Australia will be celebrating its 150th Birthday and the foundation of Sydney in that city, from January to April, to be followed by the Australian cricketers visiting England during the Australian Winter period (English Summer), when the test matches will be broadcast throughout Australia from about 9 p.m. to 4 a.m. E.A.S.T. This will allow of the maximum listening audience, and consequently the sale of radio sets will reach new high figures.

In next year's Annual we hope to record still further advances in Australian radio by way of more broadcasting stations, more listeners, and more sales, with the consequent increase in circulation of money.

To all those who have assisted in making possible the publication of this Fifth RADIO TRADE ANNUAL OF AUSTRALIA, we tender our thanks.

OSWALD F. MINGAY,
Managing Editor.

. . . The . . .
RADIO TRADE ANNUAL OF AUSTRALIA

FIFTH EDITION

1937

PRICE, 10/-
POST FREE IN AUSTRALIA
OVERSEAS PRICE, 15/-.

Whilst every care has been exercised in the compilation of this Annual, the publishers cannot accept any responsibility for any errors or omissions.

Publishers

Australian Radio Publications Ltd.

O. F. MINGAY, Managing Editor

Head Office: 30 Carrington Street, Sydney.
'Phone B 7188 (3 lines); G.P.O. Box 3765

Branch Office: 422 Little Collins Street, Melbourne.
'Phone M 5438; G.P.O. Box 1774

Also Publishers of . . .

"RADIO RETAILER OF AUSTRALIA" (the weekly trade journal circulating throughout Australia. Subscription 15/- p.a.

"RADIO REVIEW" (technical monthly). Subscription 10/- p.a.

"BROADCASTING BUSINESS" (the weekly trade publication covering the activities of Commercial Broadcasting in Australia). Subscription 15/- p.a.

"BROADCASTING BUSINESS YEAR BOOK" (an annual publication covering the business of broadcasting). Price 10/-.

Preface . . .

THIS fifth edition of the RADIO TRADE ANNUAL OF AUSTRALIA is presented again for the general use of the trade. This Annual has achieved a world-wide reputation, and is accepted overseas and in Australia by all those interested in Australian radio development as a most comprehensive publication, containing practically everything necessary as a reference to the radio industry of Australia.

This year we have decided on a few changes, as, for instance, the Act of Parliament constituting the Australian Broadcasting Commission is omitted, as it has been published on several occasions in our previous Trade Annuals. Likewise, the agreement between the Commonwealth Government and Amalgamated Wireless (A/sia) Ltd., and one or two other matters that need not be repeated every year.

The review of radio in Australia for the past year of 1936 will be found on the following pages. In every way it was one of the most satisfactory years ever experienced in Australian radio circles.

Of course, ever since 1930, when the Federal Labour Government then in office introduced a protective tariff schedule on radio apparatus, the radio industry has gone from success to success every year, despite the world-wide depression. Whilst 1936 was a good year, it is anticipated that 1937 will be even better, and, providing no calamity occurs, 1938 will be better to a marked degree. That is because next year Australia will be celebrating its 150th Birthday and the foundation of Sydney in that city, from January to April, to be followed by the Australian cricketers visiting England during the Australian Winter period (English Summer), when the test matches will be broadcast throughout Australia from about 9 p.m. to 4 a.m. E.A.S.T. This will allow of the maximum listening audience, and consequently the sale of radio sets will reach new high figures.

In next year's Annual we hope to record still further advances in Australian radio by way of more broadcasting stations, more listeners, and more sales, with the consequent increase in circulation of money.

To all those who have assisted in making possible the publication of this Fifth RADIO TRADE ANNUAL OF AUSTRALIA, we tender our thanks.

OSWALD F. MINGAY,
Managing Editor.

Developments in the Australian Radio Industry During 1936

THE year 1936 marked another substantial milestone in the radio industry of Australia. In manufacturing, merchandising, retailing, servicing and broadcasting there was material improvement.

The main indicator is the growth of listeners' licences throughout the Commonwealth, and a perusal of these (very complete details are published herein) shows that during the 12 months of 1936 there were 199,359 new licences issued, as compared to 169,621 for 1935, which is an increase of 17.4 per cent.

At the end of the year there were 887,015 listeners' licences in force in Australia, which was a net increase over the previous year, 1935, of 116,863.

A chart showing the new licenses issued during the year is printed herewith, and it clearly shows that the winter months of June and July continue to be the peak months, with a gradual improvement each year.

It must be remembered that the radio system in Australia calls for each person owning a radio set to pay the Commonwealth Government an annual fee of £1/1/-. There must be quite a large number of non-licensed radio sets in operation, and it is predicted that at December, 1936, there were well over 900,000 sets actually in operation.

Giving the value of each set at say £20, the public have an investment of about £18,000,000, and to that must be added the capital invested in the manufacturing activities, wholesalers, retailers, servicemen and last, but the most important, the broadcasting stations. All of those would bring the value not far short of £25,000,000.

The Editor of this Annual believes that at least 10,000 people are engaged in radio in Australia, with a wages bill of about £2,000,000 per annum, and a turnover of business of over £10,000,000 per annum.

The year 1936 saw a number of new radio factories erected and several existing factories extended. That development is still proceeding. It was very noticeable that several large and well-known radio firms made their presence felt by their increased activities, and that the future of the radio industry in Australia is in the hands of substantial and reputable people.

It is generally considered that the hub of radio manufacturing is in Sydney, where about 85 per cent. of receivers are produced for distribution over the whole of Australia.

During 1936 many radio executives visited overseas by air and by sea, to keep in direct touch with overseas developments.

The introduction of a Federal Trade Diversion policy in May of last year caused quite a number of big firms to plan big extensions of their activities. Notably in this extension was the well-known world-wide organisation of Philips, who have established a big radio set manufacturing plant, and now (in 1937) are installing a valve-making plant. Philco and H.M.V. also entered the Australian field. The Ever Ready Battery Co. is also erecting a big factory at an estimated cost of £50,000. Stromberg-Carlson erected a big factory at a cost of about £20,000, whilst Tasma Radio and Standard Telephones and Cables also erected huge factories.

Overseas Broadcasts.

DURING 1936 broadcasting again proved itself as being a National service of untold value to the community. The sad ending of our late King, George V; the accession of King Edward; his subsequent abdication, and the accession of King George VI, were outstanding broadcasts.

The growth of public interest in reception of overseas broadcasts was manifested during 1936, and that interest is being fostered by receiver manufacturers who have a complete range of what is popularly termed All-Wave receivers.

Broadcasting.

SEVERAL new National transmitters were completed and put in operation during last year, and also a number of commercial stations, all of which is assisting to give the Australian public—particularly those residing in the country—a better broadcasting service.

The entertainment value of the programmes from both the National and commercial stations has materially improved.

Importations.

THE general policy of the Australian Commonwealth Government is to encourage more manufacture in Australia of all radio apparatus, and therefore the importation figures do not now reflect the real growth of the radio industry. Nevertheless, the valve position does reflect the upward trend and the prosperity experienced in radio.

During 1936 there was imported into Australia 1,406,056 valves at a valuation of £278,093, equal to 3/11.4d each, as compared to 1,195,482 valves at an average valuation of £271,191, equal to 4/6.4d during 1935. This was a net increase of valve imports of 210,574, to which must be added about 25,000 valves made in the only valve factory then operating in Australia.

From the United Kingdom the valve imports dropped by 56,044 from 232,839 in 1935 to 176,795 in 1936. The average valuation was 9/6.2d in 1936 and 8/8.1d in 1935, but amongst those were a large number of transmitting valves at a high unit cost.

The valve imports from Holland (mainly Philips) showed an increase from 169,657 in 1935 to 303,206 in 1936, of 133,549. The 1935 average valuation was 9/0.6d per valve as compared to 6/0.6d in 1936.

From U.S.A. the valve imports increased by 96,835 from 781,035 in 1935 to 877,870 in 1936. The average U.S.A. valuation per valve was 2/3.9d in 1935 and 2/2.6d in 1936.

The general position was that Commonwealth importations increased by 17.6 per cent. Imports from U.K. dropped 24 per cent., from Holland they increased 78.7 per cent., and from U.S.A. the increase was 12.4 per cent.

The radio industry is firmly established in Australia, and for a country about equal to U.S.A. in area, yet with a population not quite as large as New York, the radio activity is remarkable.

Technical Trend during 1936

WHILE no outstanding changes in receiver design took place during 1936, the year was characterised by its tense activities directed towards the refinement of existing designs and the improvement of production technique. The former found expression in the simplification of receiver control and the general "ironing out" of a number of factors which had previously tended to keep radio receivers in the realm of scientific instruments. The second phase of activity was evidenced by the number of new factories which were opened and the radical re-design of many existing factories.

The trend towards better engineering which was noted during 1935 was still further consolidated and 1936 saw a marked reduction in a number of factors which could be classed as "assemblers" and not "manufacturers" in the truest sense of the word.

DEVELOPMENTS IN AUSTRALIAN RADIO —(Continued).

This trend in manufacturing technique was, to a large extent, forced on the industry by the generally higher level of performance demanded by the public from their radio receivers. It is also undoubtedly a fact that the more intense competition brought about by the introduction of several new names to the radio receiver manufacturing field contributed largely in this direction.

General Features.

ON looking closely into the general technical development of the Australian radio industry during 1936, there are a number of features which stand out and show that Australian manufacturers, generally speaking, are thoroughly up-to-date in their methods and well abreast of developments overseas. Surprisingly enough, none of these outstanding features, even though some of them were important in themselves, had a marked effect on the general tenor of the industry, in fact, this very lack of marked reaction to the introduction of these features proved as an excellent example to demonstrate the high state of stability which the radio industry in Australia has now reached. Consideration of the more important of these features should be of interest.

Metal Valves.

ALTHOUGH they can hardly be described as a "technical trend," metal valves must take pride of place in any discussion of this nature even if they are only classed as a "negative trend." Most people will be inclined to agree when we say that metal valves will undoubtedly go down in Australia's radio history as "The bombshell which failed to burst." The metal tube situation which developed in the United States after the introduction of the "tin tubes" will still be fresh in the minds of most readers, but their introduction to Australia hardly created a ripple in the smooth flow of radio design and manufacture. There are a number of reasons for this, but this is neither the time nor the place to analyse them—the fact remains that metal valves are little, if any, more popular than they were at the time of their first introduction to Australia over twelve months ago. It is quite possible that some time in the future metal valves may become standard equipment in Australian radio receivers, but before that time arrives they will have to offer more pronounced advantages than they do at the present time. In other words they must develop into something more than steel-cased prototypes of the ordinary "glass" valves in general use.

Vibrators.

ANOTHER development which could have had far-reaching effects on the radio industry in Australia, but which was quickly relegated to its proper place in the scheme of things, came about with the introduction of the vibrator-powered receiver for country operation. On surface indications the vibrator form of high tension power supply was destined to quickly oust all other forms of high tension supply for battery operated receivers. In spite of this the Australian radio industry did not allow itself to be stampeded but, instead, investigated the vibrator proposition from all angles and finally decided that the vibrator-powered receiver had a very definite field of application. Those manufacturers who considered that this field of application was worth exploiting went ahead and produced vibrator-power models. Others took their time, and it is worthy of note that even now, twelve months after the introduction of the first vibrator-powered battery receiver, there are Australian manufacturers who are not listing a vibrator-powered receiver among their range of current models.

If desired, it would be possible to list a number of examples such as the above, which go to show the high state of stability which the Australian radio industry has reached at the present time, but the two cited should be adequate.

Refinements.

Apart from the general trend towards better engineering and standardisation of manufacturing technique, 1936 was chiefly remarkable for the large number of refinements in design and construction which were introduced. As mentioned previously, these were chiefly directed towards simplification of control and better stabilisation of operating characteristics and a few examples should serve to illustrate the achievements in this direction.

The early part of the year saw the general adoption of edge-illuminated dials. At the same time dial scales became larger, and with the broadcasting station wavelength re-allocation scheme safely disposed of, most of the manufacturers were able to adopt fairly extensive systems of station call-sign calibrations. Some very ingenious dial drives made their appearance, with the object of simplifying tuning from the mechanical point of view, and the most noteworthy of these was the "automatic vernier" system introduced by one concern.

Later on, the year saw further moves towards control simplification with the introduction of such devices as "control function calibration" on the dial scales, and the elimination of as many unessential controls as possible. These factors, together with the general use of tuning indicators, especially those of the cathode ray type introduced late in 1935, had a very definite effect in popularising the more elaborate type of receiver and did much towards bringing radio receivers to the stage where they could be satisfactorily operated by even the most uninitiated.

This desire for refinement also played quite an important part in this movement and along with these, a steadily-maintained improvement in the quality of components resulted in the placing of radio receivers on a very efficient and foolproof basis.

Refinement in design and improvement in performance naturally called for more stringent testing procedure and evidence of this is found in the greatly improved production monitoring facilities to be found in the majority of factories. At the same time, design and research facilities were generally improved, and valuable assistance in this direction was given by the introduction of several new instruments.

Most outstanding among these, and one which definitely played a very considerable part in the improvement of Australian radio receiver design technique during 1936, was the "Q" meter.

This instrument was first introduced very early in 1936, but its value did not seem to be generally appreciated for quite a few months. Once its value became known however, "Q Meter Engineering" quickly became a habit, and it is safe to say that, to-day, every radio factory worthy of the name is equipped with an instrument of this nature. To avoid mis-construction of these remarks, it is necessary to point out that several of the better-equipped factories had instruments capable of performing similar functions to the "Q-meter" installed long before that instrument was heard of in Australia. These instruments were, however, complicated in their operation, and the introduction of the "Q-meter" made it possible for the average technician to perform measurements which were previously only practicable for the skilled laboratory worker.

Other instances of the general movements towards better laboratory equipment provided by the more general adoption of the cathode-ray oscillograph as a design "tool," and the fact that the necessity for a really efficient "standard" or "sub-standard" signal generator became generally acknowledged. In some quarters this last statement may seem rather peculiar, as it has been generally conceded in well-informed engineering circles, for some years now, that no self-respecting radio receiver design engineer would consider working without a standard signal generator handy. It must be remembered, however, that a really good signal generator, in Australia, costs quite a lot of money. As a result, many of the smaller organi-

(Continued on Page 14.)

Review of Radio Developments in Australia During 1936 *(Continued from Page 12)*

sations have previously considered that they should "get along" without one. As a result, it is worthy of note that the necessity for a good signal generator has now been generally acknowledged.

This move towards better test equipment has been general throughout the industry, and it is gratifying to note that the standard of gear used for "service" purposes has been improved very considerably.

The manufacture of test equipment in Australia is now a well-established phase of the radio industry, and it can be confidently claimed that Australian apparatus of this type is equal to that produced anywhere in the world.

Another section of the radio industry which consolidated its position during 1936 was that engaged in valve production. Australian-made valves are now used with the utmost confidence by receiver manufacturers, and quite a large percentage of Australia's receiver production for 1936 was equipped with locally-produced valves.

In this connection, it is already well-known that the Australian valve factory has not been content to follow overseas designs in every respect, and that, in addition to detail improvements being made in existing types, new designs have been originated. Two important types were introduced during 1935, and these quickly became very nearly standard equipment for battery-operated receivers. During 1936, two more battery-operated types were added to the range, and signs of their wide adoption are already evident.

1936 closed with plans for the installation of another Australian valve-making plant well on the way, and it is confidently expected that 1937 will see considerably increased activity in Australian valve-production circles.

In conclusion, it can be said that the most notable trend in Australian radio engineering circles recently has been directed towards making the industry more self-contained. Research departments and production facilities have been generally improved, and Australian radio receiver design is becoming characterised by a greater percentage of original effort. This is to be commended in every way and, when combined with a proper appreciation of the work done by overseas research laboratories, gives promise of a very bright future for the Australian Radio Industry.

Australian Broadcasting Commission Act

An Act relating to broadcasting, No. 14 of 1932, was assented to on May 17, 1932, and consists of six parts, all of which have been published in previous editions of this "Radio Trade Annual."

It is understood that so far no regulations have been made under that Act, which deals with establishment and constitution of the Commission; powers and functions of the Commission; finance, issue of debentures by the Commission, and miscellaneous. Copies are available from the Government Printer, Canberra, F.C.T.

Fourth Annual Report of the Australian Broadcasting Commission

Year Ended 30th June, 1936

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, the members of The Australian Broadcasting Commission, have the honour to present to you the Fourth Annual Report and Balance Sheet of the Commission, covering the financial year from 1st July, 1935, to 30th June, 1936.

During that period 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.

EXTENT OF SERVICE:

The network of National Stations for which programmes were provided was extended during the period under review by the addition of two further Regional Stations, namely 3GI Gippsland Regional and 7NT Northern Tasmania Regional. (Since June, 1936, the Northern Rivers Regional Station 2NR, situated at Grafton, N.S.W.; the North Regional Station 4NQ, situated at Townsville, Queensland; the Goldfields Regional Station 6GF, situated at Kalgoorlie, Western Australia; and the South-west Regional Station 6WA, situated at Minding, Western Australia, have also been put into operation. Regional Station 2NR has been given the same schedule of hours as 2NC Newcastle, whilst the other new regional stations have been allotted the same schedules as their parent stations, 4QG Brisbane and 6WF Perth, respectively.)

STATIONS:

The "A" Class Stations operating during the year were as follow:—

New South Wales:
2FC .. .. Sydney.
2BL .. .. "
2NC .. .. Newcastle
2CO .. .. Corowa.

Victoria:
3LO .. .. Melbourne
3AR .. .. "
3GI .. .. Gippsland Regional.

Queensland:
4QG .. .. Brisbane
4RK .. .. Rockhampton

South Australia:
5CL .. .. Adelaide
5CK .. .. Crystal Brook.

Western Australia:
6WF .. .. Perth

Tasmania:
7ZL .. .. Hobart
7NT .. .. Northern Tasmania Regional.

POWER OF STATIONS:

The power of stations previously in existence has remained unaltered, so that any enlargement of the reception-range of the Service has come from the opening of the new Stations referred to above. As, however, the South-west Regional Station 6WA operates on an aerial rating of 10 kilowatts, its transmitter is the most powerful in Australia; 2NR and 4QN are also strong stations, each having an aerial power of 7 kilowatts.

BROADCASTING SCHEDULE:

Few substantial alterations were made in the schedule except in the case of the Short-wave Station 3LR Lyndhurst, the hours of which were considerably extended for reasons stated later in this Report. The full schedule was as follows:—

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

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 p.m.

Sundays.
10 a.m. to 1.30 p.m. (5CL, 5CK, 6WF 10.30 a.m. to 1.30 p.m.)
3 p.m. to 5 p.m. (6WF to 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.
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, 2NC, and 3GI:

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 p.m.

The Schedule of Broadcasting Hours set down for Stations 2FC, 2BL, 2NC, 2CO, 3LO, 3AR, 3GI, 4QG, 4RK, 7ZL and 7NT is given in terms of Eastern Standard Time, that for 5CL and 5CK in terms of Central Standard Time (30 minutes behind E.S.T.) and that for 6WF in terms of Western Standard Time (two hours behind E.S.T.).

3LR (Short-Wave):

Mondays to Saturdays.
Australasian Zone, 6.30 p.m. to 11.30 p.m.

Sundays.
6 p.m. to 10.30 p.m.
(Australian E.S. Time.)

(This Schedule is expanded when necessary to include outstanding broadcasts.)

Mondays to Saturdays.
English Zone, 1.45 p.m. to 2.45 p.m.

Sundays.
1.45 p.m. to 2.45 p.m.
(Greenwich Mean Time.)

(On Tuesdays and Fridays there is also a special Pacific Zone broadcast of the French News Service at 6.30 p.m. A.E.S.T.)

LICENCES:

(a) Australian Statistics:

During the financial year 1935-36 the number of listeners' licences in Australia increased by 103,248 to a total of 825,136, bringing the percentage of licences to population for the Commonwealth from 10.47% to 12.22%.

The greatest improvement pro rata of population was shown in Western Australia, where the total advanced by 8,824 to 50,081—an increase equivalent to 1.89 per cent. of population. For the remaining States the increases were as follow:—

(Continued on Next Page.)

Australian Broadcasting Commission Annual Report (*Continued*)

S. Aus. .	10,985	(1.83% of population)
Tas. ..	4,047	(1.4 % „ „)
Q'land .	15,684	(1.54% „ „)
Vic. ..	26,570	(1.41% „ „)
N.S.W. .	37,174	(1.34% „ „)

South Australia maintained its position as the State in which the percentage of licences to population was highest, its ration advancing from 12.9% to 14.8%. Victoria followed closely, increasing from 12.9% to 14.31%. The remaining percentages at the end of the financial year were:—

New South Wales ..	11.87%
West Australia	11.18%
Tasmania	10.5%
Queensland	8.56%

(b) World Statistics:

During the year ended 31st December, 1935, licences throughout the world continued to expand rapidly. "Saturation point" does not yet appear to have been reached in any country, although in Great Britain the proportion of licences to population at 31st December, 1935, was as high at 16.08%, while in the United States of America (where there is no licensing system) it was estimated that 17.79 receiving-sets were in operation for every one hundred inhabits.

The table on page 24 shows the number of licences and the ratio of licences to population in the leading "radio" countries, compiled from figures supplied by L'Union Internationale de Radiodiffusion.

It will be seen that in the matter of licences—pro rata—Australia has held its position, sixth place, among all countries, but among the Dominions it has been overtaken by New Zealand, and now ranks second.

TIME "ON THE AIR":

During the year the total number of broadcasting hours from the combined Australian "A" Class (National) Stations was 64,048, as against 53,927 for the previous year. Of that total 29,518 hours were occupied by relays or re-broadcasts from other Stations, so that the nett total of original programme time was 34,530 hours.

PROGRAMME ANALYSIS:

The percentage of time devoted to each of the various types of programme was not radically altered during the year under review. Music absorbed slightly more time than before, the percentage rising from 48.63 to 51.9. Rather more attention than previously was paid to the broadcasting of essential services, especially news and news commentaries, while the proportion of time allotted to dramatic productions, talks, and sporting commentaries was slightly reduced.

PROGRAMME ANALYSIS.

	Hours.	Percentage of Total Broadcasting Hours.
Musical:		
Classical	4,927	13.94
Popular	19,185	29.95
Modern Dance ..	4,237	6.62
Old-time Dance ..	234	.36
Community Singing	657	1.03
Group total ..	33,240	51.9
Dramatic:		
Grand Opera	871	1.36
Musical Comedy, Revue	1,331	2.08
Plays, Dramatised Stories, etc. ..	1,444	2.25
Group total ..	3,646	5.69
Talks:		
General Talks ..	5,091	7.95
Addresses, Technical Talks (Farming), etc. .	881	1.38
Broadcasts to Schools	1,245	1.94
Descriptive Broadcasts (Non-sporting)	347	.54
Group total	7,564	11.81
Sporting:		
Running Descriptions	3,715	5.8
Results, Commenmentaries, Notes	2,195	3.43
Group total	5,910	9.23
Essential Services:		
News, News Commentaries	3,813	5.95
Reports (Weather Markets, etc.) .	3,625	5.66
Announcements .	1,134	1.77
Group total ..	8,572	13.38
Devotional:		
Church Services ..	2,024	3.16
Studio Broadcasts .	933	1.46
Group total ..	2,957	4.62
Children's Sessions:	2,159	3.37
	2,159	3.37
Grand total ..	64,048	100

MUSIC:

Engagements:

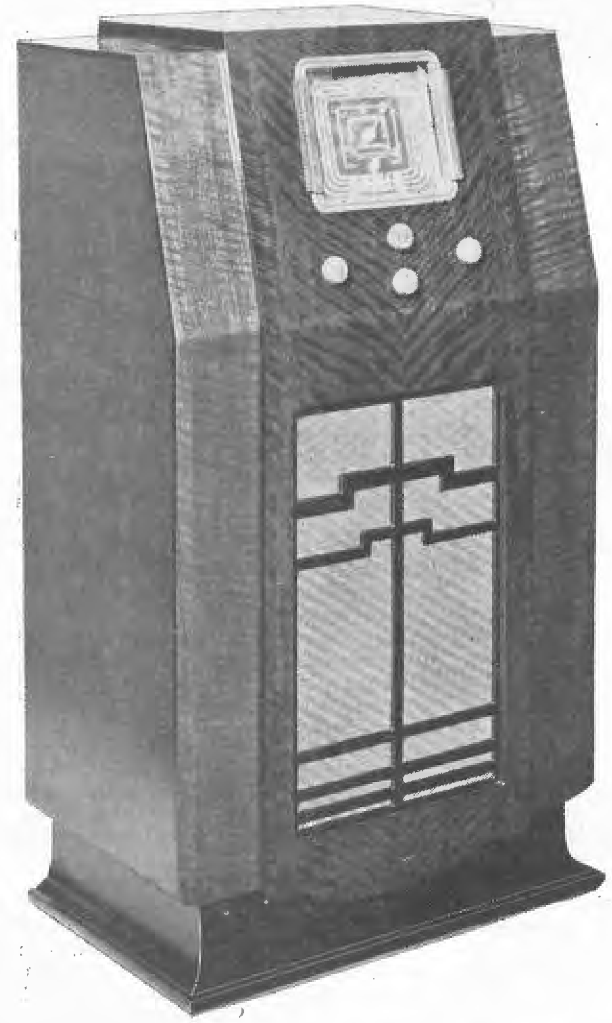
Every endeavour has been made to present the best available examples of all forms of music under the best possible conditions in the studios at present available, and to blend with works of widely recognised merit a substantial proportion of lesser-known compositions. In doing so the Commission has broadcast performances of a wide range of types of musical combination; has formed and maintained orchestras, bands, choruses and quartets; has engaged, casually or under long-term contract, soloists (including famous artists from overseas) and independent musical combinations, and has included also in its programmes mechanical recordings of the work of the world's foremost artists.

During the period under review notable oversea visitors who appeared regularly in the Commission's programmes included two Australian pianists who have succeeded abroad, viz.:—Miss Eileen Joyce and Mr. Percy Grainger. Other engagements which may be mentioned were those of Madame Florence Austral and Mr. John Amadio, Miss Thea Phillips, Mr. Ben Williams and Mr. Sidney de Vries. (Since the close of the period covered by this report, the distinguished English conductor, Dr. Malcolm Sargent, has conducted a number of highly successful orchestral performances during a tour which embraced all States, and Madame Elisabeth Rethberg and Signor Ezio Pinza have also given a series of public concerts and studio recitals under the Commission's direction. Further similar engagements have also been made for the future.)

Permanent Employees:

The following table sets out the number of orchestral musicians and choristers employed on regular fulltime weekly salary by the Commission, as distinct from those engaged temporarily or casually.

STUDIO ORCHESTRAS:			
Players:			
New South Wales	45		
Victoria	35		
Queensland	17		
South Australia	17		
Western Australia ..	17		
Tasmania	11		
	— 142		
Conductors	6		
Orchestrators and arrangers	7		
		— 13	
Total Orchestral ..			155
MILITARY BAND:			
Players	32		
Conductor	1		
Total Military Band			33
DANCE BANDS:			
Sydney	17		
Melbourne	17		
Total Dance Band ..			34
CHORUSES:			
Special Conductor	1		
Sydney	16		
Melbourne	16		
Total Choral			33
GRAND TOTAL ..			255



Australian Broadcasting Commission Annual Report (Continued.)

Recordings:

Subject to liberal recognition of its obligations to Australian artists, the Commission considers that gramophone recordings must still occupy an important part of its programmes, not only from the point of view of the public entertainment so provided, but also because these recordings keep local artists and listeners in touch with world standards. With, however, a further increase in the number of engagements for Australian artists, the number of recordings broadcast was again reduced, and represented 34.18 per cent, of programme-time for the year, as against 37.54 per cent. during the preceding 12 months.

Orchestras:

During the year the Commission completed its plan of establishing permanent concert orchestras in each capital city. The opportunity of playing together regularly under expert conductors should, when combined with the prospect of more or less permanent employment, greatly stimulate development in this field. The first fruits of this policy are already observable in a gratifying improvement, which should continue. This section of the Commission's activities has involved a large, recurring expenditure, but the Commission is satisfied that it had already been, and will continue to be, a most potent factor in raising the standard of musical performance in all parts of the Commonwealth. Without such regular bodies of competent and highly-trained musicians, the presentation of major symphonic and operatic works has, in the past, often involved an element of risk which should not exist in any country with serious pretentions to musical culture.

The cost of maintaining even reasonably large orchestral combinations is so high, and the response of the public so uncertain, that few organisations have been able to undertake the task. Now that it has been embarked on seriously, Australian music must make great strides, and this progress will no doubt we accompanied by a raising of the standard of appreciation.

Co-operation with Established Orchestras:

As in the past, the Commission made available members of its various studio orchestras to existing orchestral organisations for the purpose of strengthening the latter's performances. Towards the end of the year, however, the Commission, after consultation with representatives of such organisations, accepted in nearly all States the financial responsibility of the public symphony concerts, while still co-operating with local bodies in the matter of engagement of extra players, organisation of subscribers, and so on.

Orchestral Committees:

Towards the close of the financial year a small group of musical enthusiasts in Sydney co-operated with the Commission and formed a Citizens' Orchestral Committee, for the purpose of enlisting subscribers for, and otherwise assisting, the Commission's season of orchestral concerts. As a result of these efforts, over 1,000 subscribers were enrolled within a few weeks for the balance of the 1936 season. The Commission is glad to place on record its appreciation of the valuable assistance, given voluntarily, by this Committee, and in particular by the small group which carried the burden of the organisation.

The Commission—one might well say the music-loving community—has been fortunate in the existence for some years past of such a Committee in Melbourne, whose enthusiastic efforts last year were rewarded with a record list of 1,288 subscribers.

It is hoped that with the co-operation of the Commission, and in view of the increasingly high standard of the orchestral concerts in all States, and with the added attraction of visiting celebrity conductors and associate artists, similar orchestral committees will be organised in other States.

Symphony Hour:

An important change in practice, introduced towards the end of the year as part of the development of National Programmes, was the introduction of "Symphony Hour" periods, broadcast at 9.00 p.m. E.S.T. each Sunday. It has been clearly demonstrated that the regular recurrence of features at the same time on the same day is of great assistance to listeners and the hour fixed is believed to be a suitable one for symphonic programmes.

Notable Performances:

The more notable symphonies produced during the period covered by this report were detailed.

Conductors:

Of the public concerts broadcast by National Stations those presented by the New South Wales State Orchestra were for the most part conducted by Dr. E. L. Bainton, those of the Melbourne Symphony Orchestra by Professor Bernard Heinze, and those of the South Australian Orchestra (prior to the cessation of its activities) by Mr. Harold Parsons. Mr. Maurice de Abravanel, who was then visiting Australia, acted as Guest Conductor of public performances arranged by the Commission in several of the capital cities, while Mr. Fritz Hart and Dr. von Keussler also conducted performances for the Commission in Melbourne. The regular conductors of the studio orchestras were Sydney, Mr. E. J. Roberts (who later assisted in the formation and direction of the studio orchestras in both Brisbane and Perth) and Mr. Joseph Post; Melbourne: Mr. Percy Code; Adelaide: Mr. Will Cade; Perth: Mr. Nelson Burton; and Hobart: Mr. E. J. McCann. The formation of the Brisbane Studio Orchestra was only completed at the end of the year, and Mr. Burton was transferred to it from Perth, his place being taken by Mr. Roberts. Subsequently Mr. Clive Douglas, who had figured prominently in the Commission's Composers' Competitions, was appointed to the conductorship of the Hobart Studio Orchestra.

Young People's Concerts:

A popular and valuable feature of previous years was continued and expanded, namely, the series of Young People's Concerts for school boys and school girls. These had previously been known as "Children's Concerts," but in view of the average age of those who attended them, the present title was substituted. The concerts were, as in previous years, conducted by Professor Bernard Heinze, Ormond Professor of Music in the University of Melbourne and Music Adviser to the Commission.

Twelve of the concerts were given in Sydney, nine in Melbourne, three in Perth, and several in Victorian country centres. It is estimated that in all approximately 60,000 boys and girls attended the concerts. This will give some indication of the far-reaching influence of this valuable work.

Numerous questionnaires which were answered by the boys and girls present indicated that the concerts were genuinely and intelligently enjoyed, and that they were doing much to stimulate an interest in, and appreciation of, good music. The Commission hopes eventually to be able to present them regularly in all States.

"Hansel and Gretel":

Another musical broadcast specially intended for young people and presented by the Commission from its Studios during the 1935 Christmas Season was the Opera "Hansel and Gretel" (Humperdinck), conducted by Mr. Maurice de Abravanel.

Chamber Music:

The concert tour of the Budapest String Quartet, which began during the previous financial year, continued into the period under review. This quartet, which gave a number of studio recitals and public concerts, all of which were broadcast, was generally considered to be the finest which had ever visited Australia, and its work was much appreciated by an audience embracing many listeners other than the usual chamber-music lover.

The Quartet played almost all the Beethoven Quartets, as well as leading examples of quartet compositions by Schubert, Mendelssohn, Borodin, Mozart, Hindemith, Dohnanyi, Wolf, Brahms, Haydn, Smetana, Bartok, Mitja, Stillman, Dvorak, Grieg, Reger, Franck, Debussy, Sibelius, Tschaikowsky, Dittersdorf, and Prokofieff. One

(Continued on next Page.)

Australian Broadcasting Commission Annual Report (Continued.)

particularly interesting series of programmes, which the quartet presented in Sydney, illustrated the history of Quartet music, in its Classic Romantic, Slavonic, French and Modern phases.

The Spivakovsky-Kurtz Trio also appeared in many programmes under a long-term contract, while performances were given by the Sydney String Quartet, the A.B.C. (Melbourne) String Quartet, the Victorian String Quartet, and Elder Quartet and Trio (both attached to the South Australian Conservatorium of Music), the "Pro-Arte" Trio and other similar combinations. The Spivakovsky-Kurtz Trio, whose work reached a very high standard, performed not only the majority of the better known compositions for violin, 'cello, and piano, but also a number of sonatas for two of these instruments.

Choirs:

Performances by leading choirs in all States (including the Melbourne Philharmonic Society, the Sydney Philharmonic Society, the Brisbane State and Municipal Choir and the Hobart Orpheus Club) have, as in previous years, been broadcast, while choral-and-orchestral productions by independent organisations have received substantial support from the Commission (whether in the form of direct payment or of the lending of soloists and orchestras) in return for the right of broadcasting their performances. The Viennese Boys' Choir, which visited Australia, also broadcast.

Choral works were transmitted through National Stations during the year, either from the studio or from public concerts.

Soloists:

As in previous years, a large number of solo artists, both instrumental and vocal, appeared in the National Stations' programmes, the engagements numbering over 44,000. Most of these were Australians, resident in Australia; some were visiting artists, mainly Australians who have succeeded abroad.

Choral Works:

Many choral programmes were broadcast during the year. The A.B.C. Radio Choir was maintained in Sydney, and the A.B.C. Wireless Choruses of 16 voices each, which were regularly employed in Sydney and Melbourne respectively, assisted in a large number of broadcasts. These choruses have been useful training-grounds for soloists (though this consideration has necessarily been a secondary one) and have materially strengthened larger choirs when required.

Band Music:

Band music again figured prominently on the Commission's programmes. The National Military Band, conducted by Mr. Stephen Yorke, provided many programmes of excellent quality. Military band music is extremely popular in England, allowing, as it does, greater flexibility than is allowed bands which do not include woodwind instruments; before, however, the National Military Band was created by the Commission in readiness for the visit of Major (then Captain) H. E. Adkins, Australia was not well supplied with combinations of this type, and the Commission believes that there is a real public demand for programmes of the type conducted by Mr. Yorke. Most of the leading brass bands throughout Australia also broadcast through the "A" Class Stations from time to time.

Dance Bands:

For a substantial part of the year 1935-36 Mr. Jim Davidson's Dance Band remained under contract to the Commission and presented many popular programmes. During the later months a new band was formed in preparation for the arrival of Mr. Howard Jacobs, one of the leading English conductors of the type of music, who, together with Mr. Cecil Norman, the well-known composer, arranger, and dance-band pianist, visited Australia under contract to the Commission and made an extensive tour of the Commonwealth. Apart from Studio broadcasts, this band gave a series of public rhythm-music concerts of a type not previously attempted in this country, which were highly successful.

Composers:

The results of the A.B.C. 1934-35 Competition for Australian Composers were announced during the period under review. The entries submitted were judged in England by a distinguished musical authority, Mr. John Ireland, who commented favourably upon much of the work. The competition drew 269 entries covering a wide range of types of musical compositions—symphonic, choral, brass and military band, chamber music, operetta and vocal and instrumental solos.

The Commission was widely commended for this encouragement to local composers.

DRAMATIC:

Grand Opera:

Commencing in September, 1935, the Commission presented, mainly from its studios, but also a number from the Wilson Hall, Melbourne University, a six months' season of Grand Opera (three months in Sydney and three months in Melbourne) under the conductorship of Mr. Maurice de Abravanel, assisted by the Australian conductors, Mr. Percy Code and Mr. Joseph Post. The principal soloists included Madame Florence Austral, Miss Thea Phillips, Mr. Lionello Cecil, Mr. Ben Williams, Mr. Horace Stevens, Mr. Sydney de Vries and Mr. Raymond Beatty. The Commission's full Concert Orchestras in Sydney and Melbourne respectively, each specially augmented for the purpose, were employed for this season, and well-trained choruses, the nuclei of which were the A.B.C. (Sydney) Wireless Chorus and the A.B.C. (Melbourne) Wireless Chorus, were engaged.

Recorded Grand Opera:

Full recorded performances of Grand Opera broadcast during the year included "Lucia di Lammermoor," "The Bartered Bride," "The Damnation of Faust" and "Carmen."

Light Opera, Musical Comedy, Vaudeville, etc.:

Adaptation:

Much work was carried out in connection with the difficult task of satisfactorily adapting musical comedy and vaudeville performances for presentation by radio. Except where writers create primarily for the stage, adaptation must continue to play an important part in the presentation of programmes. Considerable progress was, it is believed, made in this field. It should be noted that a substantial part of the adaptation necessary consisted of condensation, experience having shown that few dramatic broadcasts are able to hold the attention of listeners for more than one hour. Since it had become apparent that at times drastic re-writing was necessary, the Commission retained, under contract, the services of Mr. Edmund Barclay, who not only wrote original productions of various types, but also assisted in the re-writing of well-known stage successes. Mr. Mark Makeham, another specialist in broadcasting productions, wrote the book, lyrics and music for the musical comedy "Dawn O'Day," and also contributed the "book" for a number of revues (including the humorous "Oh Quate" series), the music for which was written by another of the Commission's officers, Mr. Cecil Fraser. Mr. W. G. James wrote the score for musical versions of John Masefield's "Coming of Christ" and for a locally-written play entitled "Wo-Hie." Another member of the staff, Mr. Horace Keats, wrote the music for Paul Furniss" musical comedy "Maritza," while Mr. Alfred Lawrence wrote the libretto, book, and lyrics of "Babes in the Wood."

The Commission hopes in future to apply even more extensively its policy of encouraging local writers and composers to adapt their work to the particular requirements of radio-drama. As in the preceding year, few musical comedy broadcasts were attempted from theatres during public performances. In general such broadcasts are not satisfactory. "Yes Madam"—a work particularly suited for the purpose—was presented in that manner with, it is thought, a fair measure of success, but, for the most part, it was found more satisfactory to produce light operas, musical come-

(Continued on next Page.)

Australian Broadcasting Commission Annual Report (Continued.)

dies, revues and plays in the studio, specially adapted for broadcasting. Mention was made in the report of the light operas and musical comedies produced during the year.

Gilbert and Sullivan Recordings:

Compete recordings of all the Gilbert and Sullivan Comic Operas were again broadcast from all Stations during the period under review.

Plays:

Much that has been said concerning musical comedy applies with equal force to non-musical plays. In the presentation by radio of all forms of dramatic work, it has been found that the listener's familiarity with characters and general settings has a definite value; on the other hand, it has also been found that the majority of successful stage plays embody characteristics which are not altogether compatible with production for broadcasting purposes.

Accordingly, much re-writing—and in particular condensation—has been found to be necessary. Members of the Commission's staff have been engaged and trained for this purpose, and a general technique has now been evolved. Soon, it is hoped, leading dramatists will commence writing especially for broadcasting. The Commission has made special efforts to induce local playwrights to turn their talents to radio work, but it would appear that for some time to come standard works, suitably adapted, must constitute an important part of the dramatic programme.

Plays and Sketches Competition, 1935:

The results of the Commission's second competition for Radio-plays and Radio-sketches written by Australian authors were announced during the period under review. All prize-winning plays, and a number of other entries that were highly commended by the judges, were broadcast from the National Stations and were commended by the listening public. The entries revealed that a definite advance had been made in the technique of radio-dramatic writing since the first competition was held, and the general standard of writing gave encouraging promise for the future.

Notable Works:

During the year many outstanding examples of all established dramatic schools, including the modern English, American and Russian schools, were broadcast, in addition to lighter and more widely popular plays.

It is of interest to add that a play entitled "The Saga of Minnie Miffin," written in South Africa and obtained from the South African Broadcasting Company, proved particularly popular among listeners in this country.

Federal Department:

Pursuing its policy of federalisation of certain activities, the Commission appointed a Federal Controller of Productions.

This department will co-ordinate and direct the work of the production departments in the various States.

TALKS:

General:

Apart from solo talks, there have been discussions between two or more speakers, in the same city or in different cities, direct debates on controversial points, dramatised arguments in appropriate settings and broadcasts of public speeches. Talks of special merit and having nation-wide appeal were relayed from each of the States to all other parts of the Continent, and a great number of talks, covering a wide range of subject-matters, were broadcast in the ordinary State programmes.

Series of Talks:

Several series of National Talks are worthy of particular mention. One such series was entitled "The Causes of War" and comprised the following four talks:—"Men Like War" (by Dr. W. G. K. Duncan, of Sydney), "The Polical Factor" (by Professor G. V. Portus, of Adelaide), "The Profits of War" (by Judge A. W. Foster, of Melbourne), and "War as a Social Institution" (by Mr. W. Macmahon Ball, of Melbourne). "Education on the March" was the general title of another series of five talks, in which the educational systems of Russia, Germany, U.S.A., England and Australia were discussed, from various points of view, by men who had had personal contact with them. A third series, which perhaps served a useful purpose in helping the public at large to understand the difficulties of the man on the land, was the "You Don't Understand My Problems" series. It dealt with the following aspects of the primary producers' life:—"Our Difficulties with Finance" (by The Hon. W. C. Cambridge, M.L.C.); "Soil is Easily Exhausted" (by Mr. M. Pietriche), "Animals and Plants Will Catch Disease" (by Mr. J. F. F. Reid), "Farm Power and Haulage are so Costly" (by Mr. A. H. E. McDonald), "No Respite from Work" (by the Hon. M. P. Dunlop, M.L.C.) and "You Get Our Products Too Cheaply" (by Mr. H. D. Black). Throughout the year, talks concerning the latest developments in international affairs were given regularly by Professor A. H. Charteris (Sydney) and Dr. G. L. Wood (Melbourne).

Two changes in practice introduced during the year were, first, the decreasing number of National Talks given each week from seven to six, and secondly, the decision that the talk on Sunday night should always take the form of a discussion between two or more speakers.

The Commission would again like to record its appreciation of the assistance so willingly given it by honorary talks advisers, who devoted much time and thought in co-operation with the Commission's staff in the compiling of the talks programmes.

School Broadcasts:

As before, regular talks to boys and girls at school were broadcast on week-days at times decided upon after consultation with educational bodies. When the last annual report was presented to you, this system had been adopted in all States other than Tasmania. Shortly afterwards, the Educational Department in that State also agreed to co-operate with the Commission and since then the practice has been uniform in all parts of the Commonwealth. There can be little doubt that the work has been highly successful.

By bringing to even the most distant schools the benefit of talks by well-known authorities on their specialities, and by indicating to pupils interesting aspects of their work which might not fall entirely within the scope of ordinary lessons, the Commission has been able to help teachers and students alike. In subjects involving the pronunciation of a foreign language, broadcast lectures have, as might be expected, proved especially useful, uniform standards being otherwise difficult to attain.

As before, the subjects dealt with in these lectures in each State followed closely the syllabus prepared for each of the several public examinations. The obligation to do this naturally restricted the use which could be made of national relays, but otherwise little difficulty was met with except in the case of Station 2CO. That station is situated virtually on the border of New South Wales and Victoria, and naturally listeners on each side desired to hear lectures prepared in accordance with the examination syllabus for their own State.

The subjects dealt with in school broadcasts included: English (Syntax, Literature and Speech-Training), History, Geography, French, Elementary Science, Civics, Mathematics, German, Nature Study, Elementary International Affairs, Book-keeping, Elementary Physiology, Health and Physical Training talks, and Music. In the evenings, lectures were also given on Italian and Oriental Studies.

Booklets relating to the various school broadcasts were issued, as before, to all scholars interested in the respective courses. It has been found that some such guide is indispensable to the success of the scheme. When the previous annual report was presented no fewer than 800 schools were listening regularly to this part of the programme. At the close of the year now under review, that number had increased to 1024. These figures give some idea of the rapidity with which the experiment has found favour.

Apart from their service to the pupils of the above-mentioned schools

(Continued on next Page.)

Australian Broadcasting Commission Annual Report (Continued.)

the broadcasts proved to be of incalculable value to scholars living in more remote parts of the continent, and having, in consequence, to depend otherwise for their education upon correspondence courses. It is estimated that upward of 5000 such students listened regularly to the lectures which were broadcast during the year.

Every assistance has been received from the several State Education Departments and from the schools. The Commission desires to pay a tribute to their help and courtesy, and to thank especially those who voluntarily gave their time to act as members of the School Broadcasts Committees.

Readings:

The reading of stories over the air proved once more to be a popular part of the Commission's programmes. Many people who, for one reason or another, lack opportunity for extensive reading have found great interest in the story-readings which have been regularly broadcast. At times, these readings have been dramatised; it is believed that this greatly increases the appeal of many stories, especially where the broadcasts can be enriched by backgrounds of suitable "effects."

Descriptive Broadcasts:

The year was not as rich in opportunity for describing events of a ceremonial character as the previous one, which was marked by many notable functions associated with the Victorian Centenary Celebrations. Descriptions were, however, broadcast whenever occasion arose.

Industrial Broadcasts:

In addition to the more direct educational efforts made in the school broadcasts and the Young People's Concerts, the Commission arranged for expert describers to attend a number of factories and large-scale works and to describe the various operations carried on, for the benefit, especially, of children. The background noises picked up naturally on the microphone lent an air of reality to these descriptions and helped to excite the interest of youthful listeners.

SPORT:

All local sporting events of any importance were described, and the more outstanding descriptions were relayed to all States likely to be interested in them. Short-wave descriptions of notable sporting contests held overseas were also rebroadcast wherever possible, either directly or by means of recordings. The Commission desires to take this opportunity of expressing its appreciation of the assistance given in such matters by the B.B.C.'s Empire Station and by other shortwave organisations.

Particular mention should be made of the description arranged by the National Broadcasting Company Incorporated of America, of the Louis-Schmelling World's Heavyweight Championship boxing match. The N.B.C.'s admirable account of this interesting match was received with excellent clarity and was much enjoyed by many people in this country.

Other notable re-broadcasts were, as in previous years, the Derby and Grand National horse races, the Oxford-Cambridge boat race, and the English Association football cup final, all of which were received from the B.B.C. Empire Short-Wave Station.

Three interesting broadcasts of overseas sporting events were arranged directly by the Commission—the "synthetic" ball-for-ball description of the five cricket Test matches played by the Australian XI in South Africa; daily commentaries upon the main events of the Berlin Olympiad; and descriptions of the Davis Cup and Wimbledon tennis matches.

As to the first of these, the Commission, in conjunction with certain other Australian broadcasting organisations, sent to South Africa a representative who cabled during the tour the material from which running accounts of the play in all Test matches were reconstructed and broadcast.

The Commission was also represented during the Olympic Games, held in Berlin, by Mr. Harry Hay, a well-known swimmer and athletic authority, who supplied a series of commentaries upon and descriptions of the events which were of most concern to Australia. The Reisch-Rundfunk Gesellschaft made admirable facilities available for the service, and the quality of the transmissions was exceptionally good.

During the more important Davis Cup matches and the Wimbledon Men's Singles and Doubles Tennis Championships, a cable service was arranged, which enabled the scores to be announced game by game. This service was supplemented whenever practicable by the B.B.C. short-wave descriptions from the courts.

ESSENTIAL SERVICES:

Reports of various kinds, including market, weather, river-height, stock exchange and wool sale reports, especially designed to be of service to primary producers, and S.O.S. and other similar messages supplied by the Police Department or by other public authorities, were broadcast as in previous years.

DEVOTIONAL:

The Commission continued to broadcast morning and evening Sunday Church Services, representing all denominations, in each State, and also non-denominational studio services on week-days, including a "Daily Broadcast Service," which appeared to attract a large number of regular listeners. A "Sermon for those who may not like sermons" was also broadcast once each month. In New South Wales, one of the two Sunday morning services was replaced by an alternative programme of serious music.

The Commission also decided to improve the musical quality of the church services broadcast by making available to any church which desired such assistance the services, free of charge, of a well-trained vocal quartette.

SPECIAL SESSIONS:

Special sessions for women and for children were, as previously, broadcast at appropriate hours.

The problem of children's needs, in particular, has been receiving special attention. The tendency is definitely towards the presentation of carefully prepared and adequately rehearsed programmes for children, as well as for other listeners, in preference to relying upon the improvising ability of those—whether staff or professional artists—who contribute to the session. Serials featuring leading broadcast actors and actresses have become a permanent feature.

EMPIRE AND INTERNATIONAL RELATIONS:

Realising the importance of broadcasting—short-wave broadcasting in particular—in the scheme of international relations, and also the necessity for co-operation between broadcasting organisations in all parts of the world, the Commission appointed a special officer to supervise this work.

In order to increase the amount of first-hand information available to it concerning affairs abroad, the Commission has, since the close of the financial year 1935-1936, assisted "The Watchman"—one of its regular News Commentators—to attend a meeting of the League of Nations Council at Geneva, and Miss Constance Duncan—one of its regular speakers—to attend a Pan-Pacific Conference in America and subsequently to visit Japan, China, Manchukuo and Islands in the Pacific. It is hoped that listeners will soon be given the benefit of the additional knowledge so gained.

COMMUNITY SINGING:

Regular community singing concerts were once more arranged. The continued popularity of this form of entertainment has been a notable feature of Australian broadcasts for a number of years.

WOMEN'S SESSIONS:

As in previous years, women's sessions were broadcast at appropriate hours from all stations, and throughout the year under review totalled 973 hours, 33 minutes. They comprised items designed particularly to interest women, and included talks concerning both home and outside activities.

(Continued on next Page.)

Australian Broadcasting Commission Annual Report (Continued.)

B.B.C. RECORDED PROGRAMMES:

By arrangement with the B.B.C., recordings of some of the latter's programmes were broadcast by the Commission.

These recordings have been of excellent mechanical quality and consequently have afforded a more interesting standard of comparison with the work of the B.B.C. than can as yet be obtained from short-wave re-broadcasts.

SHORT-WAVE BROADCASTING:

Reception:

During the year there were frequent rebroadcasts of short-wave programmes. The technical quality of this form of transmission continued to improve substantially. A notable advance was also made by the more liberal use of recording machines in Melbourne and Sydney. Previously, the hours when short-wave transmissions were rebroadcast were often dictated by the most suitable hours for overseas reception. By recording locally, however, it has become possible to choose the time, or times, most likely to suit general programme balance and the convenience of Australian listeners.

As in earlier years, the B.B.C.'s Empire programmes were used freely, and in addition American and Continental stations at times contributed interesting programmes of good technical quality.

Outstanding sporting rebroadcasts have already been mentioned. Particular reference should also be made to the B.B.C. Christmas Broadcast, "The Great Family," in which typical families spoke from widely-separated parts of the Empire, and the "Youth Sings Over the Frontier" broadcast from Zeesen, arranged by l'Union Internationale de Radiodiffusion, to which children of many nationalities contributed their own songs. The Commission was happy to be able to co-operate in the arrangement of both these programmes.

Other notable broadcasts re-transmitted to Australian listeners were Mr. Baldwin's speech concerning the last hours of the late King George V and descriptions of the Funeral and Burial Services of His late Majesty; the Proclamation Ceremony upon the accession of King Edward VIII, and King Edward's speech to the Empire in March, 1936; the special service at Canterbury Cathedral on the occasion of the Bishop Broughton Centenary; and descriptions of the launching by Lord Bledisloe of the S.S. "Awatea"; of the departure of the "Queen Mary" upon its maiden voyage and of its arrival in New York.

On occasion the overseas short-wave transmissions were supplemented by the use of the radio telephone, and interviews with notable personalities in other countries and with distinguished Australians abroad (including members of the Davis Cup tennis team) were arranged by the Commission for Australian listeners.

TRANSMISSION:

The Commission has continued to supply programmes for the short-wave National Station 3LR Lyndhurst (Victoria). Although working on severely limited power, this station has at times been received with reasonable clarity in England and other parts of Europe, and also in America. Its effective overseas range, however, is restricted principally to New Zealand, the Islands in the Pacific, and the Far East of Asia, from which appreciative letters have frequently been received. Possibly, however, the most valuable use to which the station has been put, so far, is the supplying of static-free programmes to the more remote parts of Australia, which cannot be adequately served by the ordinary medium-wave stations at present in existence. Realising the effectiveness of 3LR for this purpose, the Commission has substantially increased the latter's programme output and has recently broadcast from it special news and essential-service bulletins as well as the outstanding features of the ordinary National programmes.

ARTISTS:

Artists' appearances for the year amounted to no fewer than 73,135, of which 44,473 fell within the general category of music, 19,898 within that of talking and 8,764 within that of drama. Microphone appearances over the same period totalled 33,619, the lower number (as against artists' appearances) being explained by the fact that many of the performers appeared in combinations of one kind or another.

ACCOMMODATION:

Although, as this and previous reports indicate, there has been very marked progress both in the development of the Commission's programmes and the raising of standards of performance, the Commission has been under a severe handicap owing to lack of adequate studios and staff accommodation in all States. There was no simple and quick remedy for this. The most difficult technical problems are associated with both the design and location of studios. Large broadcasting organisations in Europe and America have been experimenting on these problems. There were sound reasons for delaying the purchase of land in the major capital cities of Australia, until the conflicting elements of cost and location had been reconciled. Fortunately, the Commission was able to secure suitable sites in the two principal cities, Melbourne and Sydney, last year.

During the year the Commission sent abroad one of its officers (Mr. T. W. Bearup) to investigate broadcasting problems, and in particular problems of studio design. He was accompanied during most of this visit by the Chief Architect of the Department of the Interior, who was specially released by that Department for this investigation.

The accommodation in the smaller States is of a more or less temporary nature. Studio problems in those States will be reviewed in the light of the reports made by the experts.

Note.—These two officers have since returned, and their reports and recommendations are receiving the attention of the Commission.

FINANCE:

The appended statements show that during the period under review, revenue exceeded expenditure by £91,465, as against £95,078 in the preceding twelve months. Transfers from the surplus bring the Building Reserve to *£235,000, and an unappropriated surplus of £3,867 is carried forward to the next year. The total gross revenue for the year was £470,996 (as against £405,534 for the previous year.) Of this sum, £461,375 was received from the Postmaster-General's Department as the Commission's proportion of Broadcast Listeners' Licence Fees, payable under Section 26 (2) of the Australian Broadcasting Commission Act, 1932. Other revenue (including principally gross proceeds of public concerts and rentals) amounted to £9,621. The total expenditure for the year was £379,531 (as against £310,456 for the previous year), representing 80.58 per cent. of revenue. Programme expenses (included in the above total) increased from 42.23 per cent. of revenue to 49.36 per cent. The percentage of administrative expenses decreased slightly.

The reasons referred to in previous reports for setting aside substantial reserves from revenue may well be repeated. This policy is followed 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 licence-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. Moreover, although the Commission may borrow on the security of debentures, the amount available to it from this source at a given moment is limited under the Act to £50,000. While this limitation stands, it would appear that capital expenditure beyond this sum must come from revenue. The Commission has already been involved in heavy expenditure in

*Note.—As it will appear from the Accounts, this Reserve is represented as to cash by £100,000 only; the balance being represented by Land and Buildings, £53,260; Furniture, Equipment, etc., £81,740.

(Continued on next Page.)

Australian Broadcasting Commission Annual Report (Continued.)

the purchase of land in the capital cities, particularly in Melbourne and Sydney, and it faces an extensive building programme in order to provide studios and staff accommodation. Reference has already been made to this earlier in the report.

In considering the likely trend of broadcasting expenditure in the future, it must be remembered that the tendency everywhere is to reduce the proportion of gramophone records in favour of live broadcasting, with a consequent increase in cost. The Commission has been making this reduction voluntarily as a matter of national policy, and in response to its obligation under the Act to "give as far as possible . . . encouragement to the development of local talent . . ." The extent and success of its efforts in this direction are evident in the record embodied in this report. The Commission believes however, that the same policy will be forced, by public opinion, upon the commercial stations, which now, in Australia, depend preponderently upon recordings, and their entry into the field of competition for original programme material and artists is bound to increase the cost. Moreover, already the pinch of insufficient original material, even in the matter of music, is being felt severely. All these difficulties have arisen in an acute degree in Australia, because of our comparatively small population, our immature stage of development, both in respect of composers and artists, and our remoteness from northern centres of civilisation; but the full force of the difficulties has not yet struck us. In the early period of broadcasting the novelty of the art, the freshness of much of the material and of the artists, to some extent delayed or softened criticism. But as the comparatively brief list of local artists—musicians, actors, speakers—becomes exhausted, interest wanes, and is succeeded by boredom and criticism. It is no longer sufficient that an opera, a symphony, a play, a musician, an actor, a speaker be good, or even excellent; the item or the artist must be new or rare.

This prejudice against repetition is imposing a great strain on our resources, which can only be relieved by the expenditure of more money in the encouragement of original composition and of higher standards of performance, and in the leavening of local talent with imported, both in respect of material and artists. Standards can also be raised by improved methods of production, more adequate rehearsal, more expert studio control, and by a greater degree of specialisation in the various branches of broadcasting art. We are pushing on with our work in all these directions, though the rate of progress will be retarded by the lack of suitable studios, and the impossibility of conjuring experienced staff out of the void.

As fast as staff can be secured and trained, and so soon as new studios are available, the standard of our productions will rise—as also will our expenditure. It is certain that in future we must pay higher fees than in the past for material and artists, both inside and outside Australia; inside, partly because of increasing competition by commercial stations, and partly in order to offer inducement without which sufficient material and talent of a suitable standard will not be created or developed; abroad, partly because of the keen competition for talent by broadcasting organisations with much greater financial resources than ours, and partly because of our distance from the northern capitals, which causes most artists to look askance at the long journey, the time lost in travelling, and the break from the entertainment world of Europe and America.

TECHNICAL:

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

ENCOURAGEMENT TO LOCAL ARTISTS:

The Commission has already done a great deal to encourage Australian artists, and it will progressively increase the opportunities for such artists. A growing proportion of its programme time is now occupied by flesh and blood productions, as against recorded programmes. It has conducted competitions for playwriters and musical composers, and has now set up a Federal Music Department and a Federal Dramatic Productions Department which will, among other things, take special steps to discover and give opportunity to Australian talent. Some of the ways in which the Commission has given, and is continuing to give, employment to Australian artists have been alluded to earlier in this report and may here be briefly summarised.

(i) **Grand Opera Season:** During the past year—lasting three months in each of the larger capitals, Sydney and Melbourne, and employing up to 50 orchestral players with chorus of 32 in each city, together with some 57 Australian soloists in principal and subsidiary roles.

(ii) **Orchestras** have now been set set up in every State, giving full-time employment to over 150 musicians, and part-time employment to at least another 150 for public concert performances in each State, varying from 5 to 10 in number.

(iii) **Bands:** A Military Band of thirty-two musicians, and two dance bands of seventeen musicians each, are maintained on full time.

(iv) **Choruses:** Permanent choruses of 16 are maintained in both Melbourne and Sydney, and also part-time choruses in the other States.

(v) **Engagements** are given to outside professional or amateur orchestras, bands, choirs and dramatic societies.

(vi) **In addition** to organised groups such as those referred to above, employment on a very large scale is given to individual singers, instrumentalists, actors, speakers, producers arrangers, writers, composers, and others, in musical comedy, vaudeville, plays, sketches, debates, lectures, talks, story-readings, and so on.

(vii) **Artist appearances** for the year numbered no fewer than 73,000.

STAFF:

Mr. Charles J. A. Moses was appointed General Manager as from the 1st November, 1935.

The Commission desires to take this opportunity of thanking him and all other members of the staff for the loyal and willing service which they have given during the year.

During the year every State of the Commonwealth was visited by one or more members of the Commission, the General Manager and some of the principal executive officers. On these visits close contact has been made, not only with the Commission's own staff, but also with representatives of community life over a wide range of interests and activities—music, drama, education, press, public service and so on. This close personal supervision of the organisation and intimate contact with representative groups of listeners has enabled the Commission to keep in touch with listeners' interests, and equipped it to cater for their diverse tastes and needs.

PERSONNEL OF COMMISSION:

The Commission's personnel has remained unaltered. The original term of office of the Vice-Chairman, Mr. Herbert R. Brookes, terminated during the period under review and he was immediately re-appointed for a further term of one year.

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.

AUSTRALIAN BROADCASTING COMMISSION

BALANCE SHEET AS AT 30th JUNE, 1936.

Previous Year £ s. d.	LIABILITIES.		1935-36. £ s. d.
13,314 6 8	Sundry Creditors		18,146 5 9
145,000 0 0	Reserve for Buildings		235,000 0 0
2,401 16 0	Accumulated Fund ..	£2,401 16 0	
	Add Balance from Profit and Loss Statement	1,465 6 6	3,867 2 6
£160,716 2 8			£257,013 8 3

Previous Year £ s. d.	ASSETS.	£ s. d.	1935-36. £ s. d.
	Land and Buildings— Freehold	53,468 18 3	
16,279 1 0	Less Depreciation	209 1 8	53,259 16 7
	Office Furniture, Musical Instruments and Equipment	34,732 11 4	
17,401 14 5	Less Depreciation	13,005 6 0	21,727 5 4
1,910 16 0	Stores and Stationery		2,443 3 0
	Sundry Debtors:— Postmaster-General for Licence Fees .	54,134 16 0	
50,159 8 11	Other	1,422 16 3	55,557 12 3
1,889 12 6	Payments in Advance		2,303 16 10
	Other Investments— Fixed Deposits .	100,000 0 0	
60,183 5 10	Add Accrued Interest	958 9 10	100,958 9 10
12,892 4 0	Cash in Hand and at Bank		20,763 4 5
£160,716 2 8			£257,013 8 3

PROFIT AND LOSS STATEMENT FOR YEAR ENDED 30th JUNE, 1936.

Previous Year £ s. d.	EXPENDITURE.	1935-36. £ s. d.
171,296 12 7	To Artists' Fees and Programme Expenses .. .. (Payments to Artists, Orchestras, Lecturers, Announcers, Accompanists and Production Costs.)	232,464 15 5
40,200 13 9	Copyright Fees	44,137 10 5
9,370 5 5	Broadcasting Rights	9,679 13 4
11,281 18 10	Rental of Telephone Lines for Broadcasting and Outside Pick-up Costs	9,962 0 2
1,777 13 6	Commissioners' Fees	1,800 0 0
34,031 2 4	Staff Salaries	38,074 17 9
8,351 3 5	Rent of Offices	9,481 12 8
6,387 6 0	Publicity	4,060 2 4
3,851 17 5	Depreciation	5,324 12 7
1,587 6 3	Preliminary Expenses Written off	—
22,319 16 5	Other Expenses	24,546 0 7
95,078 16 2	Balance carried down	91,465 6 6
£405,534 12 1		£470,996 11 9
95,000 0 0	To Transfer to Reserve for Buildings	90,000 0 0
78 16 2	Balance to Accumulated Funds	1,465 6 6
£95,078 16 2		£91,465 6 6

Previous Year £ s. d.	REVENUE.	1935-36. £ s. d.
405,048 19 0	By Revenue from Licence Fees ..	461,374 18 0
314 10 10	Interest on Investments	1,656 9 0
171 2 3	Other Revenue	7,965 4 9
£405,534 12 1		£470,996 11 9
95,078 16 2	By Balance brought down	91,465 6 6
£95,078 16 2		£91,465 6 6

World License Distribution as at 31/12/35, mentioned on Page 16, Col. 1.

Country.	Population.	Total.	Licences Per 100 of Population.
1. U.S. of America ..	126,425,000	22,500,000‡	17.79
2. Denmark	3,705,559	609,226	16.44
3. Great Britain	46,047,046	7,403.109	16.08
4. Sweden	6.233.090	834.143	13.38
5. New Zealand	1,562,129	183,830	11.77
6. Australia	6,734,771	770,152	11.43
7. Netherlands	8,351,117	946,844	11.34
8. Germany	66,840,000	7,192,952	10.76
9. Switzerland	4,066,400	418,499	10.29
10. Belgium	8,092,004	746,395	9.22
11. Canada	10,376,000	862,109*	8.31*
12. Austria	6,760,000	560,120	8.286
13. South Africa	1,730,000†	130,000	7.51
14. Norway	2,870,000	191,378	6.67
15. Argentine	12,200,000	800,000‡	6.56
16. France	41,940,000	2,625,677	6.26
17. Czecho-Slovaka ..	14,726,158	847,955	5.75
18. Hungary	8,761,000	352,907	4.03
19. Finland	3,697,505	144.721	3.91
20. Chilia	4,500,000	150,000‡	3.33
21. Irish Free State ..	3,030,000	78,600	2.59
22. Japan	97,362,679	2,372,402‡	2.44
23. U.S.S.R.	168,000,000	2,800,000	1.67
24. Poland	33,584,000	491,823	1.46
25. Mexico	16,500,000†	220,000	1.33
26. Spain	23,677,794	303,983	1.28
27. Italy	43,450,000	530,000	1.22

‡Listeners are not licensed and the totals shown are estimates only of the number of receiving, sets in operation.
*As at 31st March, 1936. †Excluding natives.

Commonwealth Auditor-General's Annual Report on Wireless Matters of the Postmaster-General's Dept. for Period 1935-36.

The published accounts of the Amalgamated Wireless (Australasia) Limited for the year ended 30th June, 1936, disclose a net profit of £109,701/7/2 from Wireless Services and other sources.

This amount represents a return of 14.73 per cent. on the paid-up capital of £744,283, and is £10,123 less than the net profit for the previous year. Dividends at the rate of 11 per cent. per annum, absorbing £81,871, have been paid for 1935-36, the Commonwealth receiving £38,500, based on its capital holding of £350,000/14/—500,001 shares paid at 14/-. Dividends received to date by the Commonwealth since the Commonwealth became a sharholder in 1922, total £260,558, including dividend for half-year ended 30th June, 1936, paid on 16th October, 1936.

Under the Wireless Agreement Act 1927, the company received the sum of £33,372/5/1 from the Government, on account of the year 1935-36. 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.

As required by Section 52 (b) of the Audit Act, I append the following opinion of the Attorney-General's Department regarding the right of the Commonwealth to set off the company's revenue contribution against the Government annual subsidy.

Wireless Agreement Act 1927—Schedule, Part III., Clause 12—Constitution, Section 81, 83—Right of Commonwealth To Set Off Company's Revenue Against Commonwealth's Contribution.

OPINION.

The Auditor-General has forwarded the following memorandum to me for advice:—

"Clause 12 (3) of Part III. to the Schedule of the above Act provides—

'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 30 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.'

2. The practice in the Postmaster-General's Department, since the inception of the Agreement in 1927, has been to deduct 30 per cent. of the revenue collected by the company from the annual subsidy of £45,000. To meet the payment of £45,000, the sum of £37,000 only has been provided (see Estimates 1935-36), Item 127 (f) (1) 'Contributions to Amalgamated Wireless Limited towards the Cost of Wireless Stations'), this sum of £37,000 presumably being the net difference between the £45,000 payable by the Department and the 30 per cent. of revenue earned by the company to be paid to the Commonwealth.

3. During the last three years, the following payments and earnings have occurred:—

COUNCIL 1936-37.

Financial Year.	Annual Subsidy.	30 per cent. of the Revenue earned by the Company.	Amount Payable to the Company.
	£	£	£
1932-33	45,000	8,718 17 1	36,281 2 11
1933-34	45,000	8,869 11 1	36,130 8 11
1934-35	45,000	11,565 2 9	33,434 17 3
Totals .. .	135,000	29,153 10 11	105,846 9 1

4. The Auditor-General will be glad of your advice as to whether the full amount of £45,000, under Clause 12 (3) of the Schedule above-quoted, should be appropriated and paid to the company, and whether the 30 per cent. of the revenue earned by the company should be collected and paid to Commonwealth Revenue.

5. Reference is made to Section 3 of the Wireless Agreement Act 1927, to Treasury Regulation 30 and to Sections 81 and 83 of the Constitution."

Section 81 of the Constitution provides that all revenues or moneys raised or received by the Executive Government shall form one Consolidated Revenue Fund.

Clause 12 (3) of the Agreement provides that the Commonwealth shall pay to the Company a subsidy of £45,000 per annum, and the Company shall pay to the Commonwealth 30 per cent. of the revenue earned by the Company in respect of certain services.

Section 3 of the Wireless Agreement Act appropriates the necessary moneys for carrying out the Agreement, but apparently the practice has arisen of setting off the percentage of revenue, due to the Commonwealth against the Commonwealth's contribution, and only appropriating the excess of the contribution over the Commonwealth's share of the revenue.

If the practice is as above-stated, the moneys due by the Company to the Commonwealth are not raised or received within the meaning of section 81 of the Constitution.

Against the amount of subsidy payable by the Commonwealth there is set off the amount of revenue payable by the Company, and I see no reason for appropriating more than the difference or for insisting on the revenue as set off being actually collected and paid to revenue.

(Sgd.) GEO. S. KNOWLES,
Solicitor-General.

5th March, 1936.
The Auditor-General,
Melbourne.

PICTUREGRAM SERVICE.

40. The following figures in regard to this Service are of interest:—

Capital Cost	£12,035
Revenue, 1935-36	636
Working Expenses, 1935-36	815
Interest and Depreciation, 1935-36	1,361
Net loss on the year	1,540

Compared with the figures for the year 1934-35, the Revenue showed a decrease of £319, while Working Expenses were increased by £45. Included in the Work-

AUDITOR GENERAL'S REPORT ON WIRELESS ACCOUNTS (Continued.)

ing Expenses for 1935-36 were amounts of £174 for replacement parts to be used during 1936-37 and £103/10/- representing Exchange. The net loss on the year compared with that of the previous year was increased by £166.

BROADCASTING.

41. Broadcasting Services in Australia are supplied by two classes of stations—the National Stations provided and maintained by the Commonwealth and the licensed Commercial Stations.

There are fifteen National Stations, nine originating stations including the short-wave stations at Lyndhurst, Victoria, and six regional stations. The bulk of the programmes broadcast from regional stations is received over land lines from the metropolitan stations. Seventy-three Commercial stations were broadcasting at the end of the financial year.

Licensed broadcast listeners at 30th June, 1936, numbered 821,765, showing an increase of 102,869 over the number twelve months before.

During the year, 1,364 unlicensed listeners were convicted, fines and costs totalling £2,845.

LISTENERS' LICENCE FEES—RECEIPTS AND EXPENDITURE.

42. The broadcast listeners' licence fee of 21s. is distributed between Consolidated Revenue and the Australian Broadcasting Commission; 9s. is paid to Revenue and 12s. to the Commission. The following Statement shows the broadcasting transactions relating to listeners' fees for the year 1935-36.

INCOME.

	£	s.	d.
Balance of undistributed fees in Trust Account, Wireless Broadcasting Account at 30th June, 1935	211,039	9	0
Licence Fees received from Broadcast Listeners and Experimenters during 1935-36	861,724	14	0
	1,072,764	3	0

EXPENDITURE.

	£	s.	d.
Australian Broadcasting Commission ..	461,374	18	0
Revenue	367,751	18	0
Balance undistributed fees in Trust Account, Wireless Broadcasting Account*	243,637	7	0
	1,072,764	3	0

* Included in the foregoing figures is an amount of £897 in respect of Experimental Licence fees. When the wireless regulations were promulgated in 1924, provision was made for a portion of experimental licence fees to be paid to the "A" class broadcasting companies. The payment was continued up to the date the National Broadcasting Service was established in 1929. The contract with the Australian Broadcasting Company Limited which conducted the first national service provided for a payment of 12/- per annum per listener's licence fee collected. Subsequently, the Australian Broadcasting Commission Act 1932, similarly provided for a payment of 12/- per annum per broadcast listener's licence fee received. Notwithstanding these limitations to listeners' licence fees received, the Department, has since 2nd October, 1930 (when the experimental licence fee was increased to 30s. per annum), paid to the Australian Broadcasting Company Limited and, subsequently, to the Australian Broadcasting Commission, 12/- per annum in respect of each experimental licence issued. These payments to the Company and the Commission in respect of experimental licences have been made without statutory authority and have been illegally charged to the Parliamentary Appropriation "Refunds of Revenue." The Department has indicated that action to legalise the payments will be taken at an early date.

WIRELESS BRANCH ACCOUNTS.

43. The Accounts of the Wireless Branch of the Postmaster-General's Department, which include the receipts and expenditure on account of broadcasting activities and show the Branch Profit and Loss Account for the year, were not complete at the time of preparation of this Report.

* The amount has been reconciled with the Treasury Balance of £282,834/4/-.

The Department administers the Wireless Act generally, and, as required by the Australian Broadcasting Commission Act 1932, provides and maintains broadcasting station and studio technical equipment, and makes available both permanent programme lines to serve the regional stations and lines for relayed programmes mutually agreed upon with the Commission.

The Postmaster-General's Annual Report and Balance-sheet for 1934-35 was issued on 20th May, 1936. The Wireless Branch surplus for 1934-35 was shown as £162,343. Wireless Equipment appears in the Balance-sheet at 30th June, 1935, as £268,779.

AUSTRALIAN BROADCASTING COMMISSION.

44. The accounts of the Australian Broadcasting Commission have been subjected to a continuous audit, the examination being extended to the Branch accounts in each State. The Balance-sheet has been certified by me and a report furnished to the Minister as required by Section 31 of the Australian Broadcasting Commission Act 1932.

The total revenue of £470,996/11/9 was made up of £461,374/18/- from listeners' licence fees, £96/8/- rents from property, £9/9/9 rent from plant, £7,859/7/- proceeds from concerts, and £1,656/9/- interest on fixed deposits. The expenditure totalled £379,531/5/3, leaving a revenue surplus of £91,465/6/6.

For the purpose of comparing the Commission's operations for the past two years, the following table has been prepared:—

TABULATION OF PROFIT AND LOSS ACCOUNTS—Two Years 1934-35 and 1935-36—With Percentages of Revnue.

	1934-35. £	1934-35. Per cent	1935-36. £	1935-36. Per cent
To Artists' Fees and Programme Expenses (Payments to artists, orchestras, lecturers, announcers, accompanists, and production costs)	171,297	42.2	232,465	49.4
Copyright Fees	40,201	9.9	44,137	9.4
Broadcasting Rights .. .	9,370	2.3	9,680	2.0
Rental of Telephone Lines for Broadcasting and Outside Pick-up costs	11,282	2.8	9,962	2.1
Commission's Fees	1,778	.4	1,800	.4
Staff Salaries	34,031	8.4	38,075	8.1
Rent of Offices and Furniture	8,351	2.1	9,482	2.0
Publicity	6,387	1.6	4,060	.9
Depreciation	3,852	.9	5,325	1.1
Preliminary Expenses Written Off	1,587	.4	..	..
Other Expenses	22,320	5.5	24,546	5.2
Balance carried down ..	95,079	23.5	91,465	19.4
	405,535	100.0	470,997	100.0

	1934-35. £	1934-35. Per cent	1935-36. £	1935-36. Per cent
By Revenue from Licence Fees	405,049	99.9	461,375	98.0
Interest on Investments	315	.1	1,657	.3
Other Revenue	171		7,965	1.7
	405,535	100.0	470,997	100.0

AUDITOR GENERAL'S REPORT ON WIRELESS ACCOUNTS (Continued.)

Period.	Revenue.	Expenditure.	Surplus.	Reserve for Building.	Accumulated Fund.
Year ended 30th June, 1935	405,535	310,456	95,079	145,000	2,402
Year ended 30th June, 1936	470,997	379,532	91,465	235,000	3,867

Revenue for the year showed an increase of £65,462 on the previous year's figures, of which £56,326 was due to increase in broadcast listeners' licences and £7,778 to proceeds of concerts promoted by the Commission. Expenditure increased by £69,076, the principal items being Artists' fees and Programme expenses, £61,168; Copyright Fees, £3,936; Staff Salaries, £4,044, and other expenses £2,226. Publicity showed a decrease of £2,327.

Copyright Fees paid by the Commission to the Australian Performing Rights Association are subject to an agreement dated 2nd July, 1934. The amount payable to that Association in respect of the year 1935-36 was £39,361.

Briefly, the financial position is explained thus—The assets, Sundry Debtors, Payments in Advance and cash in hand and at bank, amounting to £78,625, are in excess of the liability, Sundry Creditors, to the extent of £60,479. This amount, added to the remaining assets as shown in the balance-sheet, namely, £178,388, offsets the remaining liabilities of £238,867. These liabilities, described as "Reserves for Buildings £235,000 and Accumulated Fund, £3,867," represent the surplus revenue for the four years ended 30th June, 1936. Land and Buildings have increased from £16,279 to £53,260, and Office Furniture, Musical Instruments and Equipment from £17,402 to £21,727. Surplus cash to the extent of £100,000 has been placed on fixed deposit.

A summary of balance-sheet items for two years follows:—

	30th June 1935		30th June 1936
Assets—			
Land and Buildings—Freehold **Less** Depreciation	16,279	..	53,260
Office Furniture, Musical Instruments and Equipment **Less** Depreciation	17,402	..	21,727
Stores and Stationery	1,911	..	2,443
Sundry Debtors	50,159	..	55,558
Payments in Advance	1,890	..	2,304
Fixed Deposits with Accrued Interest	60,183	..	100,958
Cash in hand and at Bank ..	12,892	..	20,763
	160,716	..	257,013
Liabilities—			
Sundry Creditors	13,314	..	18,146
Reserve for Building	145,000	..	235,000
Accumulated Fund	2,402	..	3,867
	160,716	..	257,013

Commonwealth Government—Amalgamated Wireless Agreement.

In previous editions of this "Radio Trade Annual" details have been given of the various agreements existing between the Commonwealth of Australia and Amalgamated Wireless A/sia Ltd.

An original agreement dated March 28, 1922, was signed and completed. An amendment of 1924, Act No. 24 of 1924, was further amended by Act No. 27 of 1927.

Full details of those Acts may be obtained from the Commonwealth Government Printer at Canberra, or from the publishers of this trade annual, Australian Radio Publications Ltd., 30 Carrington Street, Sydney, N.S.W.

Commonwealth Postal Information

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 Island, etc.), Nauru, Bougainville and Buka (Solomon Islands):—

Letters and Lettercards.—2d. per oz. (Late Fee, 1d.) (Registration Fee, 3d.).

Postcards.—1½d. each.

Second-class Mail Matter, comprising:

(a) Commercial Papers (maximum weight, 5lbs.), Patterns, Samples and Merchandise (Maximum weight, 1lb.).—1d. per oz.

(b) Printed Matter: comprising Printed Papers, Circulars and Catalogues (which may contain samples of material) and Books, Periodicals and Newspapers not registered at a General Post Office (Maximum weight, 5lbs.).—1d. per 4 oz.

Third-class Mail Matter, comprising:

Books, Periodicals, and Newspapers registered at a General Post Office for transmission as such. (Maximum weight, 5lbs.)—1d. per 6 oz.

Newspapers published by registered newspaper proprietors to addresses within the Commonwealth or Papua, 20 oz., 1½d.; to New Zealand and Fiji, 16 oz., 2d.

EXPRESS DELIVERY SERVICE.

Prepayment of special fee in addition to the postage secures immediate delivery by special messenger. Minimum fee payable is 4d.

Acknowledgment of Receipt of Registered Letter or Article.—**Fee 3d.** in addition to Postage and Registration Fee.

POSTAL INFORMATION
(Continued.)

PERMIT MAIL FREE.

Printed Circulars signed by hand or personally addressed, posted in sealed envelopes.—Printed Matter rates, plus ½d. for each article.

AERIAL SERVICE.

Within the Commonwealth.—Articles except Parcels.—3d. per ½ oz. in addition to ordinary postage.

INSURANCE OF PARCELS.

To addresses within the Commonwealth:—

Fee	
3d.	£2
4d.	£5
6d.	£10
9d.	£20
1/-	£30
1/3	£40
1/6	£50

For loss, damage, or rifling of contents.

CASH ON DELIVERY PARCELS.

Within the Commonwealth.—In addition to the postage, commission on amount to be collected from addresses:—

Not exceeding 10/-	9d.
Over 10/-, and not exceeding 20/-	1/-
„ 20/- „ „ 30/-	1/3
„ 30/- „ „ 40/-	1/6
„ 40/- „ „ 60/-	1/9
For each additional 20/-, or fraction	3d.

BEYOND THE COMMONWEALTH.

Letters and Lettercards.—To places within the British Empire.—2d. per oz.

To all other places.—3d. first oz., 2d. each additional oz. Registration Fee, 3d.

Postcards.—To places within the British Empire.—1½d. each.

To all other places.—2d. each.

Commercial Papers.—To New Zealand 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.—1d. per 4 oz.

To all other places—1d. per 2 oz.

Newspapers.—To New Zealand and Fiji.—1d. per 6 oz.

To the United Kingdom and Irish Free States—Via France or America, 1d. per 4 oz.; via All Sea Route, 1d. per 6 oz.

To places in the British Empire.—1d. per 4 oz.

To all other places.—1d. per 2 oz.

Samples.—To places within the British Empire.—1d. per 2 oz.

To all other places.—1d. per 2 oz., with a minimum of 2d.

Merchandise.—To New Zealand and Fiji.—1d. per 2 oz.

Small Packets (transmissible to certain countries only).—2½d. per 2 oz., with a minimum of 6d.

Aerial Service (Australia-Singapore-London)—1/6 per ½ oz. in addition to postage.

PARCELS (Limit of Weight, 11lbs.)

To New Zealand.—1lb., 8d.; each additional lb., 6d.

To United Kingdom, by Long Sea Route, 1lb., 1/4; each additional lb., 6d.

To United States of America, via 'Frisco, 1lb., 1/-; each additional lb., 6d.; via London, 1lb., 3/1; 2lbs., 3/5; 3lbs., 3/9; 4lbs., 6/1; 5lbs., 6/8; 6lbs., 7/-; 7lbs., 7/4; 8lbs., 9/11; 9lbs., 10/3; 10lbs., 10/7; 11lbs., 10/11; via Vancouver, 1lb. 1/1½, each additional 1lb., 7½d.

Insurance of Parcels.—To addresses in New Zealand: Up to £12, 6d.; £24, 9d.; £36, 1/-; £50, 1/6, in addition to postage.

MONEY ORDERS.

Within the Commonwealth.—6d. for each £5 or part.

New Zealand, Papua, Rabaul (New Guinea), New Caledonia.—3d. for each £1 or part. Minimum, 6d.

Fiji.—3d. for each £1 or part. Minimum, 6d. Exchange, 1.6 pence for each 1/- or 2/8 for each £1.

Gilbert and Ellice Islands, Solomon Islands and Tonga.—4d. for each £1 in first £6, and 3d. for each additional £1 or part. Minimum, 9d.

Philippine Islands.—4d. for each £1 in first £6, and 3d. for each additional £1 or part. Minimum, 9d. Exchange, 2d. for each 1/- or part.

United Kingdom, Canada, Ceylon, China, Dutch East Indies, Egypt, Federated Malay States, Germany, Hong Kong, India, Irish Free State, Italy, Japan, Malta, Mauritius, Norway, North Borneo, Straits Settlements, South Africa, United States of America.—4d. for each £1 in the first £6, and 3d. for each additional £1 or part. Exchange, 3d. for each 1/- or part.

Other Countries in Europe, Asia, Africa, North America, and Islands adjacent to those continents.—4d. for each £1 in the first £6, and 3d. for each additional £1 or part. Minimum, 9d. Exchange, 3d. in 1/-. These must be forwarded via London and are subject to an additional charge of 2d. in each £1 or part. Minimum, 4d.

Until further notice only £100 will be allowed for each remitter per week.

POSTAL NOTES.

Payable throughout the Commonwealth.—1/, 1/6, 2/, 2/6—1d.; 3/, 3/6, 4/, 4/6—1½d.; 5/, 5/6, 6/, 7/6—2d.; 10/, 11/, 15/, 20/—3d.

TELEGRAPHIC RATES.

City and Suburban, or within 15 miles of sending station.—16 words, including address and signature, 9d. Each additional word, 1d.

Country.—16 words, including address and signature, 1/-. Each additional word, 1d.

Interstate.—16 words, including address and signature, 1/4. Each additional word, 1d.

Urgent Telegrams and Sunday, Christmas Day and Good Friday, double the above rates.

To New Zealand, 4½d.; to Suva, 6d.; to United Kingdom, ordinary, 2/-; deferred, 1/-; to New York, ordinary, 2/5, deferred, 1/2½; to Paris, ordinary, 2/7, deferred, 1/3½ per word.

Lettergrams to addresses within the Commonwealth will be forwarded by Telegraph during the night, and delivered as ordinary letters by first delivery.—30 words, 1/3; each additional word, ½d.

TELEGRAMS TO CATCH MAIL STEAMERS.

On payment of postage in addition to telegraphic rates, telegrams may be sent to any telegraph office in Australia, to be forwarded thence by post to any destination beyond the Commonwealth.

DAILY LETTER TELEGRAMS.

Between Australia and the undernoted places:—

	Minimum 25 words	Each add. word
To United Kingdom	16/8	8d.
„ Canada (via Pacific)	13/2½	6⅓d.
„ United States (via Eastern)	20/2	9⅔d.
„ Straits Settlements	20/10	10d.
„ India — Burma and Ceylon	20/10	10d.

and many other countries at varying rates.

NIGHT LETTER TELEGRAMS.

	Minimum 25 words	Each add. word
To New Zealand (Cable)	3/9	2d.
„ Suva (Cable)	5/10	3d.

WIRELESS TELEGRAMS.

To and from any ship registered in Australia or New Zealand, 6d. per word.

To British ships, 11d.; Finnish or Latvian, 8½d.; Swedish, 10d.; Spanish, 10d. per word.

To ships of Australian Navy, 4d.; of British Navy, 7d. All other ships, 11d. per word.

To Fiji, Suva, 6d.; Night Letters (25 words), 5/10; Levuka, 8d. per word. Night Letters (25 words), 7/4.

To Friendly Islands, 1/3; Ocean Island, 1/-; Tarawa, 1/6; Lord Howe Island, 1½d., minimum, 2/-; Nauru, 1/3; New Caledonia, 1/2; Apia, 1/3; Solomon Islands, 1/-; Union Island, 1/6; Willis Island, 3d. per word.

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 committted 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**, 1905-15.

2. Sections four, five and six of the **Wireless Telegraphy Act**, 1905, are amended by omitting the words "The Post master-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**, 1905-15 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

Unaer 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 therof 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 regulations 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 the 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.

COMMONWEALTH WIRELESS REGULATIONS

(Continued from Page 30.)

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.

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 whatsover 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.

COMMONWEALTH WIRELESS REGULATIONS

(Continued from Page 31.)

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.

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) 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 Rule 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.

Amendment of the Wireless Regulations Approved November 27, 1935.

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 apply 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 nor 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."

Amendments of Wireless Regulations, July 1, 1936.

1. Regulation 2 of the Wireless Telegraphy Regulations is amended by omitting the words "Part VI.—Proficiency Certificates for Operators and Watchers," and inserting in their stead the words "Part VI.—Certificates of Proficiency in Wireless Telegraphy."

2. Regulation 3 of the Wireless Telegraphy Regulations is amended—(a) by omitting the definition of "The International Convention for the Safety of Life at Sea," and inserting in its stead the following definitions:—'The Safety Convention' means the International Convention for the Safety of Life at Sea signed in London on the thirty-first day of May, 1929, and includes any Convention amending or superseding that Convention to which the Commonwealth is a party; the Telecommunication Convention' means the International Telecommunication Convention signed in Madrid on the ninth day of December, 1932, and includes any Convention amending or superseding that Convention to which the Commonwealth is a party"; (b) by omitting the definition of "The Secretary"

COMMONWEALTH WIRELESS REGULATIONS

(Continued from Page 32.)

and inserting in its stead the following definition:—" 'The Director-General' means the Director-General of Posts and Telegraphs"; and (c) by omitting the definitions of "International Telegraph Convention," the "International Telegraph Regulations," "The Radiotelegraph Convention" and "The Radiotelegraph Convention, 1912."

3. Regulation 4 of the Wireless Telegraphy Regulations is amended by omitting from sub-regulation (7) the word "Secretary" (wherever occurring), and inserting in its stead the word "Director-General."

4. Regulation 23 of the Wireless Telegraphy Regulations is amended by omitting the words "Radiotelegraphic Convention and the Service," and inserting in their stead the words "Telecommunication Convention and the."

5. Regulations 25, 27 and 37 of the Wireless Telegraphy Regulations are amended—(a) by omitting the words "International Telegraph Regulations" and "International Telegraphic Regulations" (wherever occurring) and inserting in their stead "Regulations under the Telecommunication Convention"; and (b) by omitting the words and figures "Radiotelegraphic Convention 1912" (wherever occurring) and inserting in their stead "Telecommunication Convention."

New Certificates.

6. Part VI. of the Wireless Telegraphy Regulations is repealed and the following Part insterted in its stead:—"Part VI.—Certificates of Proficiency in Wireless Telegraphy."

"126. A station (other than a Broadcast Listeners' Station) shall not be operated except by a person—(a) who holds such of the certificates referred to in this Part as is determined by the Postmaster-General or an authorised officer to be appropriate for that station; or (b) is qualified, to the satisfaction of the Postmaster-General or an authorised officer, to operate that station.

"127. (1) The Postmaster-General may issue certificates in accordance with Forms 11, 12, 13, 14 and 14a in the Schedule to these Regulations to persons who have reached the age of 18 years (or 15 years in the case of an Amateur Operator's Certificate of Proficiency) and who satisfy him, by examination or otherwise, that they possess the knowledge and qualifications referred to in those certificates respectively:

Provided that a First Class, Second Class or Third Class Commercial Operator's Certificate of Proficiency shall not be issued to a person who is not a British subject unless—(a) the consent in writing of the Minister for Defence has first been obtained; or (b) the Postmaster-General is satisfied that the circumstances justify the issue of a certificate as a matter of urgency, and any certificate issued under paragraph (b) of this proviso shall be in force in respect of one voyage only of a ship or aircraft upon which the holder of the certificate is to be carried.

"(2). In the event of a certificate being lost, the Postmaster-General may issue a duplicate certificate upon payment of the prescribed fee.

"(3). The fees specified in the Table contained in the Second Schedule to these Regulations shall be charged in connexion with—(a) the examination of candidates; (b) the issue of certificates without examination; and (c) the issue of duplicate certificates, under these Regulations.

"128. (1). The Director-General or an authorised officer may from time to time conduct examinations of applicants for certificates.

"(2). The examinations shall be held in such manner and subject to such conditions as the Director-General determines.

"129. The Examination for a First Class Commercial Operator's Certificate of Proficiency shall be such as to show that a successful candidate possesses the knowledge and qualifications specified in this regulation, namely:—(a) A knowledge of the general principles of electricity, of the theory of wireless telegraphy and wireless telephony, and of the regulation and practical working of the types of apparatus used in the mobile service. (b) A theoretical and practical knowledge of the working of the accessory apparatus used in the operation and adjustment of the apparatus referred to in paragraph (a) of this regulation. (c) The ability to effect, with the means available on board ship, repairs to damage which may occur to the wireless telegraph or wireless telephone installation during a voyage. (d) The ability to send correctly and to receive correctly, by ear, in Morse code, code groups at a speed of 20 groups per minute, and a message in plain language at a speed of 25 words per minute. (e) The ability to send and receive messages correctly by telephone. (f) A detailed knowledge of—(i) such of the Radiocommunication Regulations annexed to the Telecommunication Convention as relate to the exchange of radiocommunications and assessment of charges in the mobile service; and (ii) that portion of the Safety Convention which relates to radiotelegraphy. (g) A knowledge of the general geography of the world, especially the principal navigation routes and the most important cable, telegraph, wireless telegraphy and wireless telephony routes.

"130. The examination for a Second Class Commercial Operator's Certificate of Proficiency shall be such as to show that a successful candidate possesses the knowledge and qualifications specified in this regulation, namely:—(a) An elementary theoretical knowledge of elementary theoretical and practical knowledge of the adjustment and practical working of the types of wireless telegraph apparatus used in the mobile service. (b) An elementary theoretical and practical knowledge of the working of the accessory apparatus used in the operation and adjustment of the apparatus referred to in paragraph (a) of this regulation. (c) The ability to effect minor repairs to damage occurring to the apparatus referred to in paragraphs (a) and (b) of this regulation. (d) The ability to send correctly, and to receive correctly by ear, in Morse code, code groups at a speed of 16 groups per minute. (e) A detailed knowledge of—(i) such of the Radiocommunication Regulations annexed to the Telecommunication Convention as relate to the exchange of radiocommunications and the assessment of charges in the mobile service; and (ii) that portion of the Safety Convention which relates to radiotelegraphy. (f) A knowledge of the general geography of the world, especially the principal navigation routes and the most important cable, telegraph, wireless telegraphy, and wireless telephony routes.

"131. (1). A Third Class Commercial Operator's Certificate of Proficiency shall be issued in respect of proficiency in wireless telegraphy or wireless telephony.

"(2). The examination for a Third Class Commercial Operator's Certificate of Proficiency shall be such as to show that a successful candidate possesses the knowledge and qualifications specified in this sub-regulation, namely:—(a) In the case of an examination for a Third Class Commercial Operator's Certificate of Proficency in wireless telegraphy—(i) a practical knowledge of the working and adjustment of such type or types of wireless telegraph installation as is, or are, specified by the Director-General; (ii) ability to send correctly, and to receive correctly by ear, in Morse code, a message in plain language at a speed of 10 words per minute; (iii) a knowledge of the Radiocommunication Regulations annexed to the Telecommunication Convention relating to the exchange of radio-telegraph communications, to interference and to the Distress, Urgency, Alarm, and Safety Signals; and (iv) a knowledge of the precautions necessary for the safety of the installation referred to in sub-paragraph (i) of this paragraph. (b) In the case of an examination for a Third Class Commercial Operator's Certificate of Proficiency in wireless telephony—(i) a practical knowledge of the working and adjustment of such type or types of wireless telephone installation as is, or are, specified by the Director-General; (ii) ability to send

COMMONWEALTH WIRELESS REGULATIONS

(Continued from Page 33.)

and receive correctly messages by telephone; (iii) a knowledge of the Radiocommunication Regulations annexed to the Telecommunication Convention relating to the exchange of radiotelephone communications, to interference and to the Distress, Urgency, Alarm, and Safety Signals. (iv) a knowledge of the precautions necessary for the safety of the installation referred to in sub-paragraph (i) of this paragraph. (c) In the case of an examination for a Third Class Commercial Operator's Certificate of Proficiency in both wireless telegraphy and wireless telephony—the knowledge and qualifications specified in paragraphs (a) and (b) of this sub-regulation.

"132. The examination for a Broadcast Station Operator's Certificate of Proficiency shall be such as to show that a successful candidate possesses the knowledge and qualifications specified in this regulation, namely:—(a) A knowledge of the general principles of electricity and of radio-technology and of all the electrical and wireless telephony equipment used by broadcasting stations. (b) A practical knowledge of the working and adjustment of all apparatus normally used by broadcasting stations. (c) Ability to adjust and carry out repairs to the apparatus referred to in the last preceding paragraph of this regulation. (d) A knowledge of the provisions of Division 1 of Part III. of these regulations.

"133. The examination for an Amateur Operator's Certificate of Proficiency shall be such as to show that a successful candidate possesses the knowledge and qualifications specified in this regulation, namely—(a) An elementary knowledge of wireless telegraphy and wireless telephony and electrical principles. (b) A knowledge of —(i) such of the Radiocommunication Regulations annexed to the Telecommunication Convention as relate to the operation of experimental stations; (ii) the principal abbreviations set out in Appendix 9 of those Regulations; and (iii) Part IV. of these Regulations. (c) Ability to send correctly, and to receive correctly by ear, in Morse code, a mesasge in plain language at a speed of 12 words per minute.

"134. The Postmaster-General may cancel or suspend any certificate issued under this Part—(a) if the holder of the certificate is convicted of a criminal offence; or (b) if the Postmaster-General is of the opinion, on account of the incompetence of the holder of the certificate or for any other reason, that it is desirable that the certificate should be cancelled or suspended.

"135. The Postmaster-General may at any time, by notice in writing, require the holder of a certificate issued under this Part to satisfy him, by examination or otherwise, within the time specified in the notice that he possesses the knowledge and qualifications referred to in the certificate. If the holder fails so to satisfy the Postmaster-General, the Postmaster-General may, by notice published in the "Gazette," cancel the certificate.

"Second Schedule," Regulation 127.

TABLE OF FEES AND CLASS OF CERTIFICATE.

	£	s.	d.
For examination for First Class Commercial Operator's Certificate of Proficiency	£1	0	0
For examination for Second Class Commercial Operator's Certificate of Proficiency		15	0
For examination for Third Class Commercial Operator's Certificate of Proficiency		10	0
For examination for Broadcast Station Operator's Certificate of Proficiency		15	0
For examination for Amateur Operator's Certificate of Proficiency		7	6
For the issue of any certificate without examination		2	6
For the issue of a duplicate certificate where original lost		2	6

Australian Radio Research Board

8th Annual Report for the Year Ended 30th June, 1936

THE Radio Research Board of the Council for Scientific and Industrial Research 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). Its previous annual report was published in this journal (Vol. 8, No. 4, November, 1935).—Ed.

General

During the period under review, the investigations of the Board were concentrated on (i) propagation problems, which in turn involved studies of conditions in the ionosphere, and (ii) atmospherics. The last year's operations constitute the third year's activities of the three-year programme towards the cost of which, as mentioned in the last report, the Postmaster-General's Department and the Council for Scientific and Industrial Research are contributing on a 3:1 basis. Arrangements have been made for a continuation of the work on the same basis.

Still further changes in the staff of the Board have taken place. Dr. A. L. Green resigned in September, 1935, to take up an industrial appointment, and Mr. R. W. Boswell resigned in April, 1936, to join the staff of the Research Section of the Postmaster-General's Department. The vacancy left by Dr. A. L. Green has recently been filled by the appointment of Dr. D. M. Myers, a graduate of the University of Sydney, who for the last few years has been obtaining further research experience in Great Britain. He will reach Australia in about October, 1937, and will be located at the University of Sydney. Mr. A. F. B Nickson and Mr. F. G. Nichols have been appointed on a part-time basis to carry out much of the atmospherics work previously undertaken by Mr. Boswell.

Work on Fading and the Ionosphere

Since practically all radio communication on wavelengths below 100 metres is by reflection from one or other of the reflecting layers of the ionosphere, the direct importance of a knowledge of the diurnal and seasonal changes of conditions in these regions is obvious.

In addition, the radio methods developed for ionospheric observation enable many deductions to be made concerning the nature, pressure, temperature, and ionisation of the gases present in the region between 50 and 250 k.m. above the earth—matters which are of great importance to the meteorologist.

The work of the Radio Research Board in this sphere is centred in the University of Sydney, and its progress has been, technically, towards ever-increasing accuracy and comprehensiveness of the information obtained, combined with careful and exhaustive examination of all data as they become available so as to trace out all the implications. Considerable advances have been made both in technique and theory during the last twelve months.

RADIO RESEARCH BOARD — ANNUAL REPORT

(Continued from Page 34.)

The frequency-change method of investigation which has been in use for several years has served a very useful purpose, but it has two main disadvantages. It is prodigal in labour and materials for the amount of information obtained, and the records become very difficult to interpret if multiple echoes are present, as is very frequently the case on wavelengths below 200 metres.

The first disadvantage has been largely obviated by a modified arrangement in which a faster frequency-change is employed and the resultant fringe pattern appears on the screen of a cathode-ray tube. Its appearance and changes can thus be observed directly and photographed when necessary.

For the separation of multiple echoes, however, some form of the pulse method is preferable, and this system has been developed and improved to a very advanced stage. The first type of apparatus makes a continuous record, on motion picture film, of the time delay in arrival of all echoes on any one wavelength. From this record, the heights of the reflecting layers can be deduced. For this work, transmitters have been constructed to send out pulses of very short duration at regular intervals, and special receivers and recording apparatus designed and brought into use. Modifications at the receiver enable the intensities of the echoes also to be measured; some additional information is thus obtained.

The next advance was to enable the transmitter and receiver to be varied rapidly through a large range of frequencies so that the range of frequencies reflected by each layer can be determined at any time. From the frequency which penetrates a layer, the ionisation density can be deduced. In the earlier apparatus, the frequency change was by steps, but in the latest equipment it takes place continuously and automatically. Incidentally, the records obained give direct information as to the best frequencies for transmission at given times.

A further advance, in this case an original development, is a receiving system which combines most of the merits of the frequency-change and pulse methods. In this system, each echo produces on the cathode-ray tube screen an ellipse which indicates the intensity and state of polarisation, including the sense of rotation. The apparatus now in use is therefore capable of giving very comprehensive data on ionospheric conditions.

The examination of data obtained has already led to important deductions concerning the constitution of, and conditions in, the ionosphere. Further, the information obtained from the radio work has enabled order to be found in what hitherto appeared to be conflicting results from other sources of evidence such as meteor trails, aurorae, and luminous night clouds. The results of these considerations have been embodied in a paper read before the Royal Society in London (see Proc. Roy. Soc. A., 154; 755, 1936). A further paper embracing more recent results is in preparation.

Briefly, the work done to date has led to the following findings:—

The F region of the ionosphere is found to be at temperatures of the order of 1,000 deg. C. These high temperatures exist both in summer and winter, although during winter nights a limited amount of cooling occurs.

The high temperatures thus found are attributed mainly to the absorption of solar ultra-violet light by ozone, which is present in a concentration of about 1 in 10,000. The cooling occurring on a winter night is attributed to radiation by water vapor in a concentration of 1 in 6,000.

The atmosphere is found to be almost completely mixed at the level of the ionosphere, and consists mainly of molecular nitrogen and atomic oxygen.

It is found that the free electrons in the ionosphere disappear by attachment to neutral oxygen particles very quickly, so that none would be present a few minutes after sunset but for the presence of a counterbalancing detaching agent. This agency is found to be the energy of recombining into molecular oxygen. The high energy electrons thus liberated are able to excite the green line spectrum of the night sky. These views are supported by consideration of Lord Rayleigh's measurements of the absolute intensity of the green line, and of its seasonal and diurnal variations, which follow closely the corresponding variations of ionisation in the F region.

Consideration of the temperatures below the 100 kms. level shows a maximum temperature of 175 deg. C. at 60 kms., and a minimum of minus 113 deg. C. at 82 kms. The low temperature at this level, in conjunction with the presence of water vapour, permits the separation of ice crystals, thus giving rise to luminous night clouds.

The ionisation densities in the E and F regions are found to correlate directly, and the height of the F region indirectly, with the barometric pressure at the ground. This correlation is attributed to the temperature changes occasioned by changes in ozone concentration.

In addition to the direct work of the Board's officers, some useful combined work with kindred branches of the University of Sydney has resulted. The assistance of Professor V. A. Bailey, of the Department of Physics, was mentioned in the previous report, particularly in connection with his paper on the influence of electric waves on the ionosphere and the Luxemburg effect.

Mr. Godfrey, in collaboration with Mr. W. L. Price, of the Sydney Technical College, following up a line suggested by Dr. Martyn, has developed some interesting mathematical results concerning temperatures in the upper atmosphere which he has embodied in a paper entitled, "Radiation Equilibrium above 200 kilometres in the upper atmosphere," which he presented to the Conference of Australian physicists which met in Sydney in May, 1936. Following on some work of the Board's officers, Mr. R. N. Morse has developed a new method of investigating transient phenomena in electrical circuits.

A good deal of special auxiliary apparatus has been developed in the course of the year's work, e.g.,

- A temperature-compensated low-frequency oscillator of very good frequency stability.
- A new type of harmonic analyser.
- A new type of calibrator for C.R.O. time scales.
- Thyratron time bases.

Work on Atmospherics

The close connection found between moving sources of atmospherics and cold fronts over the Australian Bight in the summer of 1934-5 suggested a continuation of the work, to determine the value of atmospherics direction-finders for weather forecasting, especially for south-eastern Australia. The Commonwealth Weather Bureau has kindly agreed to co-operate in this work, and the joint programme has been in operation since August, 1935. It is proposed to continue it for one year from that date.

A narrow-sector directional recorder has been installed at Hobart and has been in operation since October, 1935. Further adjustments have been made to the Watheroo and Canberra recorders, so that it is now possible to locate most of the major sources of atmospherics over the Australian Bight, south-eastern Australia, and the

RADIO RESEARCH BOARD — ANNUAL REPORT

(Concluded.)

Tasman Sea over the whole 24 hours. (Cathode-ray direction-finders, at Laverton and Canberra, are still operated in the daytime.) The meteorological analysis is carried out entirely by the Weather Bureau.

In contrast to the previous spring and summer, few sources were observed in the Australian Bight, and few of these persisted more than 24 hours and moved across south-east Australia. It thus appears that during the year under review the majority of cold fronts over the Australian Bight were unaccompanied by (sea) thunderstorms, so that the number of occasions when information of possible use for forecasting was obtained was small. More sources were observed over the Tasman Sea, which suggests that the method may on occasions be of more value for New Zealand weather forecasting.

In assessing the usefulness of the method for forecasting, it is even more important to know what percentage of sea sources are associated with well-marked fronts. An entirely suitable criterion of "association" is lacking, but, judging from proximity (allowing for errors in location), between 50 and 60 per cent. of sea sources appear to be associated with well-marked fronts, mostly cold fronts, for the Australian Bight and Tasman Sea south of 30 deg. S. The analysis of some earlier data has shown that the percentage is considerably lower for more northerly sea areas. Final conclusions have not yet been reached.

Another aspect of this investigation is the possibility of thunderstorm warnings to aircraft, particularly on air routes over sea. On a few occasions, it has been possible to communicate useful information to Essendon (Melbourne) aerodrome regarding the location of thunderstorms near air routes. This information has always been derived from cathode-ray direction-finders, and it would appear that the most promising application of the method is in the use of cathode-ray direction-finders for the combined purpose of locating the position of the aeroplane and of thunderstorms.

An investigation has been commenced with the object of determining the total energy radiated (in the "radio" portion of the spectrum) by the average lightning flash. The necessary apparatus is still under construction and involves the putting together of a special amplifier to give constant amplification over a very wide range of frequencies. In addition to the total energy radiated, it is hoped to obtain some additional information regarding the wave-form of atmospherics, on which subject some discrepancies appear to exist between the results of previous investigations.

Publications

The following publications have been made during the past year as a result of the investigations carried out by the officers of the Board and by independent investigators who have been closely associated with these officers.

(a) Publications of the Council for Scientific and Industrial Research.

1. Bulletin 95.—"Radio Research Board: Report No. 9." (1) "A Study of the Magneto-Ionic Theory of Wave Propagation by Means of Conformal Representation," by V. A. Bailey, M.A., D.Phil., F.Inst.P. (2) "Disperson 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., F.Inst.P. (3) "A Temperature-Compensated Dynatron Oscillator of High Frequency Stability," by J. H. Piddington, B.Sc., B.E. (4) "The Amplification of Programme Transients in Radio Receivers," by Geoffrey Builder, Ph.D., F.Inst.P. (5) "A Multi-Range, Push-Pull, Thermionic Voltmeter," by Geoffrey Builder, Ph.D., F.Inst.P. (6) "The Graphical Solution of Simple Parallel-Tuned Circuits," by Geoffrey Builder, Ph.D., F.Inst.P. (7) "An Electrical Harmonic Analyser of the Fundamental Suppression Type," by J. H. Piddington, B.Sc., B.E.

2. Bulletin 100—"Radio Research Board: Report No. 10." (1) "A Directional Recorder for Atmospherics," by W. J. Wark, M.Sc., R. W. Boswell, M.Sc., and H. C. Webster, Ph.D., F.Inst.P. (2) "Observations of Atmospherics with a Narrow Sector Directional Recorder at Canberra," by G. H. Munro, M.Sc., A.M.I.E.E., W. J. Wark, M.Sc., and A. J. Higgs, B.Sc. (3) "Characteristics and Distribution of Sources of Atmospherics," by G. H. Munro, M.Sc., A.M.I.E.E., W. J. Wark, M.Sc., and A. J. Higgs, B.Sc. (4) "Sources of Atmospherics Over the Tasman Sea," by R. W. Boswell, M.Sc.

(b) Other Publications

1. "Interaction of Radio Waves," by V. A. Bailey, M.A., D.Phil., and D. F. Martyn, Ph.D., A.A.C.Sc. Nature, 135, 585, 1935.

2. "A Receiver Discriminating between Right- and Left-handed Circularly Polarised Wireless Waves," by O. O. Pulley, Ph.D., B.E. Phys. Soc. 47, 1098, 1935.

3. "Modulation Frequency-Change Technique for Ionaspheric Measurements," by Geoffrey Builder, Ph.D., F.Inst.F., and A. L. Green, Ph.D. Phys. Soc. (6), 47, 1925.

4. "The Delineation of Selectivity Curves," by W G. Gordon, B.Sc., Rad. Rev., Nov., 1935.

5. "Aircraft Radio Communication and Navigation," by H. B. Wood, B.Sc., B.E., Rad. Rev., Sept., 1935.

6 "Design of a Simple Linear Time-Base for the Cathode Ray Oscillograph," by O. O. Pulley, Ph.D., B.E., and A. H. Mutton, Rad. Rev., November, 1935.

7. "Wireless Direction-Finding and its Application," by G. H. Munro, M.Sc., A.M.I.E.E., Australasian Engineer, August, 1925.

8. "The Ionosphere and its Influence upon the Propagation of Radio Waves," by J. P. V. Madsen, B.E., D.Sc., Macrossan Lectures, University of Queensland, 1935.

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, at the commencement 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. This work is still in progress.

Commonwealth & State Taxes

COMMONWEALTH INCOME TAX.

Income of year ended 30-6-'34 (or substituted accounting period).

EXEMPTIONS.

Personal Exertion:—£250, diminishing at the rate of £1 for every £2 by which the income exceeds £250, and disappearing at £750. The deduction is allowed first against property income.

Property:—£200, diminishing at the rate of £1 for every £2 by which the income exceeds £200, and disappearing at £600.

The above exemption is not allowed to absentees or companies.

RATES OF TAX.

First Schedule.

Personal Exertion:—85% of 3d. plus 1/160d. for each £ of taxable income up to £6,900.

Example:—Taxable incomes £240, the rate is therefore—

$$\frac{85}{100}\left(3 + \frac{240}{160}\right) = 3.825\text{d.}$$

and the tax £240 × 3.825 = £3 16s. 6d.

When the taxable income exceeds £6,900 all in excess of that amount is taxed at a rate of 76.5d. in the £.

Example:—Taxable income, £7,700

Tax is £6900 @ $\frac{85}{100}\left(3 + \frac{6900}{160}\right) = 39.20625 =$ £1127 3 7

£800 @ 76.5d. = 255 0 0

Total £7700 — £1382 3 7

SECOND SCHEDULE.

Property:—If taxable income does not exceed £500.

$$3\text{d.} + \frac{1\text{d.}}{100}$$

for each £ of taxable income.

Example:—Taxable income, £250.

$$\text{Rate} = 3\text{d.} + \frac{250\text{d.}}{100} = 5\tfrac{1}{2}\text{d.}$$

If the taxable income exceeds £500, but does not exceed £1,500—

$$1\text{d.} + \frac{14\text{d.}}{1000}$$

for each £ of taxable income.

Example:—Taxable income £1,000. Rate = 15d.

If the taxable income exceeds £1,500, but does not exceed £3,700—

$$4\tfrac{3}{4}\text{d.} + \frac{23\text{d.}}{2000}$$

for each £ of taxable income.

If the taxable income exceeds £3,700, rate of tax on the first £3,700 is as above, viz:—

$$4\tfrac{3}{4} + \frac{3700 \times 23}{2000}$$

on each £ in excess of £3,700 the rate is 90d.

For both personal exertion and property the rate is that appropriate to the average taxable income of not more than 5 years.

SPECIAL TAX.

Subject to an exemption of £250 allowed to "Residents," there is a special tax of 6% payable upon the net income derived from:—

(a) Property.

(b) Interest, dividends, rents or royalties whether derived from personal exertion or property.

When a company pays such tax upon any income which is subsequently distributed to a shareholder, the sharheholder is not liable for special tax in respect thereof.

Example:—

(1) Nil payable upon £250 quoted in first example of Second Schedule.

(2) Net income from property £1,000.

Tax.—Ordinary Property,
1,000 @ 15d. . £62 10 0
Special tax,
750 @ 12d. . 37 10 0

£100 0 0

THIRD SCHEDULE.

Income partly from Personal Exertion and Property Income.

The rate for each class of taxable income would be the appropriate rate applicable to the total of the two classes of taxable income.

Example:—

Taxable Personal Exertion Income	£250
Taxable Property Income ..	300
	£550

The £250 Taxable Personal Exertion income is taxable at the rate appropriate to a Personal Exertion income of £550, similarly the £300 Taxable Property income is taxable at the rate appropriate to a Property income of £550.

FOURTH SCHEDULE.

Rate of Tax Payable by a Trustee.

For every £1 of the taxable income in respect of which a Trustee is liable to be separately assessed, and to pay tax, the rate of tax shall be the rate which would be payable under the First, Second, or Third Schedules, as the case requires if one individual were liable to be separately assessed and to pay tax on that taxable income.

FIFTH SCHEDULE.

Rates of Tax Payable by a Company.

(a) Subject to the Fourth Schedule, for every pound of the taxable income of a Company, the rate of tax shall be 12 pence.

(b) For every pound of interest paid or credited by the Company to any person who is an absentee in respect of debentures of the Company or on money lodged at interest with the Company by such person, the rate of tax shall be 12 pence.

SIXTH SCHEDULE.

Rate of Tax Payable by an Individually Owned Partnership.

Individually owned partnerships other than Trusts which are partnerships.

For every pound of the taxable income of an individually owned partnership, the rate of tax shall be determined as follows:—

(a) From the total amount of tax which would be payable by the member specified under sub-section (2) of section twenty-nine of the **Income Tax Assessment Act,** 1922-1934, if the taxable income of the partnership were added to his own taxable income, subtract the amount of tax actually payable by him in respect of his own taxable income; and

(b) Divide the amount obtained by the application of the last preceding paragraph by the number of pounds in the taxable income of the partnership.

Trusts which are individually owned partnerships.

For every pound of the taxable income of a trust which is an individually owned partnership, the rate of tax shall be determined as follows:—

(a) From the amount of tax which would be payable by the person by whom the trust was created if the taxable income of the partnership were added to his own taxable income, subtract the amount of tax actually payable by him in respect of his own taxable income; and

(b) Divide the amount obtained by the application of the last preceding paragraph by the number of pounds in the taxable income of the partnership.

SEVENTH SCHEDULE.

Rate of Tax Payable by a Severally Owned Partnership.

For every pound of the taxable income of a severally owned partnership, the rate of tax shall be determined as follows:—

(a) Compute the total of the amounts of tax that would be payable by the several members specified under sub-section (2) of section twenty-nine of the Income Tax Assessment Act, 1922-1934, if the severally owned partnership were a partnership (other than a severally owned partnership) between those members with equal interests;

COMMONWEALTH INCOME TAX (Continued.)

(b) from the total tax obtained by the application of the last preceding paragraph subtract the total of the amounts of tax actually payable by those several members on their own taxable incomes; and

(c) Divide the difference obtained by the application of the last preceding paragraph by the number of pounds in the taxable income of the partnership.

COMMONWEALTH ESTATE DUTY.

Upon Estates of Deceased persons:
Under £1,000, exempt.
From £1,001 to £2,000, 1 %.

Over £2,000, 1% with an additional one-fifth% for every £1,000 or part of £1,000 above that amount, maximum duty 15%.

A rebate of six shillings and eightpence % allowed on the portion of the Estate bequeathed to widow, children, or grand-children of the deceased.

Consolidated and Inscribed Stock (3¾ and 4%) are accepted at face value for the payment of these Duties, Interest upon the Bonds or Inscribed Stock is allowed up to the due date of such Duties, or date of payment, which ever is the earlier.

STATE INCOME AND LAND TAXES.

QUEENSLAND.—INCOME TAX.

When net income of a taxpayer domiciled in Queensland does not exceed £640, an allowance is made of £60 for each child under 16 years and each invalid child, and £72 for wife. In the case of a widower, £72 for any female relative who may reside with him for the purpose of caring for any child under 16 or invalid child. £60 for mother if she resides in Queensland and is wholly maintained by taxpayer. A further allowance up to £50 for expenses actually incurred in education of each child under 16 years of age where it is proved to the satisfaction of the Commissioner that suitable educational facilities are not provided by the State within reasonable daily travelling distance of the place of residence of the taxpayer. Medical expenses are allowed when net income does not exceed £900, including dividends.

The amount of £150 (statutory exemption) shall be exempt when income does not exceed £253. When the income is £254 the exemption is £149, and the exemption is reduced by £1 for each four pounds of income in excess of £254, but no exemption is allowed on net incomes of £850 or over.

The allowance for dependents diminishes:—If the net income exceeds £640, the allowance of £60 diminish by £1 for every six pounds by which the income exceeds £640, and £1 in each five pounds in respect of the £72 for dependents by which his income exceeds £640. The allowance is further reduced by the amount of any net income whatsoever of which the dependent is in receipt.

Personal Exertion:—For each £ up to £8,000, sixpence plus as many times 6/1000d. as there are pounds in the income. Over £8,000, fifty-four pence for the first £8,000, and sixty pence in £ on remainder.

Income from Property, and all Incomes of Absentees:—For each £ up to £3,000, one shilling plus as many times 4/1000d. as there are pounds in the income. From £3,000 to £8,000, sixpence plus as many times 6/1000d. as there are pounds in the income. Over £8,000, fifty-four pence for the first £8,000 and sixty pence in £ on remainder.

Companies, not being public utility or monopoly companies, or foreign companies, as prescribed in the Act:
If profits do not exceed 6 per cent.—21 pence in £.
6 per cent to 7 per cent.—24 pence in £.
7 per cent. to 8 per cent.—27 pence in £.
8 per cent. to 9 per cent.—30 pence in £.
9 per cent to 10 per cent.—33 pence in £.

Increasing 3d. in £ for each additional 1 per cent. up to 19 per cent., which is 60 pence in £.

Exceeding 19 per cent., which is 60 pence in £.

Public Utility or Monopoly Companies:—
If profits do not exceed 6 per cent.—21 pence in £.
6 per cent. to 7 per cent.—27 pence in £.
7 per cent. to 8 per cent.—33 pence in the £.
8 per cent. to 9 per cent.—39 pence in £.
9 per cent. to 10 per cent.—45 pence in £.

Increasing sixpence in £ for each additional 1 per cent up to 16 per cent., which is 81 pence in £. Exceeding 16 per cent.—87 pence in £.

Foreign Companies (not being Public Utility Companies or Monopoly Companies) under sections 14, 16 and 17 of the Act, viz., Fire, Accident, Fidelity, Guarantee, or Marine Insurance Co., assessed on 25 per cent. of the Premiums.—39 pence in £. Banking Companies.—48 pence in £.

Mutual Life Assurance Companies, where all profits are divided amongst Policy Holders.—28d. in £ of taxable income. Life Assurance Companies in which both Policy Holders and Shareholders participate in profits.—(a) 28d. in £ on so much of the taxable income as bears the same proportion of the taxable income as the profits divided for the same year among Policy Holders bear to the total profits of the Company; (b) on remainder of taxable income, 39d. in £.

Super Tax.—20 per cent. A person who derives his income from sources in Queensland during part only of the year whose taxable income does not exceed £250, is not liable to pay any super tax.

Additional Tax (except Absentees and Companies):—

Taxable Income:	£780	to	£849	15%
,, ,,	850	,,	899	16%
,, ,,	900	,,	949	18%
,, ,,	950	,,	999	20%
,, ,,	1000 and over			27½%

Additional Tax (Absentees): 27½%.

Lotteries 5 per cent. of selling price of tickets with a minimum of 3d.

QUEENSLAND UNEMPLOYED RELIEF TAX.

Income from Employment up to £78 p.a., exempt. £78 to £104, 2d. in £; £104 to £208, 5d. in £; £208 to £499, 8d. in £; exceeds £499, 11d. in £. Other income, average rate:—Up to £104, 2¼d. in £; £104 to £208, 5¼d. in £; £208 to £499, 8¼d. in £; exceeds £499, 11¼d. in £.

Where total taxable income of any person (not being a company or absentee) does not exceed £78 p.a., exempt.

Super Tax:—On taxable value up to £2,499, nil; £2,500 to £2,999, 1d. in £; £3,000 to £3,999, 1½d. in £; £4,000 and over, 2d. in £.

Mutual Life Assurance Society.—On taxable value up to £2,499, nil; £2,500 and over, 1d. in £.

NEW SOUTH WALES.—INCOME TAX.

For the year ended 30th June, 1935 (or substituted accounting period).

Exemptions: — Resident persons, £250, less £1 for every £8 by which net income exceeds £250.

Non-Resident persons.—£50, less £1 for every £8 by which net income exceeds £50. Minimum tax, 10/-.

Companies.—Nil.

FIRST SCHEDULE.

Rates of Tax.

Personal Exertion:—Taxable incomes up to £7,000:—

$$\frac{85}{100}$$

$$7 \text{ plus } \left(\frac{\text{Taxable income}}{250} \right) \text{ pence.}$$

Taxable incomes exceeding £7,000:

$$£7{,}000 \ @ \ \frac{85}{100} \times 35 \text{ pence.}$$

$$\text{Balance } @ \ \frac{85}{100} \times 60 \text{ pence.}$$

Example:—Taxable income £1,000.

$$\text{Rate } \frac{85}{100}$$

$$\left(7 \text{ plus } \frac{1000}{250} \right) \text{ pence} = 9.35 \text{ pence.}$$

£1,000 × 9.35 in £ = £38 19 2 amount of tax.

SECOND SCHEDULE.

Property:—Taxable incomes up to £5,500:—

$$\frac{85}{100}$$

N.S.W. INCOME TAX (Continued.)

$$9 \text{ plus } \left(\frac{\text{Taxable income}}{500} \right) \text{ pence.}$$

Taxable incomes exceeding £5,500:

$$£5{,}500 \ @ \ \frac{85}{100} \times 42 \text{ pence.}$$

$$\text{Balance } @ \ \frac{85}{100} \times 60 \text{ pence.}$$

Example:—Taxable income £1,000:

$$\text{Rate } \frac{85}{100}$$

$$\left(9 \text{ plus } \frac{1000 \times 3}{500} \right) = 12.75 \text{ pence.}$$

£1,000 × 12.75 in £ = £53/2/6 amount of tax.

THIRD SCHEDULE.

Incomes derived partly from personal exertion and partly from property.

The two amounts are added together and each portion is charged with the rate payable on the gross amount.

Example:—Taxable income £1,000, consisting of £500 personal exertion and £500 property:—

£500 @ 9.35 in £	=	£19 9 7
£500 @ 12.75 in £	=	£26 11 3
Amount of tax		£46 0 10

FOURTH SCHEDULE.

Rate of tax payable by a Trustee:—For every £ of taxable income for which a trustee is liable to be separately assessed, the rate shall be that payable under First, Second and Third Schedules, as the case requires if one individual were liable to be separtely assessed.

FIFTH SCHEDULE.

(1) On the Taxable income of a company registered in N.S.W., the undernoted rates:—

Up to £500			1/9 in £
Exceeds £500	up to	£1000 .	1/10 ,,
,, £1000	,,	£1500 .	1/11 ,,
,, £1500	,,	£2000 .	2/- ,,
,, £2000	,,	£2500 .	2/1 ,,
,, £2500	,,	£3000 .	2/2 ,,
,, £3000	,,	£3500 .	2/3 ,,
,, £3500	,,	£4000 .	2/4 ,,
,, £4000	,,	£4500 .	2/5 ,,
,, 4500 and over			2/6 ,,

(2) Mutual Life Assurance Company, 1/6 in £.

(3) Life Assurance Company (other than mutual company) upon the profits of life assurance business distributed to shareholders, 1/6 in £. Upon remainder of profits, 2/6 in £.

(4) Company not registered in New South Wales, 2/6 in £ on the whole of taxable income.

(5) In addition to any other Income Tax payable by it, a company shall also pay 1/6 in £ or interest paid or credited by the company to any non-resident person or foreign company on debentures used in the State or money lodged at interest with the company in the State.

ENTERTAINMENT TAX.

Admission.—1/6½ to 1/11½, ½d.; 2/-, 1d.; 2/0½ to 2/6, 1½d.; and ½d. for each 6d. thereafter.

SPECIAL INCOME AND WAGES TAX.

(As from 1st January, 1936).

On Salaries, Wages, Commission, etc. Employers are required to deduct tax from all employees of £2 or more per week. (Board and Lodgings to be included as £1 per week).

£2 0 0	to	£2 10 0	6d.
2 10 1	,,	3 0 0	9d.
3 0 1	,,	3 10 0	1/3
3 10 1	,,	3 12 5	1/6
3 12 6	,,	3 14 11	1/7
3 15 0	,,	3 17 5	1/8
3 17 6	,,	3 19 11	1/9
4 0 0	,,	4 1 11	1/11
4 2 0	,,	4 3 11	2/-
4 4 0	,,	4 5 11	2/2
4 6 0	,,	4 7 11	2/3
4 8 0	,,	4 9 11	2/5
4 10 0	,,	4 11 11	2/6
4 12 0	,,	4 13 11	2/8
4 14 0	,,	4 15 11	2/9
4 16 0	,,	4 17 11	2/11
4 18 0	,,	4 19 11	3/-
5 0 0			3/2

and one penny extra for each additional 2/- thereafter.

Where employees are paid other than weekly the rate is:—

(a) Fortnightly, £4 to £5, tax 1/-.

(b) Fortnightly, £5/0/1 to £6, tax 1/6 etc.

SPECIAL INCOME TAX.

Resident.—On incomes from all sources other than (1) Income from employment; (2) from Australian Consolidated Loans; (3) From a business outside New South Wales (not shareholders' dividends).

Non-Resident.—On incomes from all sources in New South Wales other than income from employment.

By a Reciprocal Agreement with Victorian Government, residents of Victoria are not assessable upon income derived from N.S.W.

Exemption:—No tax is payable by a person, other than a company, resident in N.S.W., whose total income from all sources is £100 or less. No exemption allowed when total exceeds £100.

	On the first £100 of Net Assessable Income	On the Second £100	On the Balance
(a) £101 to £156 ..	4½d in £	8d in £	—
(b) £157 to £200 .	5d ,,	8d. ,,	—
(c) £201 to £250 .	5½d ,,	8d. ,,	10d in £
(d) Exceeding £251	6d. ,,	8d. ,,	10d ,,

VICTORIA.—ORDINARY INCOME TAX.

Individuals.—The minimum income subject to tax is £201. £200 deduction is allowed upon individual incomes between £201 and £500, after which it diminishes at the rate of £4 for every £1 above £500, finally disappearing at £550. No deduction is allowed to companies.

Personal exertion, not exceeding £500, 6d.; property, 12d. in the £. Exceeding £500:—First £500—Personal exertion, 7d.; property, 14d. in the £; second £500—Personal exertion, 8d.; property, 16d. in the £; third £500—Personal exertion, 9d.; property, 18d. in the £; balance over £1,500—Personal exertion, 10d.; property, 20d. The above rates are subject to a Super Tax of 7½ per cent.

Additional Tax.—Where the income exceeds £800, whether from Personal Exertion or from Property, or from Personal Exertion and Property combined:—

£ 801 to £1,000	..	10%	additional.
£1,001 to £1,250	..	12½%	,,
£1,251 to £2,200	..	15%	,,
£2,201 to £5,000	..	20%	,,
£5,001 upwards	..	25%	,,

Special Income Tax:—

£101 to £1,000	per £100	.. ..	6/-
1,001 ,, 1,250	,,	.. ..	7/-
1,251 ,, 1,750	,,	.. ..	8/-
1,751 ,, 2,000	,,	.. ..	9/-
2,001 ,, 2,500	,,	.. ..	11/-
Over 2,500	,,	.. ..	12/6

Companies.—22.575 pence in every £1 of taxable income. (Mutual Life Assurance Companies, 1/- in £1 on Life Assurance business).

SOUTH AUSTRALIA.—INCOME TAX.

Exemption, £100, diminishing £1 for every £9 by which the net income exceeds £100, plus £30 for wife and £30 for each dependent child or grand-child under 16. The wife and child deductions are not allowable if the net income exceeds £650. Wife who wholly maintains her husband, £30, provided the husband is not in receipt of income of £50 or over. No exemption to companies and absentees.

Widow with one or more dependent children under 16 is allowed exemption of £200.

A widower, whose income is under £650 and has one or more dependent children under 16 years, may claim £30 as if his wife were living.

An unmarried taxpayer, whose income is under £650, and who wholly or mainly supports a parent or brother or sister under 16 years, is allowed deduction of £30 inrespect of each dependent.

Personal Exertion.—(Except income of Unmarried Adults) up to £1,000, eighteen pence plus two one-thousandths of a penny for the first £, increasing by two one-thousandths of a penny for each additional £.

From £1,000 to £7,000, twenty pence, plus six one-thousandths of a penny in £ for that portion exceeding £1,000.

S.A. INCOME TAX
(Continued.)

Exceeding £7,000, fifty-six pence in £.

Unmarried Adults (other than returned soldiers, army nurses and widowers with children).—Up to £1,000, twenty-seven pence in £. From £1,000 to £7,000, twenty-seven pence, plus six one-thousandths of a penny in £ for that portion in excess of £1,000.

Exceeding £7,000, sixty-three pence in £.

Property Income (except incomes of Unmarried Adults).—Up to £1,000, twenty-seven pence in £. From £1,000 to £7,000, twenty-seven pence plus six one-thousandths of a penny in £ for that portion in excess of £1,000.

Exceeding £7,000, sixty-three pence in £.

Unmarried Adults (other than returned soldiers, army nurses and widowers with children).—Up to £1,000, thirty-two pence in £. From £1,000 to £7,000, thirty-two pence, plus six one-thousandths of a penny for that portion in excess of £1,000. Exceeding £7,000, sixty-eight pence in £.

In the 1934 Act it is provided that where an unmarried adult person (other than a returned soldier, army nurse, or widower with children) resident in the State had a parent, or a brother or sister under sixteen years of age at the commencement of the period for which the income is computed wholly or mainly dependent upon his earnings during the whole of that period, the rates of tax on income derived by him from personal exertion shall in all circumstances be less by sixpence in the pound than the rates fixed for an unmarried adult person. This provision applies to income derived in the year ended 30th June, 1934.

In the 1935 Act it is provided that where an unmarried adult person (other than a returned soldier, army nurse, or widower with children) resident in the State had a parent, or a brother or sister under sixteen years of age at the commencement of the period for which the income is computed, wholly or mainly dependent upon his earnings during the whole of that period, the rates of tax on income derived by him from personal exertion shall be at the same rates as those fixed for a married person.

Composite Incomes (whether derived by an unmarried or married taxpayer).—Where income is derived partly from Personal Exertion and partly from Property, the rates applicable to the total income are applied to the amounts of Personal Exertion and Property Income respectively.

Sixpenny Dividends Tax.—Dividends received by any person ordinarily resident in South Australia from any company, whether registered in South Australia or not, and whether such dividends arise or accrue in or are derived from the State or not, are taxed at the rate of 6d. in £ if received during the years 30th June, 1931, 30th June, 1932, 30th June, 1933, or 30th June, 1934.

Taxation of Dividends.—The 1935 Act provides that in computing the taxable amount of income of a shareholder in a company (whether the company is incorporated in the State or not) there shall, if the shareholder is ordinarily resident in the State, be included dividends paid to him by the company out of profits derived by it from any source. The 1935 Act also provides that a shareholder shall be entitled to a rebate in his assessment of the amount obtained by applying to that part of the dividends which is included in the taxable amount of his income a rate equivalent to:—

(a) The rate of tax payable by him on income consisting of the produce of property; or

(b) The rate of tax payable by companies, for the year during which the shareholder is liable to be assessed, whichever is the less.

Income Tax on Companies, including Life Asurance Companies.—The Taxation Act, 1935, enacts that the income tax on income derived by a company shall be at the rate of two shillings on each pound of the taxable amount of that income.

A company is not allowed the exemption of £100.

Minimum tax payable by any taxpayer, £1.

WESTERN AUSTRALIA.—INCOME TAX

The rate is a graduated one. Up to £100 chargeable it is 2d. in £, increasing by .007 of a penny up to a maximum of 4/ in £. Incomes of £6,672 and upwards are 4/- in £, minimum tax, 2/6. These rates are subject to 20 per cent. rebate.

Exemptions.—When taxpayer is married or has a dependent, £200 less £2 for every £ by which net income exceeds £200. If single, £100 less £2 for every £ by which net income exceeds £100.

Any male person over 65 years, or female over 60 years, whose income does not exceed £250 per year.

Where a single person contributes at least £26 a year towards the support of a dependent, he is allowed the general exemption of £200. If he has more than one dependent he is allowed the actual amount contributed up to £40 (if at least £26 contributed) for each dependent after the first.

A married person contributing at least £26 is also allowed up to £40 for money actually expended towards support of each dependent,

A person is a dependent when total annual income, including contribution paid by taxpayer for maintenance is less than £100, and he resides in West Australia.

£62 allowed for each child under 16 years residing with or dependent upon him.

Travelling expenses from place of residence to place where taxpayer earns his income allowed up to £15, also travelling expenses incurred in producing or protecting income.

Medical expenses incurred, if income chargeable does not exceed £350.

Premiums up to £50 on Life Assurance of taxpayer, his wife or children. Premiums up to £50 for fidelity guarantee or bond which taxpayer is required to provide for exercise of his profession, trade, or employment. Rates and Taxes actually paid in W.A. but not State Income Tax.

Gifts to charitable institutions, parks, reserves, university or public school, library, art gallery, museum, or other institutions, for public education, recreation or enjoyment subsidised by the Government provided such payment is applied solely to such charitable or public purposes. Funds for the relief of necessitous persons or for constructing, supporting or maintaining a public hospital in W.A.

Repairs to taxpayer's residence up to £50. Business losses incurred during the three years preceding the year of assessment. Income from mining tenements is only taxable after recoup of expended capital.

Absentees are not allowed any general exemption, insurance premium, medical expenses, travelling expenses or deductions for children or dependents.

W.A. Hospital Tax, 1½d. in £.

DIVIDEND DUTIES

Companies 1/3 in £ on profits earned plus 15 per cent. super tax, except Life Assurance Companies, which are taxed upon incomes from interest and investments, and are not subject to super tax. Insurance companies, other than life, pay 2 per cent. of gross premium income less re-insurance, plus 15 per cent. super tax.

Hospital Tax.—1½d. in £ on all salaries and wages, business profits, property income, earnings and profits of companies. Life Insurance Companies, 1½d. for every £3/2/6 of premiums received.

Financial Emergency Tax.—On the same lines as Hospital Tax, but rate varies from 4d. to 9d. in £. Insurance Company (not Life), 6d. for every £3/2/6 of premiums received.

TASMANIA.—INCOME TAX.

Exemptions.—£200 for any married person (or widower or widow having a child under sixteen years dependent upon him or her). £125 for any unmarried person.

Deductions.—Any married person (or widower or widow having a child under sixteen years dependent upon him or her) whose net income did not exceed £500, £1 for every £2 by

Tasmanian Income Tax (Cont.)

which the net income was less than £500. Any unmarried person whose net income did not exceed £400, £1 for every £6 by which the net income was less than £400.

Child Allowance. — From gross amount of income a deduction of £39 for each child under sixteen wholly maintained by taxpayer.

Where the income of any person (not being a company) is partly from business and partly from property, the deduction shall be made from his income from business, and if his income from business is insufficient to allow him the full benefit of such deduction, then the balance of such deduction shall be made from his income from property (other than dividends upon which income tax has been paid).

No exemption or deduction is allowed in respect of any prize in any lottery authorised by the State of Tasmania.

Rates.—Lotteries: Four shillings and threepence in the £ upon the amount of prize. Companies: One shilling and sixpence in the £ upon dividends. All other Incomes.—The rates set forth in Schedule.

Additional tax on profits from manufacture or sale of liquor under a wholesale or importer's licence 1/- in £, but the taxpayer under this section shall be entitled to a rebate equal to the amount of licence aforesaid.

SCHEDULE OF "THE INCOME TAX ACT, 1934."

Rate of Tax upon Income from Business

For so much of the taxable amount as does not exceed £7,600, the rate of tax per pound shall be threepence and three eight-hundredths of one penny where the taxable amount is one pound, and shall increase uniformly with each increase of one pound of the taxable amount by three eight-hundredths of one penny.

Exceeding £7,600, the rate shall be sixty pence.

Where the taxable amount does not exceed £7,600, the rate of tax per pound may be calculated from the following formula:—

R = rate of tax in pence per pound.
I = taxable income in pounds.

$$R = \left(3 + \frac{3}{800} I \right) \text{ pence.}$$

RATE OF TAX UPON INCOME FROM PROPERTY

I.—For incomes of a taxable amount not exceeding £546, the rate of tax shall be calculated from the following formula:—

R = rate of tax in pence per pound.
I = taxable income in pounds.

$$R = \left(3 + \frac{1}{181.07} \right) \text{ pence.}$$

II.—For income of a taxable amount exceeding £546, but not exceeding £2,000, the rate of tax shall increase continually in a curve of the second degree:—

				pence
Taxable	amount	£546	..	11.713
,,	,,	600	..	12.768
,,	,,	700	..	14.672
,,	,,	800	..	16.512
,,	,,	900	..	18.288
,,	,,	1000	..	20.000
,,	,,	1500	..	27.600
,,	,,	2000	..	33.600

III.—From £2,000 to £6,500 the rate of tax shall increase continually in a curve of the third degree:—

				pence
Taxable	amount	£2000	..	33.600
,,	,,	2500	..	40.000
,,	,,	3000	..	45.300
,,	,,	3500	..	49.600
,,	,,	4000	..	53.000
,,	,,	4500	..	55.600
,,	,,	5000	..	57.500
,,	,,	5500	..	58.000
,,	,,	6000	..	59.600
,,	,,	6500	..	60.000

For every pound in excess of £6,500, sixty pence.

Rates of Tax upon Income which is partly Income from Business and partly Income from Property:—

I.—For every pound of the taxable amount of the income from business the rate of tax shall be ascertained by dividing the total amount of the tax that would have been payable under this schedule if the total taxable amount of the taxpayer has been exclusively income from business, by such total taxable amount.

II.—For every pound of the taxable amount of the income from property the rate of tax shall be ascertained by dividing the total amount of the tax that would have been payable under this schedule if the total taxable amount of the taxpayer had been exclusively income from property (other than dividends) by such total taxable amount.

The tax in the case of companies is at the rate of 1/6 in the £.

A special tax on all net incomes of £52 and upwards other than salary or wages is payable as follows:—

(a) Up to £312, 4d. in the £.

(b) Exceeding £312 but not exceeding £520, 4d. on £312; 5d. on balance.

(c) Exceeding £520 but not exceeding £1,500. As in (b) up to £520, and 9d. in £ on balance.

(d) Exceeding £1,500. As in (c) up to £1,500, and 1/ in £1 on balance.

Companies are also liable to the Special Tax on the same rates.

Wages Tax is payable on a weekly basis at the same rate as Special Tax, but where payment is made at less than £6 per week, the tax is 1d. for each completed 5/-.

Important Australian Statistics

POPULATION AND VITAL STATISTICS.

States and Territories.	Area Square Miles	Population Estimated 30/9/36 Males	Females	Persons	Popn. Capital Cities 31/12/35
N.S.W.	309,432	1,350,836	1,321,727	2,672,563	1,254,780
Victoria	87,884	914,130	935,266	1,849,396	1,008,300
Queensland .	670,500	515,064	468,161	983,225	306,154
South Aust. .	380,070	294,160	293,696	587,856	315,130
West Aust. ..	975,920	238,680	212,513	451,193	210,365
Tasmania ..	26,215	116,558	113,045	229,603	60,900
North. Terr. .	523,620	3,628	1,728	5,356	1,650
F.C.T.	940	5,407	4,540	9,947	7,700
Total	2,974,581	3,438,463	3,350,676	6,789,139	3,164,979

ESTIMATED INCREASE OF POPULATION.

ADJUSTED IN ACCORDANCE WITH THE REVISED RESULTS OF THE CENSUS OF THE 30th JUNE, 1933.

States and Territories	1933	1934	1935	1.1.35 to 30.9.35	1.1.36 to 30.1.36
N.S.W.	21,788	22,684	21,463	13,625	14,897
Victoria	11,092	13,011	5,609	2,302	6,297
Queensland	9,934	10,466	11,222	10,557	12,506
South Australia	3,384	1,617	2,149	841	1,413
West Australia .	3,944	2,346	5,135	4,130	3,448
Tasmania	1,503	− 663	1,585	− 2,883	− 3,429
North. Territory	32	126	147	245	265
F.C.T.	689	− 61	127	276	628
Total	52,366	49,526	47,437	34,859	36,025

NOTE.—Minus sign (−) denotes decrease.

WOOL (as in the Grease) PRODUCED.

SEASON ENDED 30th JUNE.

	lbs. in 1933	lbs. in 1934	lbs. in 1935	lbs. in 1936
N.S.W. (*a*) ..	533,710,404	486,152,493	496,876,887	473,800,000
Victoria ..	170,807,900	161,146,436	156,761,979	162,573,452
Queensland ..	185,833,546	169,989,516	174,088,413	170,000,000
South Aust. ..	75,727,946	79,288,903	77,790,933	81,000,000
West Aust. (*b*)	81,307,832	85,118,808	95,836,161	90,300,000
Tasmania ..	15,200,000	14,200,000	14,035,000	14,000,000
North. Terr. ..	35,000	35,000	35,000	35,000
Total ..	1,062,622,628	995,931,156	1,015,424,373	991,708,452

(*a*) Including F.C.T.; (*b*) For year ended previous 31st December.

ESTIMATED GROSS VALUE OF ALL PRODUCTION.

	1931–32 £'000	1932-33 £'000	1933-34 £'000	1934–35 £'000
Agricultural	74,489	75,562	70,731	68,587
Pastoral	61,540	64,851	95,613	74,556
Dairy, Poultry and Bee Farming	41,478	39,622	40,306	44,763
Forestry and Fisheries	7,703	8,470	9,605	10,856
Mining	13,352	15,583	17,608	19,949
Manufacturing (a) ..	106,456	114,136	123,355	137,349
Total	305,018	318,224	357,218	356,060

(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.

PRINCIPAL CROPS—AUSTRALIA.

AREA UNDER CROPS.

	1932–33 Acres	1933–34 Acres	1934-35 Acres
Grain—			
Wheat	15,765,504	14,901,271	12,544,178
Oats	1,027,262	1,373,921	1,561,553
Maize	228,260	303,761	294,981
Hay	2,727,408	3,080,680	3,178,173
Sugar Cane	307,281	328,839	322,457
Total area under all crops	22,408,489	22,454,327	20,428,799

TOTAL PRODUCTION.

	1932–33 Bushels	1933–34 Bushels	1934-35 Bushels
Grain—			
Wheat	213,926,981	177,337,803	133,393,232
Oats	16,159,628	16,922,031	16,906,022
Maize	5,066,321	7,494,080	8,100,827
Hay (tons)	3,571,047	3,582,748	3,810,708
Sugar Cane (tons) ..	3,703,188	4,898,040	4,498,804
Cane Sugar (tons) ..	532,594	666,145	640,589

BIRTHS, DEATHS AND MARRIAGES.

States and Territories	1933	1934	1935	1.1.35 to 30.9.35	1.1.36 to 30.9.36
Births—Number.					
N.S.W.	44,195	43,335	44,676	33,291	34,461
Victoria	28,392	27,828	27,884	20,619	21,535
Queensland	17,150	17,360	17,688	13,319	14,238
South Australia	8,900	8,459	8,270	6,094	6,584
West. Australia .	7,874	7,801	8,119	6,060	6,348
Tasmania	4,553	4,470	4,456	3,261	3,383
North. Territory	74	88	84	65	83
F.C.T.	131	134	148	107	123
Total	111,269	109,475	111,325	82,816	86,755
Deaths—Number.					
N.S.W.	22,322	23,474	24,547	18,801	18,547
Victoria	17,456	18,648	18,456	14,062	14,324
Queensland	8,354	8,192	8,851	6,806	6,518
South Australia	4,904	5,403	5,163	3,931	4,143
West. Australia	3,790	4,076	4,118	3,111	3,137
Tasmania	2,192	2,345	2,353	1,814	1,823
North. Territory	61	60	70	54	39
F.C.T.	38	31	41	33	34
Total	59,117	62,229	63,599	48,612	48,565
Marriages—Number.					
N.S.W.	18,399	20,210	22,361	16,231	16,685
Victoria	12,668	13,862	15,409	11,018	11,464
Queensland	6,471	7,635	8,280	6,007	6,053
South Australia	3,973	4,310	4,845	3,441	3,801
West. Australia .	3,374	3,682	3,940	2,927	3,152
Tasmania	1,629	1,678	1,875	1,330	1,503
North. Territory	28	30	42	32	29
F.C.T.	53	58	74	52	54
Total	46,595	51,465	56,826	41,038	42,741

BASIC WEEKLY WAGE RATES FIXED BY STATE INDUSTRIAL TRIBUNALS.

State.	Males. £ s. d.	Females. £ s. d.	Date of Operation.	Family Unit (for Male Rate).
N.S.W.	(*a*) 3 10 0	1 18 0	1/11/36	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 9 6	(*d*) 1 13 0	—	Man, wife and three children.
West. Aust. ..	(*e*) 3 13 9	1 19 10	16/11/36	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) Operative from 7th January, 1937. (d) Operative from 16th January, 1936. (e) Metropolitan area. Basic wage for Goldfields Areas and other portions of State, exclusive of the S.W. Land Division: Males, £4/7/-; Females, £2/7/-; Agricultural Areas and S.W. Land Division: Males, £3/14/8; Females, £2/0/4.

TAXATION—Commonwealth and State per Head. Year ended 30th June.

	1933 £ s. d.	1934 £ s. d.	1935 £ s. d.	1936 £ s. d.
Taxation by Commonwealth Government (a):				
Customs and Excise .	5 13 0	4 19 11	5 2 11	6 2 9
Other	(c) 3 2 4	(c) 3 10 0	(c) 3 6 7	(c) 3 5 9
Total	8 15 4	8 10 0	8 9 6	9 8 6
Taxation by State Governments (b)	5 8 11	5 13 3	5 3 7	6 1 8
Total Taxation (a) ..	14 4 0	14 3 1	13 12 11	15 9 11

(a) Based on mean population of Commonwealth for each finanial year.

(b) Based on aggregate population of the six States, mean for each financial year.

(c) Inclusive of Sales Tax, £1/15/9 per head in 1931-32; £1/8/5 in 1932-33; £1/6/2 in 1933-34; £1/5/4 in 1934; and £1/7/11 in 1935-36; also Flour Tax, 3/9 per head in 1933-34, 2/5 in 1934-35, and 3/5 in 1935-36.

IMPORTANT AUSTRALIAN STATISTICS.

(Continued)

MANUFACTURING INDUSTRIES.

Percentage of each item of outlay on value of Total Output, 1934-35.

Particulars	N.S.W. %	V. %	Q. %	S.A. %	W.A. %	Tas. %	Ttl. %
Wages (a) .	19.11	21.62	17.14	21.14	21.25	22.17	19.96
Fuel & light	3.82	2.84	2.28	3.37	4.80	6.75	3.38
Materials used	56.40	55.69	65.94	59.44	52.28	49.53	57.29
Margin for profits and miscellaneous expenses and charges ..	20.67	19.85	14.64	16.05	21.67	21.55	19.37
Total Output	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Per cent. of Wages on value of Production	48.04	52.14	53.95	56.85	49.50	50.70	50.70

(a) Exclusive of amounts drawn by working proprietors.
NOTE.—Production figures for 1935-36 are not available.

AVERAGE AMOUNT OF SALARIES AND WAGES PAID PER EMPLOYEE (a)

Year.	N.S.W.	Vic.	Q'land.	South Aust.	Western Aust.	Tas.	Total
1932-33—							
Males	213.72	193.84	201.02	188.62	208.05	188.75	202.37
Females ..	95.78	89.71	81.08	70.62	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
1934-35—							
Males	208.57	193.31	219.93	190.22	210.66	183.68	202.48
Females ..	90.40	90.27	84.51	80.64	87.30	77.93	89.17

(*a*) Exclusive of working proprietors and amounts drawn by them.

AVERAGE NUMBER OF MALES AND FEMALES EMPLOYED, 1934-35.

Sex.	N.S.W.	Vic.	Q'land.	South Aust.	Western Aust.	Tas.	Total.
Males	127,114	110,910	34,596	27,271	14,253	8,321	322.465
Females ..	47,919	58,781	8,452	6,226	3,521	2,234	127,133
Masculinity (*a*) ..	275	189	409	438	405	372	254

(*a*) Number of males per 100 females.

MANUFACTURING TOTALS.

	1932-33 No.	1933-34 No.	1934–35 No.
Number of establishments	22,330	23,297	24,211
Hands employed	370,727	405,909	449,598
Salaries and Wages Paid (a)	£59,416,436	£64,444,660	£72,824,549
Value of Plant, Machinery, Land and Buildings ..	226,386,729	227,714,293	233,481,612
Value of Materials used	175,148,548	189,827,264	209,047,017
Value of Production ..	119,203,148	129,091,915	143,527,197
Value of Output	304,797,868	330,134,060	364,912,421

(a) Exclusive of amounts drawn by working proprietors.

MOTOR VEHICLES REGISTERED IN AUSTRALIA, 1935-36.

State and Territories	Motor cars	Commercial Vehicles	Motor cycles	Total	Drivers' and Riders' Licences Issued
N.S.W.	178,402	58,895	23,048	260,345	367,710
Victoria	143,330	50,500	26,095	219,925	289,486
Queensland ..	67,605	32,410	8,151	108,166	135,340
S. Australia ..	47,501	16,836	9,264	73,601	92,227
W. Australia ..	32,329	17,362	6,861	56,552	65,912
Tasmania	14,036	3,639	3,920	21,595	25,358
N. Territory ..	354	631	40	1,025	1,033
F.C.T.	1,275	294	88	1,657	2,277
Total	484,832	180,567	77,467	742,866	979,343

ALL SAVINGS BANK DEPOSITS

(including Commonwealth.)

	31/12/'34 £'000	30/6/'35 £'000	31/12/'35 £'000	30/6/'36 £'000	31/12/'36 £'000
N.S.W.	76,167	77,906	78,534	80,000	79,467
Victoria	70,375	72,019	72,256	73,890	73,272
Queensland	25,809	26,197	27,029	27,132	27,347
South Australia	23,556	24,208	24,569	25,308	25,434
West. Australia .	10,539	10,929	11,286	11,517	11,517
Tasmania	6,198	6,430	6,569	6,818	6,859
F.C.T.	228	230	222	239	240
N. Territory ...	50	53	60	58	58
Total	212,922	217,972	220,525	224,962	224,194

AVERAGE DEPOSIT PER HEAD OF POPULATION.

	31/12/34 £ s. d.	30/6/35 £ s. d.	31/12/35 £ s. d.	30/6/36 £ s. d.	31/12/36 £ s. d.
N.S.W.	28 17 10	29 9 2	29 11 0	30 0 3	29 13 0
Victoria	38 5 11	39 3 8	39 4 1	40 0 2	39 10 10
Queensland ..	26 17 10	27 1 3	27 16 11	27 13 3	27 15 10
South Australia ..	40 6 3	41 7 1	41 17 11	43 1 10	43 3 8
West. Australia ..	23 16 1	24 10 5	25 4 2	25 11 7	25 9 7
Tasmania	26 15 7	28 2 3	28 3 10	29 14 1	29 6 3
F.C.T.	24 15 11	24 15 2	23 17 7	24 8 1	23 19 8
North. Terr. ..	10 4 4	10 9 6	11 14 10	10 17 2	11 10 5
Total	31 15 0	32 8 3	32 13 1	33 4 1	32 18 9

BASIC WEEKLY WAGE RATES FIXED BY COMMONWEALTH COURT OF CONCILIATION AND ARBITRATION FOR EACH CAPITAL CITY (a).

Capital	1/3/'35		1/12/'35	1/12/'36	1/3/'37
Sydney	68 0		70 0	70 0	70 0
Melbourne	66 0		66 0	69 0	69 0
Brisbane	62 0		64 0	66 0	66 0
Adelaide	65 0	(64 0)	67 0	69 0	69 0
Perth	68 0		68 0	71 0	71 0
Hobart	69 0	(68 0)	69 0	69 0	69 0
Weighted Average—Six Capitals	66 0		68 0	68 0	70 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.

P.M.G.'s 25th ANNUAL REPORT

For Period July 1st, 1934 - - June 30th, 1935

THIS Annual Report of the Postmaster-General covering period July, 1934, to June, 1935, was not issued until May 1936, and therefore was not included in our 1936 Annual The report for period ending June, 1936, is not yet available.

The report discloses that £114,240 was expended and charged to capital account on behalf of wireless equipment. It also shows that there was a surplus of £162,343 for the period under consideration, as compared with a surplus of £87,235 for 1933-34. The earnings for 1934-35 were £371,604, an increase of £101,964, or 37.81 per cent. The expenditure, including interest charges was £209,261, an increase of £26,856 or 14.72 per cent.

National Stations

The Report says:—

The construction of the National Broadcasting System is proceeding according to plan, and so far six new regional stations have been brought into service. Five further regional stations are under construction and will be brought into operation at the earliest possible date. In addition, a site has been acquired and a contract for the equipment has been let for the regional station to serve Kalgoorlie, W.A., and surrounding districts.

A new form of transmitting aerial for broadcasting purposes has been invented and developed in the Department's Research Laboratories and will be used in certain of the new broadcasting stations. This form of aerial makes it possible to achieve with masts from 500 to 600 feet in height, results similar to those that could only be obtained with masts of from 800 to 1,000 feet in height.

Commercial Broadcasting Stations

THERE are now 57 commercial broadcasting stations in operation, four additional stations having commenced service during the year. Twenty-one stations are located in the capital cities and 36 in the country areas; the aerial power of the metropolitan stations varies from 100 to 1,000 watts, and the country stations from 50 to 2,000 watts.

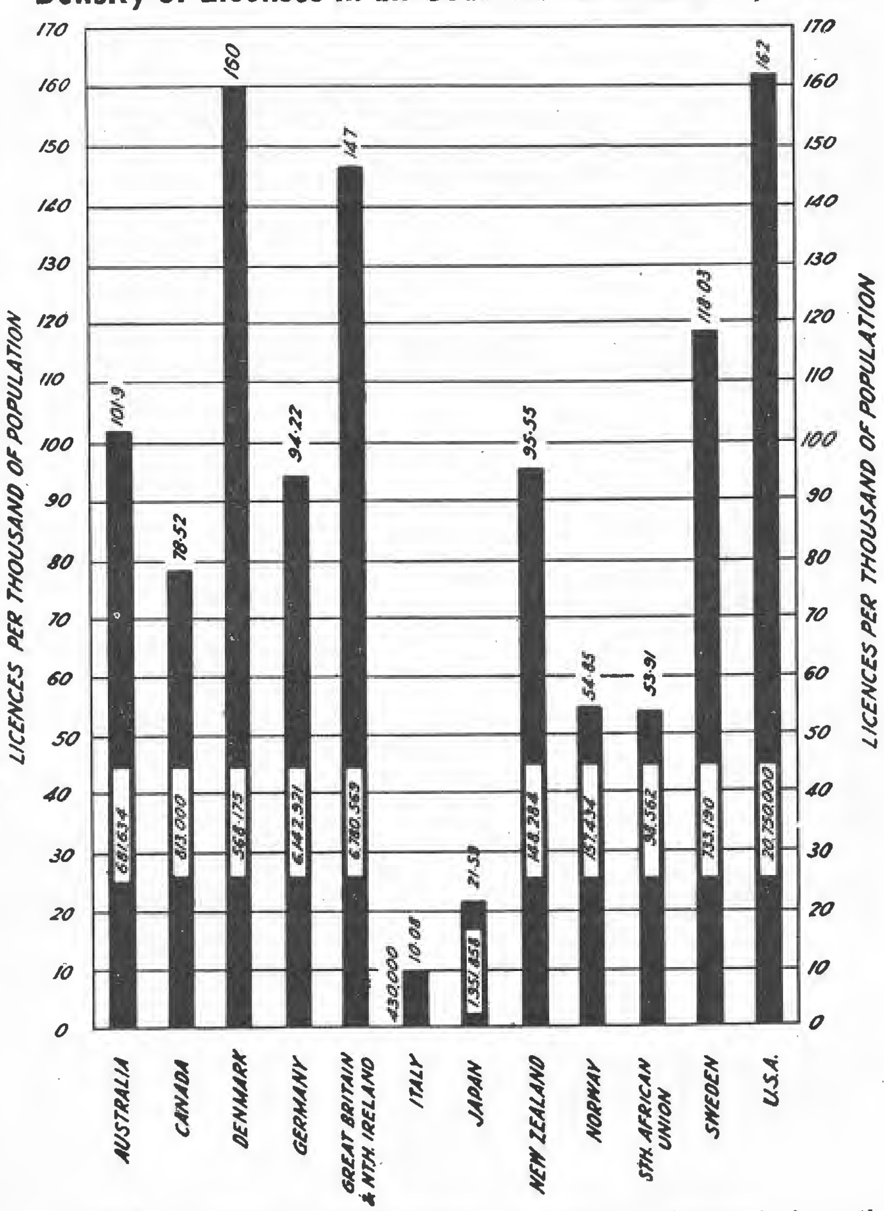
The aggregate weekly programme hours exceeds 3,000.

Licenses have been granted for the establishment of 22 additional stations to be put into operation during the next few months.

Use of Trunk Lines for Broadcasting Purposes

During 1934-35 unprecedented calls were made on the Department by the Australian Broadcasting Commission and licensed broadcasting organisations for the use of trunk line channels to permit programmes to be relayed for simultaneous radiation by two or more stations. This increased demand coincided with a period during which there has been a marked upward trend in normal trunk line business and special measures have been necessary to meet the broadcast ing needs.

Density of Licenses in all Countries at Dec. 31st, 1934



NOTES: 1. The figures inset represent the number of licenses in force, the figures at the top of each bar indicating the number of licenses per thousand of population. 2. In the case of U.S.A. the figures indicate the estimated number of receivers in operation, there being no wireless license system in that country.

P.M.G.'s REPORT. — (Cont.)

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 each hookup, expert staff must be provided at several points along the route where the delicate repeater apparatus has to be suitably adjusted and, where control must be exercised at suitable "zone control" stations, experienced technical officers are located.

The Department has put forward exceptional efforts to meet the wishes of broadcasting authorities in the provision of the required facilities, as it realises to the full that the value and interest of broadcasting are enhanced considerably by the concentration of programme resources at convenient points from which the programmes can be transmitted simultaneously to any number of stations desired. Moreover, the frequent linking together of stations in this way is essential if happenings of national interest are to be broadcast to listeners over wide areas in a convenient and economical manner. From this standpoint, the nationwide telephone system operated by the Post Office, with its associated highly-skilled technical staffs available at almost every town and village throughout the Commonwealth, has contributed very materially to the efficient operation of the broadcasting service and its increasing popularity.

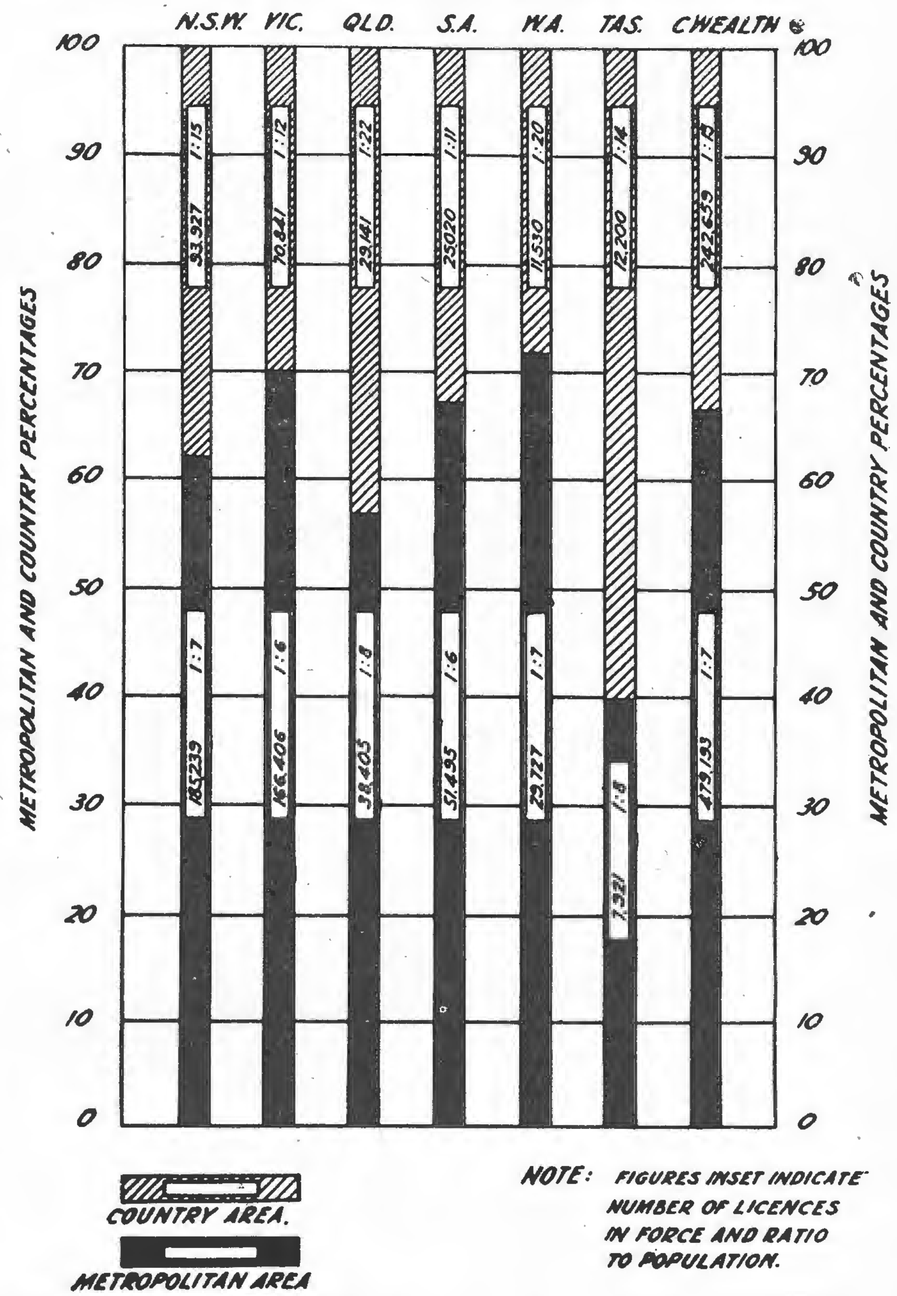
Trunk line channels were used during the year for broadcasting purposes for an aggregrate period of 16,654 hours, an increase of nearly 70 per cent. on the corresponding figures for the preceding year. The channels were used on 4,115 occasions by the Australian Broadcasting Commission and on 5,282 occasions on behalf of licensed stations.

The interstate channels were used by the Australian Broadcasting Commission on 2,349 occasions, while licensed stations were provided with 1,336 interstate relays. Of the total relays which took place, 356 extended to five States, 573 to four States, 769 to three States, and 1,987 to two States.

The diversity of the broadcast items relayed over trunk lines is shown by the following statement which relates to National service programmes transmitted over interstate channels during 1934-35—

Item	No. of Relays
Race descriptions	965
Musical programmes	382
Talks and speeches	296
Cricket descriptions	171
New sessions	127
Operas, plays, etc.	119
Overseas programmes	163
Aeroplane flights	48
Sporting descriptions	32

Listeners' Licenses in Force in Metropolitan and Country Areas of the Commonwealth at June 30th, 1935



Item	No. of Relays
Concerts	20
Miscellaneous items	86
	2,349

A specific illustration of the vital part played by the Post Office in linking up broadcasting stations by means of the comprehensive trunk line system, and the magnitude of the task involved, was the linking together for a simultaneous broadcast on one occasion during the year of 67 stations scattered throughout the Commonwealth, necessitating the use of approximately 12,000 miles of trunk line channels.

In view of the progressive increase that is taking place in the use of the trunk lines for the transmission of broadcast programmes, the Department has made appropriate provision in connection with the expansion of the long distance system so that service of the highest possible quality will be available when needed.

In designing the submarine cable for connection of the Mainland with Tasmania, provision was made for a high quality broadcast programme channel to enable the interchange of programmes between the two States.

(Continued on next page.)

P.M.G.'s Report (Continued.)

Broadcast Listeners' Licenses

Listeners' licenses increased during the year by 122,693 or 21 per cent., compared with 129,682 or 28 per cent. for the previous year; the total for the Commonwealth at 30th June, 1935, being 721,852. This number represents 46 per cent. of the total dwellings. The greatest percentage increase was recorded in Western Australia, where the number of licenses increased by 9,781 or 31 per cent., bringing the total in that State to 41,257 representing 38 per cent. of the dwellings.

The greatest density exists in South Australia(including Northern Territory), where 76,515 homes or 54 per cent. of the total dwellings are equipped with licensed receivers.

The corresponding totals and percentages for the other States, in order of density, are:—

Victoria, 237,247 (54 per cent.); New South Wales (inc. F.C.T.), 279,166 (45 per cent.); Tasmania, 20,121 (38 per cent.); Queensland, 67,546 (30 per cent.).

Of the total licenses in the Commonwealth, 66 per cent. are in the metropolitan areas. Published herewith are graphs showing:—

(a) the number and percentage of licenses in the metropolitan areas,

(b) the density of listeners' licenses in Australia and other countries.

The fees payable in respect of broadcast listeners' licenses were reduced on 6th August, 1934, as follows:

For Zone 1 (within 250 miles of a station of the National Broadcasting Service), from 24/- to 21/- p.a.

For Zone 2 (territory beyond Zone 1), from 17/6 to 15/- p.m.

Unlicensed Listeners

Prosecutions during the year, in connection with the use of unlicensed broadcast receivers, numbered 2,190, the total amount of fines and costs inflicted totalling £5,190. Up to 30th June, 1935, 10,176 persons were convicted for this offence, the fines and costs aggregating £24,456.

Radio Inductive Interference

During 1934,1935, 7,431 cases of interference were reported for treatment, including 973 cases carried over from the previous year. In 5,000 of these the interference was eliminated as a result of the departmental efforts, while 748 cases were not cleared because of failure to secure co-operation of the responsible party or the existence of causes for which there is yet no economic remedy, etc.

Profit and Loss Account of Wireless Branch—for Year Ended 30th June, 1935.

EXPENDITURE.

	Percentages of Net Income	£	s.	d.
Upkeep and Operation of Broadcasting Stations	12.16	45,185	13	7
Upkeep and Operation of Broadcasting Studios .	7.36	27,351	4	3
General Supervision and Cost of Issuing Licenses	16.79	62,400	18	3
Telephone Circuits used for Broadcasting and Miscellaneous Expenditure	8.50	31,582	8	0
	44.81	166,520	4	1
Proportion of Administration Expenses	.87	3,217	0	0
Depreciation	5.06	18,809	18	3
Proportion of Superannuation Liability and Pensions	1.33	4,960	0	0
	52.07	193,507	2	4
Surplus, exclusive of Interest, carried down ..	47.93	178,097	3	3
	100.00	371,604	5	7
Interest and Exchange charges	4.24	15,754	0	0
Surplus, inclusive of Interest, transferred to General Profit and Loss Account	43.69	162,343	3	3
	47.93	178,097	3	3

REVENUE.

	£	s.	d.
Gross Revenue	776,653	4	7
Less— Payments to Australian Broadcasting Commission	405,048	19	0
Net Revenue: License Fees, Fines, etc.	371,604	5	7
Surplus, exclusive of Interest, brought down	178,097	3	3

In the course of their investigations, the officers engaged on this useful work travelled more than 50,000 miles and made 8,159 inspections. As a result of the purchase of motor cars and up-to-date equipment for the use of investigating officers, the Department is well equipped for this service to broadcast listeners and is achieving considerable success in diminishing the nuisance.

Proficiency Certificates

During the year, 529 candidates were examined for Operators' Certificates of Proficiency. The number of certificates issued during the year was—

Commercial—	
First Class	37
Second Class	28
Limited—	
Radiotelegraphy	9
Radiotelephony	48
Amateur	175
Total	297

Other Radio Services

The total number of radio-communication stations (other than Broadcasting Stations and Experimental Stations) in operation in the Commonwealth, including Papua, at 30th June, 1935, was 280, compared with 234 at the end of the previous year. The comparative figures for the various classes are—

	Number at June 30 1935	Number at June 30 1934
Coast Stations ..	21	21
Ship Stations	105	100
Aircraft Stations ..	12	—
Land Stations	67	33
Portable Stations ..	28	32
Special Stations ..	47	48
	280	234

The increase in the number of Land Stations (most of which are established in the far outback regions) is indicative of the growing use which is being made of wireless for communications purposes in the remote areas. Stations in the Mandated Territory of New Guinea at 30th June, 1935, numbered 25.

Experimental Stations increased during the year from 1,170 to 1,319.

The Balance Sheet shows on the liabilities side, wireless fees paid in advance, £406,813/4/6.

On the assets side, fixed assets and plant for wireless equipment is shown at £268,779/6/9.

(Continued on next page.)

P.M.G.'s REPORT (Cont.) DETAILS OF FIXED ASSETS

Wireless Plant

Description	Value on July 1, 1934	Expenditure 1934-35	Gross Value on June 30, 1935	Dismantled Assets Depreciation written off, and Assets Transferred 1934-35	Nett Value on June 30, 1935
		£	£	£	£
National Station Equipment	110,531	103,917	214,448	403	214,045
National Studio Equipment	33,768	8,646	42,414	190	42,224
National Miscellaneous Assets	1,283	662	1,945	190	1,755
National Studio Furniture	525	50	575	10	565
Other Broadcasting & Wireless Assets	9,283	965	10,248	58	10,190
Total Wireless Plant	155,390	114,240	269,630	851	268,779

The results of working the Wireless Branch are as follows:

State	1934-35 Deficit £ s. d.	1934-35 Surplus £ s. d.	1933-34 Deficit £ s. d.	1933-34 Surplus £ s. d.
New South Wales	..	66,407 14 11	..	36,442 15 2
Victoria	..	74,556 14 9	...	55,427 4 10
Queensland	..	5,983 18 3	5,181 16 10	..
South Australia	..	12,755 6 1	..	3,405 0 1
Western Australia	..	3,064 19 10	683 11 6	—
Tasmania	425 10 7	..	2,174 11 0	..
	425 10 7	162,768 13 10	8,039 19 4	95,275 0 1

Total Net Surplus, 1934-35	£162,343 3 3
Total Net Surplus, 1933-34	£87,235 0 9

Summary of Financial Results —— Wireless Branch.

	N,S,W.	Vic.	Q'ld.	S.A.	W.A.	Tas.	Total 1934-35	C'wealth 1933-34
	£	£	£	£	£	£	£	£
Earnings	142,233	127,600	31,838	39,769	19,897	10,267	371,604	269,640
Working Expenses (exclusive of Interest)	70,944	49,742	23,155	24,787	15,222	9,657	193,507	170,711
Earnings compared with Working Expenses—								
Surplus	71,289	77,858	8,683	14,982	4,675	610	178,097	98,929
Deficit	—	—	—	—	—	—	—	—
Interest on Capital including Exchange thereon	4,881	3,301	2,699	2,227	1,610	1,036	15,754	11,694
Result, after providing for Working Expenses and Interest—								
Surplus	66,408	74,557	5,984	12,755	3,065	—	162,343	87,235
Deficit	—	—	—	—	—	426	—	—
Percentage of Working Expenses to Earnings	49.88	38.98	72.73	62,33	76.50	94.06	52.07	63.31

Profit and Loss

Expenditure—Wireless, £193,507/2/4 (1.36 per cent.); Surplus—Wireless, £178,097/3/3 (1.26 per cent.); Interest and Exchange——Wireless, £15,754 (0.11 per cent.); Surplus after charging interest—Wireless, £162,/-343/3/3 (1.15 per cent.).

Revenue

Wireless, £371,604/5/7 (2.62 per cent.).

Summary of Depreciation in Profit and Loss (Wireless Branch)

Depreciation of Stores in stock and miscellaneous plant	£214
Depreciation reserve	£18,596

Depreciation Reserve (Wireless Branch)

N.S.W.: £6,150; Vic.: £1,917; Qld.: £3,319; S.A.: £4,196; W.A.: £1,764; Tas.: £883. Total: £18,229.

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 B 040.

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.

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.

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 the number of such licences 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 licence 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 licence 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 isued, 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 Prificiency in Wireless Telegraphy and Wireless Telephony;

Second Class Commercial Operators' Certificate of Proficiency in Wireless Telegraphy;

*Third Class Commercial Operator's Certificate of Proficiency in Wireless Telegraphy;

*Third Class Commercial Operator's Certificate of Proficiency in Wireless Telephony;

Broadcast Station Operator's Certificate of Proficiency;

Amateur Operator's Certificate of Proficiency.

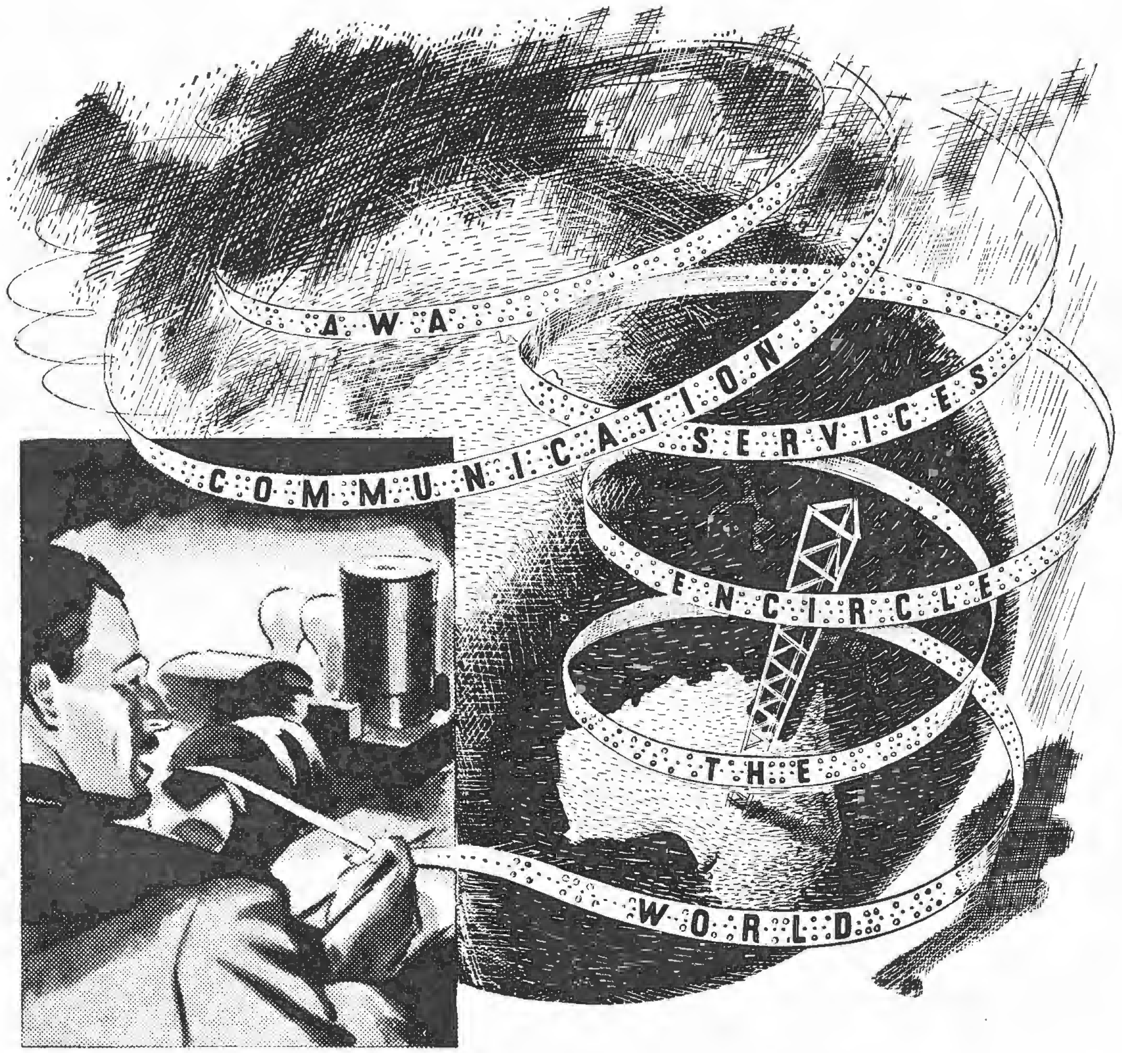
*These Certificates are now issued in lieu of Limited Certificates of Proficiency in Radiotelegraphy and Radiotelephony.

Interested persons should communicate with the nearest Senior Radio Inspector for full details.

Broadcast Listeners' Licenses.

This is the type of licence 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 licence 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 licence 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 licence fee covers the administrative costs, the far great part being what might be termed the subscription fee,



WIRELESS CONTROL IN AUSTRALIA—(Cont.)

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 licence 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.

Despite the obligation on listeners to obtain a licence, 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 1936 there were more than 3,200 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 vale of 6d. or more, when affixed in the spaces provided on this card, will be accepted at any Post Office Licence Issuing Office in partial or full payment for a new listener's licence or for the renewal of any existing licence.

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 licence, and, even if it contains stamps to the value of a licence, it is illegal to use a receiving set until the actual licence has been obtained.

If, after certain stamps have been affixed, the owner of this card does not wish to purchase a broadcast listener's licence, 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 Licence.

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.

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 eight 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.

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 licence 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 licence. 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.

Communication Services of the P.M.G.'s. Department

THROUGHOUT the world the Postal Service is universally regarded as a public utility which it is fitting to place under direct Government control, its activities being of vital importance to the well-being of the general community in both business and social relations.

Hence, when the Commonwealth of Australia was constituted by the Federation of the six States in 1900, and it became necessary to define the affairs of State which, from their National character, it would be appropriate to transfer from the jurisdiction of the States to the Federal Parliament, the Post Office was naturally included in the functions deputed to the newly constituted governing authority.

The carrying out of the work of the Post Office in Australia at the present time necessitates the employment, either fully or for part time, of over 44,000 persons, through the medium of some 10,000 offices, the transactions at which involve annual financial turnover of approximately £158,000,000. The number of postal articles dealt with exceeds 1,000,000,000 per annum.

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 journey 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 horseback, by pack-horse, and occasionally by camel. For many miles in the outlying parts roads are not available and somewhat indefinite tracks point the way.

Aviation.

TO no country in the world has the newest means of transportation — aviation — offered greater benefits from the commercial and social standpoints than to Australia, with its great distances and scattered settlements in isolated territories. The Post Office was quick to recognise the possibilities of this rapid means of communication, and has availed itself of every opportunity to use regular aerial services for the conveyance of mails.

The expansion of the internal air mail system is evidenced by the increase in the route distance of services operating in Australia from 5927 miles in 1931, to 15,801 miles in 1937, and by the increase in the total distance flown in air mail operations from 1,067,000 miles in 1931 to 5,125,950 per annum at the present time.

The Australia-Singapore section of the overseas air mail service, which was duplicated in May, 1936, now provides a twice weekly frequency between Britain and the Commonwealth.

Expansion During 1936.

The year 1936 has seen a marked expansion of the telephone system, 32,541 telephones having been added as compared with 30,771 during 1935. With the gradual return to pre-depression levels the development of telephone subscribers' services has shown a consistent improvement during recent years and the 1936 figures are the best recorded since 1927. The improvement has not been confined to the metropolitan areas, the nett increase in country services in 1936 having totalled 8,164.

At the end of December, 1936, there were 579,567 telephones in service throughout the Commonwealth, of which 232,381 were connected to exchanges situated outside the telephone networks of the State capital cities. With an average of 8.53 telephones per hundred people Australia occupies seventh place in the list of nations showing the greatest telephone density.

Record figures were also reached during the year in regard to the business handled. Approximately 498,000,000 local calls were dealt with as against 455,000,000 in 1935, and about 36,500,000 trunk calls were completed in comparison with 34,300,000 in the preceding year. The total length of telephone wire in use is in the region of 2,700,000 miles and there are 9,000 exchanges in operation.

The quality of the telephone service rendered is determined by its speed, accuracy and dependability, and setting out to achieve a high standard in these respects the Department has spared no effort to avail itself of the most modern methods or scientific aids. Not only have the products of the research laboratories in other countries been adopted wherever they are suited to Australian conditions, but constant researches have been made locally by specially trained staffs for the purpose of remedying likely defects in the service and introducing improved practices and procedure.

Australia has not been slow to avail itself of the advantages of the automatic system, and the proportion of dial telephones throughout the Commonwealth is much higher than in many leading countries overseas. 254,000 telephones in the metropolitan areas, or 73 per cent. of the total connected in the various capital city networks, are now served by automatic exchanges, and the number is steadily increasing. Each year additional manual exchanges are converted to the automatic system and the plans contemplate the complete conversion of the metropolitan networks within the next few years.

The benefits of the automatic system in provincial and country centres are also recognised, and, whilst the conversion of all exchanges is out of the question because of the prohibitive cost which would be entailed, a gratifying and steady advance has been made in installing in rural areas automatic units which have been developed specially to meet the needs of small communities. Twenty-nine such units are now in service, and a further 54 are listed for installation in the near future.

The efficiency and range of the long distance system has also received close attention, with the result that to-day the system penetrates into almost every settled locality in Australia, and a subscriber in one part of the Commonwealth can make a call to any other part of the Continent, including Tasmania, clearly, quickly and at low cost. In 1926 the average time taken to connect a trunk call was 13 minutes, and practically no calls could be obtained without some delay. Now the average waiting time is little more than three minutes, and 65 per cent. of the calls can be had while the caller remains at the telephone.

With the erection of high quality channels serving important centres and the installation of repeaters at suitable points, enormous distances can now be bridged with almost the same clarity as that of a local call, as, for instance, a call between Wiluna in Western Australia and Cloncurry in Queensland, a distance of 5,500 miles, which is possibly a record in long distance landline telephony.

Carrier Wave.

Another scientific development which has had a pronounced effect on the trunk line service is the carrier wave apparatus. By means of this equipment several channels of communication can be secured from one pair of wires, thus obviating the very heavy expense involved in the erection of new wires. Not only does the carrier system enable substantial economies to be effected in plant costs, but it also appreciably improves the quality

Communication Services by the P.M.G's Department

of the transmission. There are now 75 such systems in use in Australia, and each system on the average saves the erection of nearly 1,500 miles of wire. 40 further systems will be installed in the near future.

The telephone circuits have been equipepd 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 Townsville station in Queensland to the Wagin station in Western Australia the circuit distance is 4,500 miles, and on several occasions programmes have been simultaneously broadcast at these extreme distances with many other intermediate broadcasting stations transmitting the same programme at the same time.

During 1930 a page in telephone history was turned with the establishment of radio telephone services with Great Britain, New Zealand and Java. These services have extended rapidly and there is now a steady stream of traffic to London and to places on the Continent such as Paris and Berlin, as well as to America. It is now possible for a subscriber in Australia to telephone any one of more than 32,000,000 telephones situated in fifty-one countries abroad. Calls may also be made to certain Trans-Atlantic liners whilst they are at sea, including the latest leviathan, the "Queen Mary," and the "Awatea," which trades between Sydney and New Zealand.

During the seven years since the inception of the overseas services, 12,131 calls have been completed, of which 6,999 originated in Australia. Great Britain has shared in 8,571 calls, New Zealand in 2,421, the United States of America in 416, France in 151, Germany in 116 and Ireland in 79, whilst the remainder have been distributed over other countries with which communication is practicable. Altogether calls have been made to 29 different countries in addition to ships at sea. Approximately 52 per cent. of the calls have been of a business character and 48 per cent. of a domestic or social nature.

The telegraph service is conducted from 10,000 offices interconnected by 300,000 channel miles of circuit. It deals with 16 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. A facsimile of a picture, photograph or any document capable of photographic reproduction may be transmitted over 600 miles of carrier 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 runing of the race.

Private wire teleprinter services are made available by the Post Office for communication between two points either in the same area or thousands of miles apart. Transmission is effected by the operation of a keyboard similar to that of a typewriter, a printed record being made simultaneously at both terminals. The apparatus may be operated by any typist of overage skill. Teleprinters may also be utilised for the transmission of telegrams between a subscriber's premises and the local telegraph office.

A telephone subscriber may telephone telegrams to a telegraph office for onward transmission, the charges being included in the telephone account. A telegram addressed to a telephone number will be telephoned to the addressee without extra charge, thus ensuring more expeditious delivery of the message.

Broadcasting Services.

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 12 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 privately-owned group consists of 78 broadcasting stations which are distributed in the more densely populated areas of the Commonwealth. Frequently, by mutual arrangements among the managements of a number of these stations, extensive simultaneous broadcasting is effected. In a recent instance there were no less than 66 privately-owned stations simultaneously transmitting by means of the Post Office telephone trunk system.

Activities in connection with Commercial Stations

AS the licensing and controlling authority, the Depart- Stations. Applications for new stations, alterations ment is closely associated with the Commercial 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.

Use of Long Distance Telephone Service for Broadcasting Purposes

THE Australian Broadcasting Commission and Commercial Broadcasting organisations continue to make extensive use of the long distance telephone system to link up stations for the simultaneous radiation of programmes of special interest, and during 1936 telephone channels were used for relay purposes on 12,497 occasions. Since 1932 the number of transmissions over trunk lines for broadcasting purposes in any one year has increased by 490 per cent. The progressive growth in the past five years is shown by the folowing figures:—

Year	Number of Transmissions Over Trunk Lines.
1932	2,118
1933	3,478
1934	7,679
1935	9,997
1936	12,497

Of the total relays which took place in 1936, 2,324 extended to two States, 1,348 to three States, 749 to four States, 1,163 to five States, and 488 to six States. The remaining 6,425 relays concerned only stations in the State of origin. These figures exceed all previous records for the Commonwealth, involving as they do the occupation of channels for 21,444 hours. The total mileage for trunk lines used in connection with these broadcasts was in the region of 20,000,000 miles.

Some idea of the variety of the items which are relayed over the trunk lines for broadcasting can be gained from the following details which relate to National service programmes transmitted over interstate channels during last year, viz.:—

Item	Number of Relays
Race descriptions	1219
Talks and speeches	783
News sessions	721
Musical programmes	709
Stock Exchange, market and corn reports	650
Cricket descriptions	285
Programmes from overseas stations	125
Operas, plays, musical comedies and revues	98
Other sporting events	60
Concerts	23
Miscellaneous items	57
	4,730

All previous records for a simultaneous broadcast were broken on one occasion during the year when 87 separate broadcasting stations in the Commonwealth were linked together. This necessitated the use of 18,000 miles of telephone trunk lines which had to be withdrawn temporarily from their normal functions wherein transmission in both directions is essential, and specially prepared to give high quality transmission from the originating station out to the remaining 86 stations. This highly complex network of line equipment was set up by the technical staff of the Post Office, no less than 150 officers having to be employed for this occasion.

Broadcasting authorities have found that chain broadcasts enhance the value of their programmes and are keen to supplement their purely local programmes by descriptions of important events occurring outside their own localities or of performances of exceptional interest or merit arranged by other stations. It is in providing the means of transmitting these items to any number of stations that the telephone trunk line system plays such an important part in broadcast entertainment in this country.

The provision of channels suitable for programme transmission between broadcasting stations is now a feature demanding constant consideration in the planning of the long distance telephone system. In addition to the millions of miles of telephone channels which are diverted temporarily for broadcasting purposes, 5,700 miles of special high quality channels are used exclusively in this way. The association of certain country and metropolitan broadcasting stations for the purpose of programme economy and a wider advertising field has also resulted in the permanent leasing of channels between the stations concerned.

Listeners' Licenses in Australia 1934-5-6.

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.	C'WEALTH Licenses in force.	C'WEALTH Ratio to 100 of Population.
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
April	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
April	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	12.28	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
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
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	81,788	13.85	45,580	10.22	21,951	9.59	763,598	11.35
1936														
Jan.	297,033	11.17	254,198	13.81	75,712	7.80	82,626	13.99	46,636	10.44	22,446	9.82	778,651	11.56
Feb.	300,282	11.29	255,898	13.91	76,938	7.93	83,598	14.16	47,234	10.57	22,542	9.86	786,492	11.67
Mar.	305,545	11.47	256,493	13.92	78,043	8.03	84,483	14.29	47,653	10.63	22,898	9.95	795,115	11.78
April	308,406	11.58	258,980	14.05	79,849	8.13	85,289	14.42	48,293	10.78	23,204	10.09	803,215	11.90
May	312,137	11.72	259,473	14.07	81,075	8.34	85,873	14.52	48,986	10.93	23,456	10.19	811,000	12.02
June	316,340	11.87	263,817	14.31	83,230	8.56	87,500	14.80	50,081	11.18	24,168	10.50	825,136	12.22
July	323,246	12.09	269,529	14.59	85,402	8.77	88,953	15.02	51,160	11.39	24,648	10.66	842,938	12.45
Aug.	327,848	12.26	270,867	14.66	86,916	8.92	89,651	15.13	52,193	11.62	24,924	10.78	852,399	12.59
Sept.	331,542	12.39	271,388	14.69	88,461	9.02	90,597	15.28	53,344	11,84	25,497	11.10	860,829	12.70
Oct.	336,733	12.58	274,168	14.84	89,686	9.14	91,784	15.48	54,051	12.00	25,860	11.26	872,282	12.87
Nov.	338,762	12.66	275,186	14.90	90,712	9.25	92,526	15.61	54,448	12.09	26,213	11.41	877,847	12.96
Dec.	341,493	12.76	277,344	15.02	92,208	9.40	93,881	15.84	55,246	12.27	26,843	11.69	887,015	13.09

Growth of Licenses in Commonwealth since 1924

The total number of licenses in operation during the various months since 1924 are given hereunder, together with the ratio to 100 population.

	Licenses.	Ratio.
1924.		
July	1,206	.02
August	8,688	.1
September	16,859	.3
October	22,087	.4
November	31,529	.54
December	38,336	.66
1925.		
January	44,274	.76
February	50,223	.85
March	54,853	.93
April	58,133	.99
May	61,231	1.04
June	63,874	1.08
July	66,605	1.1
August	72,483	1.24
September	77,485	1.31
October	79,271	1.34
November	80,853	1.37
December	85,130	1.44
1926.		
January	90,640	1.5
February	97,219	1.6
March	103,145	1.7
April	109,500	1.8
May	116,491	1.9
June	128,060	2.14
July	141,392	2.3
August	154,736	2.5
September	165,436	2.7
October	175,298	2.9
November	183,020	3.02
December	187,228	3.09
1927.		
January	193,542	3.2
February	197,872	3.2
March	201,288	3.3
April	206,515	3.4
May	215,801	3.5
June	225,249	3.68
July	233,286	3.82
August	241,338	3.93
September	249,375	4.06
October	254,738	4.15
November	257,010	4.17
December	258,179	4.19
1928.		
January	260,304	4.22
February	262,363	4.23
March	263,340	4.22

GROWTH OF LICENSES SINCE 1924—(Continued)

	Licenses.	Ratio.
April	265,067	4.25
May	267,178	4.28
June	270,507	4.33
July	275,441	4.42
August	280,688	4.50
September	284,690	4.54
October	285,550	4.56
November	288,457	4.59
December	288,784	4.59
1929.		
January	289,164	4.60
February	291,289	4.61
March	293,120	4.64
April	296,317	4.69
May	298,551	4.73
June	301,199	4.75
July	303,192	4.78
August	303,562	4.79
September	304,156	4.78
October	309,820	4.86
November	310,313	4.87
December	309,981	4.86
1930.		
January	311,074	4.86
February	309,001	4.83
March	309,572	4.84
April	308,711	4.81
May	311,322	4.87
June	312,192	4.88
July	323,004	5.03
August	335,037	5.21
September	330,169	5.13
October	329,627	5.12
November	328,307	5.10
December	329,465	5.12
1931.		
January	326,993	5.08
February	326,270	5.06
March	327,413	5.07

	Licenses.	Ratio.
April	329,134	5.08
May	328,815	5.09
June	331,128	5.12
July	330,918	5.10
August	326,620	5.03
September	326,599	5.02
October	330,179	5.08
November	333,714	5.13
December	337,654	5.19
1932.		
January	341,394	5.25
February	347,555	5.33
March	350,661	5.38
April	357,433	5.48
May	363,772	5.56
June	369,936	5.67
July	376,759	5.77
August	384,787	5.88
September	390,552	5.97
October	397,490	6.08
November	409,264	6.25
December	419,180	6.40
1933.		
January	427,821	6.53
February	434,632	6.62
March	444,379	6.77
April	448,788	6.83
May	459,007	7.00
June	469,477	7.14
July	481,374	7.32
August	491,233	7.41
September	500,341	7.55
October	508,534	6.67
November	514,287	7.76
December	518,628	7.81
1934.		
January	527,003	7.93
February	534,887	8.05
March	543,715	8.17

	Licenses.	Ratio.
April	557,423	8.37
May	574,115	8.62
June	599,159	9.00
July	622,674	9.34
August	645,631	9.67
September	654,848	9.81
October	666,563	9.98
November	674,425	10.10
December	681,634	10.19
1935.		
January	687,765	10.28
February	694,479	10.38
March	702,206	10.47
April	708,781	10.57
May	718,598	10.71
June	721,852	10.74
July	729,959	10.87
August	736,600	10.97
September	746,225	11.09
October	770,152	11.43
November	754,250	11.22
December	763,598	11.35
1936.		
January	778,651	11.56
February	786,492	11.67
March	795,115	11.78
April	803,215	11.90
May	811,000	12.01
June	825,136	12.22
July	842,938	12.45
August	852,399	12.59
September	860,829	12.70
October	872,282	12.87
November	877,847	12.96
December	887,015	13.09

Details in respect to the number of licenses in each particular State for the periods abovementioned will be found in previous copies of this Radio Trade Annual.

GROWTH BY STATES AND SUMMARY OF LICENSES

IN FORCE AT 31st DECEMBER EACH YEAR FROM 1924 TO 1936.

Commonwealth Totals.

31st December Year ended	in force Number	Population 100 of Ratio to	Actual during the year Increase	%
1924	38,336	.66	—	—
1925	85,130	1.44	46,794	122
1926	187,228	3.09	102,098	120
1927	258,179	4.19	70,951	38
1928	288,874	4.59	30,695	12
1929	309,981	4.86	21,107	7
1930	329,465	5.12	19,484	6
1931	337,658	5.19	8,193	2
1932	419,180	6.40	81,522	24
1933	518,628	7.81	99,448	24
1934	681,634	10.19	163,006	31
1935	770,152	11.43	88,518	13
1936	887,015	13.09	116,863	15

New South Wales.				
1924	26,071	1.1	—	—
1925	34,911	1.5	8,840	34
1926	48,858	2.1	13,947	40
1927	72,854	3.05	23,996	49
1928	91,709	3.78	18,855	26
1929	107,503	4.37	15,794	17
1930	119,131	4.79	11,628	11
1931	125,409	5.00	6,278	5
1932	159,972	6.33	34,563	28
1933	197,869	7.56	37,897	24
1934	262,988	9.97	65,119	33
1935	294,232	11.06	31,244	12
1936	341,493	12.76	47,261	16
Victoria.				
1924	8,327	.5	—	—
1925	33,988	2.0	25,661	308
1926	97,744	5.8	63,756	188
1927	134,825	7.80	37,081	38
1928	141,890	8.11	7,065	5
1929	144,141	8.16	2,251	2
1930	141,687	7.95	– 2,454	– 2
1931	134,173	7.46	– 7,514	– 5
1932	156,307	8.66	22,134	16
1933	184,861	10.14	28,554	18
1934	227,135	12.33	42,274	23
1935	250,758	13.63	23,623	10
1936	277,344	15.02	26,586	11

Growth by States

and Summary of Licenses in Force since 1924

Queensland.

Year ended 31st December	Number in force	Ratio to 100 of Population	Increase during the year Actual	%
1924	633	.07	—	—
1925	4,141	.49	3,508	554
1926	19,414	2.2	15,273	369
1927	24,433	2.73	5,019	26
1928	25,224	2.77	791	3
1929	22,449	2.42	– 2,775	– 11
1930	24,418	2.59	1,969	9
1931	26,449	2.76	2,031	8
1932	32,183	3.31	5,734	22
1933	40,918	4.31	8,735	27
1934	62,721	6.54	21,803	53
1935	74,911	7.72	12,190	19
1936	92,208	9.40	17,297	23

South Australia.

Year ended 31st December	Number in force	Ratio to 100 of Population	Increase during the year Actual	%
1924	1,345	.25	—	—
1925	6,985	1.29	5,640	419
1926	15,165	2.7	8,180	117
1927	18,792	3.29	3,627	24
1928	22,120	3.81	3,328	18
1929	25,481	4.38	3,361	15
1930	28,447	4.90	2,966	12
1931	32,160	5.51	3,713	13
1932	43,362	7.40	11,202	35
1933	55,762	9.51	12,400	29
1934	72,476	12.31	16,714	30
1935	81,788	13.85	9,312	13
1936	93.881	15.84	12,093	15

Western Australia.

Year ended 31st December	Number in force	Ratio to 100 of Population	Increase during the year Actual	%
1924	1,716	.4	—	—
1925	4,192	1.15	2,476	144
1926	4,114	1.09	– 78	– 2
1927	3,872	1.00	– 242	– 6
1928	3,814	.95	– 58	– 1
1929	4,727	1.15	913	24
1930	8,030	1.92	3,303	70
1931	10,800	2.57	2,770	35
1932	16,127	3.79	5,327	49
1933	25,325	5.76	9,198	57
1934	37,417	8.46	12,092	48
1935	46,219	10.34	8,802	24
1936	55.246	12,27	9,027	19

Tasmania.

Year ended 31st December	Number in force	Ratio to 100 of Population	Increase during the year Actual	%
1924	244	.1	—	—
1925	913	.41	669	274
1926	1,933	.92	1,020	112
1927	3,403	1.63	1,470	76
1928	4,117	1.95	714	21
1929	5,680	2.67	1,563	34
1930	7,752	3.59	2,072	36
1931	8,667	3.96	915	12
1932	11,229	5.08	2,562	30
1933	13,893	6.11	2,664	24
1934	18,897	8.29	5,004	36
1935	22,244	9.73	3,347	18
1936	26,843	11.69	4,599	20

Monthly Totals by States

Broadcast Listeners' License Figures for Year 1936

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.

JANUARY.

	New Issues	Renewals	Total Issues	Cancellations	Monthly Total	Net Increase	Popln. Ratio	Total Includes Experimental	Total Includes Free Blind
N.S. Wales	4,445(10)	18,245(94)	22,690	1,644(10)	297,033	2,801	11.17	551	542
Victoria	3,721(6)	14,230(87)	17,951	281(5)	254,198	3,440	13.81	383	599
Queensland	1,614(4)	3,992(14)	5,606	813(3)	75,712	801	7.80	179	196
S. Australia	1,326(4)	4,375(17)	5,701	488(6)	82,626	838	13.99	156	221
W. Australia	744(12)	2,219(16)	2,963	327(—)	46,636	417	10.44	91	164
Tasmania	550(2)	1,202(10)	1,752	348(1)	22,446	202	9.82	39	92
C'wealth	12,400(38)	44,263(238)	56,663	3,901(25)	778,651	8,499	11.56	1,399	1,814

FEBRUARY.

	New Issues	Renewals	Total Issues	Cancellations	Monthly Total	Net Increase	Popln. Ratio	Total Includes Experimental	Total Includes Free Blind
N.S. Wales	4,780(7)	17,351(54)	22,131	1,531(3)	300,282	3,249	11.29	567	546
Victoria	3,629(3)	13,527(40)	17,156	1,929(13)	255,898	1,700	13.91	389	589
Queensland	1,571(1)	4,252(16)	5,823	345(—)	76,938	1,226	7.93	184	197
S. Australia	1,410(2)	4,067(21)	5,477	438(3)	83,598	972	14.16	157	220
W. Australia	735(6)	2,123(18)	2,858	137(—)	47,234	598	10.57	90	170
Tasmania	543(7)	723(4)	1,266	447(6)	22,542	96	9.86	39	93
C'wealth	12,668(26)	42,043(153)	54,711	4,827(25)	786,492	7,841	11.67	1,426	1,815

MARCH.

	New Issues	Renewals	Total Issues	Cancellations	Monthly Total	Net Increase	Popln. Ratio	Total Includes Experimental	Total Includes Free Blind
N.S. Wales	7,092(9)	17,763(45)	24,855	1,829(8)	305,545	5,263	11.47	591	547
Victoria	3,629(3)	13,527(40)	17,156	3,142(—)	256,493	595	13,92	388	611
Queensland	1,621(2)	4,465(14)	6,086	516(7)	78,043	1,105	8.03	201	192
S. Australia	1,438(3)	4,608(21)	6,046	553(—)	84,483	885	14.29	162	223
W. Australia	879(—)	2,323(12)	3,202	460(5)	47,653	419	10.63	89	165
Tasmania	543(7)	723(4)	1,266	321(—)	22,898	356	9.95	44	93
C'wealth	15,444(36)	43,832(161)	59.276	6,821(20)	795,115	8,623	11.78	1,475	1,831

APRIL.

	New Issues	Renewals	Total Issues	Cancellations	Monthly Total	Net Increase	Popln. Ratio	Total Includes Experimental	Total Includes Free Blind
N.S. Wales	5,129(11)	17,009(27)	22,138	2,268(7)	308,406	2,861	11.58	589	551
Victoria	3,534(1)	17,019(40)	20,553	1,047(25)	258,980	2,487	14.05	391	587
Queensland	1,543(5)	4,348(15)	5,891	543(3)	79,043	1,000	8.13	190	194
S. Australia	1,471(7)	5,201(22)	6,672	665(—)	85,289	806	14.42	157	230
W. Australia	902(4)	2,923(7)	3.825	262(3)	48,293	640	10.78	86	166
Tasmania	619(—)	1,040(3)	1,659	313(—)	23,204	306	10.09	44	93
C'wealth	13,198(28)	47,540(114)	60 738	5,098(38)	803,215	8,100	11.90	1,457	1,821

MAY.

	New Issues	Renewals	Total Issues	Cancellations	Monthly Total	Net Increase	Popln. Ratio	Total Includes Experimental	Total Includes Free Blind
N.S. Wales	6,775(9)	22,895(29)	29 670	3,044(2)	312,137	3,731	11.72	590	558
Victoria	5,010(9)	19,251(57)	24,261	4,517(9)	259,473	493	14.07	399	587
Queensland	2,860(5)	5,974(17)	8,834	828(—)	81,075	2,032	8.34	198	199
S. Australia	1,666(2)	6,781(29)	8,447	1,082(2)	85,873	584	14.52	159	230
W. Australia	1,254(4)	3,977(20)	5,231	561(5)	48,986	693	10.93	87	165
Tasmania	756(1)	1,465(3)	2,221	504(2)	23,456	252	10.19	44	92
C'wealth	18,321(30)	60,343(155)	78,664	10,536(20)	811,000	7,785	12.02	1,477	1 831

JUNE.

	New Issues	Renewals	Total Issues	Cancellations	Monthly Total	Net Increase	Popln. Ratio	Total Includes Experimental	Total Includes Free Blind
N.S. Wales	6,850(9)	25,898(48)	32,748	2,647(4)	316,340	4,203	11.87	609	563
Victoria	9,073(1)	20,470(41)	29.543	4,729(1)	263,817	4,344	14.31	403	587
Queensland	2,506(7)	7,301(21)	9,807	351(—)	83,230	2,155	8.56	202	206
S. Australia	1,948(5)	8,763(19)	10,711	321(1)	87,500	1,627	14.80	165	234
W. Australia	1,490(2)	4,701(11)	6,191	395(2)	50,081	1,095	11.18	94	165
Tasmania	1,125(1)	2,013(9)	3,138	413(—)	24,168	712	10.50	50	93
C'wealth	22,992(25)	69,146(149)	92,138	8,856(8)	825,136	14,136	12.22	1,523	1,848

MONTHLY TOTALS OF LICENCES BY STATES FOR 1936—(Continued).

JULY.									
N.S. Wales	8,551(13)	32,683(35)	41,234	1,645(—)	323,246	6,906	12.09	621	576
Victoria	7,020(6)	26,385(49)	33,405	1,308(6)	269,529	5,712	14.59	409	587
Queensland	2,791(2)	7,995(14)	10.786	619(1)	85,402	2,172	8.77	208	207
S. Australia ..	2,214(—)	9,455(21)	11,669	761(2)	88,953	1,453	15.02	164	232
W. Australia ..	1,525(1)	5,123(11)	6,648	446(2)	51,160	1,079	11.39	94	164
Tasmania	1,132(2)	2,132(5)	3,264	652(2)	24,648	480	10.66	47	93
C'wealth	22,992(25)	69,146(149)	92,138	5,431(13)	842,938	17,802	12.45	1,543	1,859
AUGUST.									
N.S. Wales	6,803(3)	30,036(45)	36,839	2,201(3)	327,848	4,602	12.26	616	576
Victoria	5,956(6)	24,728(47)	30,684	4,618(2)	270,867	1,338	14.66	431	591
Queensland	2,469(3)	6,810(18)	9,279	955(—)	86,916	1,514	8.92	207	210
S. Australia	1,904(6)	9,238(18)	11,142	1,206(4)	89,651	698	15.13	164	234
W. Australia ..	1,522(3)	4,695(6)	6,217	489(—)	52,193	1,033	11.62	92	167
Tasmania	994(1)	2,200(3)	3,194	718(1)	24,924	276	10.78	45	93
C'wealth	19,648(22)	77,707(137)	97,355	10,187(10)	852,399	9,461	12.59	1,555	1,871
SEPTEMBER.									
N.S. Wales	5,850(6)	24,041(23)	29,891	2,156(—)	331,542	3,694	12.39	640	582
Victoria	4,280(2)	17,509(33)	21,789	9,750(3)	271,388	521	14.69	440	590
Queensland	2,144(5)	6,194(14)	8,338	599(1)	88,461	1,545	9.02	209	214
S. Australia	1,493(—)	5,725(11)	7,218	547(2)	90,597	946	15.28	170	232
W. Australia ..	1,329(4)	3,752(3)	5,081	178(6)	53,344	1,151	11.84	96	165
Tasmania	1,071(1)	1,394(5)	2,465	498(—)	25,497	573	11.10	47	94
C'wealth	16,167(18)	58,615(89)	74,782	7,737(12)	860,829	8,430	12.70	1,602	1,877
OCTOBER.									
N.S. Wales	6,281(10)	23,216(26)	29,497	1,090(8)	336,733	5,191	12.58	642	584
Victoria	4,998(1)	19,393(35)	24,391	2,218(2)	274,168	2,780	14.84	444	589
Queensland	1,974(8)	5,979(13)	7,953	749(—)	89,686	1,225	9.14	217	222
S. Australia	1,738(4)	5,503(5)	7,241	551(—)	91,784	1,187	15.48	170	236
W. Australia ..	1,141(6)	3,569(8)	4,710	134(2)	54,051	707	12.00	93	169
Tasmania	768(—)	1,311(5)	2,079	405(1)	25,860	363	11.26	49	93
C'wealth	16,900(29)	58,971(92)	75,871	5,447(13)	872,282	11,453	12.87	1,615	1,893
NOVEMBER.									
N.S. Wales	5,601(8)	20,499(39)	26,100	3,572(1)	338,762	2,029	12.66	656	591
Victoria	4,210(10)	16,359(26)	20,569	3,192(7)	275,186	1,018	14.90	458	592
Queensland	1,484(2)	5,745(11)	7,229	458(2)	90,712	1,026	9.25	223	222
S. Australia	1,533(1)	4,917(13)	6,450	791(—)	92,526	742	15.61	171	237
W. Australia ..	1,047(3)	3,236(7)	4,283	650(2)	54,448	397	12.09	98	170
Tasmania	781(2)	1,212(7)	1,993	428(3)	26,213	353	11.41	49	92
C'wealth	14,656(26)	51,968(103)	66,624	9,091(15)	877,847	5,565	12.96	1,655	1,904
DECEMBER.									
N.S. Wales	4,366(7)	19,334(27)	23,700	1,635(4)	341,493	2,731	12.76	664	594
Victoria	3,898(3)	15,728(13)	19,626	1,740(3)	277,344	2,158	15,02	464	592
Queensland	1,700(4)	4,876(11)	6,576	204(—)	92,208	1,496	9.40	224	226
S. Australia	1,763(3)	5,344(6)	7,107	408(—)	93,881	1,355	15.84	172	240
W. Australia ..	1,078(7)	2,959(6)	4,037	280(—)	55,246	798	12.27	96	177
Tasmania	927(3)	1,214(4)	2,141	297(2)	26,843	630	11.69	50	93
C'wealth	13,732(27)	49,455(67)	63,187	4,564(9)	887,015	9,168	13.09	1,670	1,922

COMMONWEALTH MONTHLY TOTALS OF BROADCAST LISTENERS' LICENSE FIGURES FOR 1936.

	Issues New	Renewals	Total Issues	Can-cellations	Monthly Total	Net Increase	Popln. Ratio	Totals include Experi-mental	Totals include Free Blind
January	12,400(38)	44,263(238)	56,663	3,901(25)	778,651	8,499	11.56	1,399	1,814
February	12,668(26)	42,043(153)	54,711	4,827(25)	786,492	7,841	11.67	1,426	1,815
March	15,444(36)	43,832(161)	59,276	6,821(20)	795,115	8,623	11.78	1,475	1,831
April	13,198(28)	47,540(114)	60,738	5,098(38)	803,215	8,100	11.90	1,457	1,821
May	18,321(30)	60,343(155)	78,664	10,536(20)	811,000	7,785	12.02	1,477	1,831
June	22,992(25)	69,146(149)	92,138	8,856(8)	825,136	14,136	12.22	1,523	1,848
July	23,233(24)	83,773(135)	107,006	5,431(13)	842,938	17,802	12.45	1,543	1,859
August	19,648(22)	77,707(137)	97,355	10,187(10)	852,399	9,461	12.59	1,555	1,871
September	16,167(18)	58,615(89)	74,782	7,737(12)	860,829	8,430	12.70	1,602	1,877
October	16,900(29)	58,971(92)	75,871	5,447(13)	872,282	11,453	12.87	1,615	1,893
November	14,656(26)	51,968(103)	66,624	9,091(15)	877,847	5,565	12.96	1,655	1,904
December	13,732(27)	49,455(67)	63,187	4,564(9)	887,015	9,168	13.09	1,670	1,922
	199,359(239)	687,656(1593)	887,015	82,496(208)	9,992,919	116,863	147.81	18,397	22,286

Country—Metropolitan License Distribution

In Various States and the Commonwealth During 1936

THE following figures show the quarterly license figures in the various metropolitan and country areas for each State for 1936.

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.

	31.3.36	30.6.36	30.9.36	31.12.36
Metropolitan—				
Licenses	200,078	204,165	209,821	214,669
Population	1,257,385	1,257,385	1,258,494	1,258,494
Ratio: Licenses to 100 Popn.	15.91	16.24	16.67	17.05
Dwellings	67	69	71	72
% of State	66	65	63	63

Metropolitan area of Sydney includes: Alexandria, Annadale, 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, Kuringai, 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.

	31.3.36	30.6.36	30.9.36	31.12.36
Country.				
Licenses	105,467	112,175	121,720	126,824
Population	1,406,115	1,406,115	1,416,773	1,416,773
Ratio: Licenses to 100 Popn.	7.50	7.98	8.59	8.97
Dwellings	33	35	37	39
% of State	34	35	37	37
State—				
Licenses	305,545	316,340	331,542	341,493
Population	2,663,500	2,663,500	2,675,267	2,675,267
Ratio: Licenses to 100 Popn.	11.47	11.87	12.39	12.76
Dwellings	49	51	53	55
% of State	—	—	—	—

Victoria.

	31.3.36	30.6.36	30.9.36	31.12.36
Metropolitan—				
Licenses	176,645	182,123	185,556	189,399
Population	1,002,948	1,002,948	1,010,341	1,010,341
Ratio: Licenses to 100 Popn.	17.61	18.15	18.37	18.74
Dwellings	74	76	77	78
% of State	69	69	68	68

Metropolitan area of Melbourne includes: Box Hill, Brighton, Brunswick, Camberwell, Caulfield, Chelsea, Coburg, Collingwood, Essenden, Fitzoy, 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.

	31.3.36	30.6.36	30.9.36	31.12.36
Country—				
Licenses	78,849	81,694	85,832	87,945
Population	840,052	840,052	836,503	836,503
Ratio: Licenses to 100 Popn.	9.38	10.21	10.26	10.51
Dwellings	39	42	42	43
% of State	31	31	32	32
State—				
Licenses	255,494	263,817	271,388	277,344
Population	1,843,000	1,843,000	1,846,844	1,846,844
Ratio: Licenses to 100 Popn.	13.86	14.31	14.69	15.02
Dwellings	57	59	61	62
% of State	—	—	—	—

Queensland.

	31.3.36	30.6.36	30.9.36	31.12.36
Metropolitan—				
Licenses	43,927	47,146	48,513	50,688
Population	208,803	308,803	309,178	309,178
Ratio: Licenses to 100 Popn.	14.22	15.27	15.69	16.39
Dwellings	61	65	67	70
% of State	56	57	55	55

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).

	31.3.36	30.6.36	30.9.36	31.12.36
Country—				
Licenses	34,116	36,084	39,948	41,520
Population	663,197	663,197	671,672	671,672
Ratio: Licenses to 100 Popn.	5.14	5.44	5.94	6.18
Dwellings	22	23	26	27
% of State	44	43	45	45
State—				
Licenses	78,043	83,230	88,461	92,208
Population	972,000	972,000	980,850	980,850
Ratio: Licenses to 100 Popn.	8.02	8.56	9.02	9.40
Dwellings	35	37	39	41
% of State	—	—	—	—

South Australia.

	31.3.36	30.6.36	30.9.36	31.12.36
Metropolitan—				
Licenses	57,835	60,135	62,157	63,912
Population	314,681	314,681	315,587	315,587
Ratio: Licenses to 100 Popn.	18.37	19.10	19.69	20.25
Dwellings	74	77	80	82
% of State	68	69	69	68

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.

	31.3.36	30.6.36	30.9.36	31.12.36
Country—				
Licenses	26,648	27,365	28,440	29,969
Population	276,519	276,519	277,019	277,019
Ratio: Licenses to 100 Popn.	9.63	9.89	10.26	10.81
Dwellings	41	42	44	46
% of State	32	31	31	32

Country—Metropolitan License Distribution

	31.3.36	30.6.36	30.9.36	31.12.36
State—				
Licenses	84,483	87,500	90,597	93,881
Population	591,200	591,200	592,606	592,606
Ratio: Licenses to 100 Popn.	14.29	14.80	15.28	15.84
Dwellings	59	61	63	66

Western Australia.

	31.3.36	30.6.36	30.9.36	31.12.36
Metropolitan—				
Licenses	34,185	35,696	37,487	37,962
Population	216,329	216,329	211,545	211,545
Ratio: Licenses to 100 Popn.	15.34	16.91	17.72	17.94
Dwellings	66	73	76	77
% of State	71	71	70	69

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, Nedland, Peppermint Grove, Perth, Perth South, Swan (part).

	31.3.36	30.6.36	30.9.36	31.12.36
Country—				
Licenses	13,468	14,385	15,857	17,284
Population	231,671	231,671	238,698	238,698
Ratio: Licenses to 100 Popn.	5.81	6.26	6.64	7.24
Dwellings	23	25	27	29
% of State	28	29	30	31
State—				
Licenses	47,653	50,081	53,344	55,246
Population	448,000	448,000	450,243	450,243
Ratio: Licenses to 100 Popn.	10.63	11.18	11.84	12.27
Dwellings	44	46	49	51
% of State	—	—	—	—

Tasmania.

	31.3.36	30.6.36	30.9.36	31.12.36
Metropolitan—				
Licenses	8,775	9,161	9,511	9,890
Population	60,115	60,115	59,976	59,976
Ratio: Licenses to 100 Popn.	14.59	15.24	15,86	16.49
Dwellings	62	65	67	70
% of State	38	38	37	37

Metropolitan area of Hobart includes: Glenoreby, Hobart, Kingborough (part), Clarence (part).

	31.3.36	30.6.36	30.9.36	31.12.36
Country—				
Licenses	14,123	15,007	15,986	16.953
Population	169,885	169.885	169,574	169,574
Ratio: Licenses to 100 Popn.	8.31	8.83	9.43	10.00
Dwellings	36	38	40	43
% of States	62	62	63	63
State—				
Licenses	22,898	24,168	25,497	26.843
Population	230,000	230,000	229,550	229.550
Ratio: Licenses to 100 Popn.	9.95	10.50	11.10	11.69
Dwellings	43	45	48	50
% of State	—	—	—	—

Commonwealth.

	31.3.36	30.6.36	30.9.36	31.12.36
Metropolitan—				
Licenses	521,445	539,426	553,045	566,520
Population	3,160,261	3,160,261	3,165,121	3,165,121
Ratio: Licenses to 100 Popn.	16.50	17.06	17.47	17.89
Dwellings	69	71	73	75
% of State	66	66	64	64
Country—				
Licenses	272,671	285,710	307,784	320,495
Population	3,587,439	3,587,439	3,610,239	3,610.239
Ratio: Licenses to 100 Popn.	7.60	7.96	8.53	8.87
Dwellings	33	34	36	38
% of State	34	34	36	36
State—				
Licenses	794,116	825,136	860,829	887,015
Population	6,747,700	6,747,700	6,775,360	6,775,360
Ratio: Licenses to 100 Popn.	11.76	12.22	12.70	13 09
Dwellings	50	52	54	56
% of State	—	—	—	—

N.Z. Radio Licenses in Force at 31st December, 1936

CLASS OF LICENSE.	DISTRICTS. Auckland	Canterbury	Otago	Wellington	Total
Receivers	72,844	41,967	31,524	83,346	229,681
Dealers	446	221	171	433	1,271
Experimental (Amateur)	251	202	117	407	977
Experimental (Research)	1	—	—	1	2
Multiple	2	2	—	2	6
Special	—	—	—	1	1
Free	266	124	95	213	698
Broadcasting	3	2	7	9	21
Totals	73,813	42,518	31,914	84,412	232,657

Extracts from N.Z. Radio Regulations.

Radio receiving licenses cost £1/5/- per annum.

Temporary licenses can be obtained for 10/- per week of 7 days or fraction thereof.

All licenses expire on March 31 of each year, and any licenses renewed within 3 months of March 31 have to pay the additional 12 months' license at 2/1 per calendar month.

Free licenses are issued to blind persons, to institutions, homes, and asylums for blind persons, and to schools, hospitals, and charitable institutions.

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. Licenses of Class 4 are for issue to individual dealers not having a fixed place of business.

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 to be used in the repair and servicing of radio sets, such repairs and servicing to be carried out by the license holder. 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/- pa., Class 3 £2 p.a., Class 4 £15 p.a., Class 5 £5/5/- p.a.

Listeners' License Figures in Force in Areas Within 50 Miles of Principal Cities and Towns

QUARTER ENDING MARCH, 31, 1936.

N.S.W. and F.C.T.

Locality	Licenses	Population	Ratio of Licenses to 100 of Popn.	Ratio of Licenses to 100 of Homes
Sydney	220,720	1,448,616	15.24	64
Remainder of State	84,825	1,214,884	6.98	31
State (inc. F.C.T.)	305,545	2,663,500	11.47	49
Albury—N.S.W. Sec.	3,120	30,792	10.13	46
Vic. Sec.	3,043	38,016	8.00	34
Armidale	1,470	31,562	4.65	20
Bathurst	6,793	93,390	7.27	30
Broken Hill (ex. S.A.)	2,456	28,257	8.69	35
Canberra (in. N.S.W.)	2,775	33,586	8.26	36
Corowa—				
N.S.W. Sec.	3,164	32,168	9.84	44
Vic. Sec.	3,913	48,963	7.99	34
Deniliquin—				
N.S.W. Sec.	1,217	15,954	7.63	34
Vic. Sec.	1,722	22,271	7.77	34
Dubbo	2,125	31,277	6.79	30
Goulburn	4,415	61,541	7.17	32
Grafton	2,423	42,314	5.73	25
Gunnedah	2,637	47,214	5.59	26
Katoomba—				
(exc. Met. area)	16,331	168,687	9.68	40
Lismore—				
N.S.W. Sec.	4,529	90,680	4.99	23
Q'd Sec.	222	5,812	3.81	16
Moss Vale	10,658	114,179	9.33	40
Newcastle	26,931	242,606	11.10	48
Orange	4,151	79,855	5.22	22
Tamworth	3,020	50,312	6.00	27
Wagga	5,081	73,086	6.95	32
Wollongong—				
(exc. Sydney)	17,446	147,073	11.86	49

Victoria.

Locality	Licenses	Population	Popn.	Homes
Melbourne	198,460	1,206,240	16.46	68
Remainder of State	57,034	636,760	8.94	37
State	255,494	1,843,000	13.86	57
Ballarat	20,373	161,826	12.58	50
Bendigo	10,680	126,454	8.44	33
Birchip	3,418	44,214	7.73	35
Geelong—				
(exc. Melbourne)	23,981	156,164	15.35	63
Hamilton	4,824	55,555	8.68	37
Horsham	3,902	44,380	8.79	37
Mildura—Vic. Sec.	2,210	23,976	9.21	39
N.S.W. Sec.	288	3,584	8.04	31
Sale	4,998	49,869	10.02	40
Shepparton—				
Vic. Sec.	6,808	81,247	8.37	36
N.S.W. Sec.	311	4,319	7.20	32
Swan Hill—				
Vic. Sec.	2,260	29,583	7.63	33
N.S.W. Sec.	283	5,490	5.15	23
Warrnambool	5,154	50,119	10.28	45

Queensland.

Locality	Licenses	Population	Popn.	Homes
Brisbane	50,942	406,956	12.51	54
Remainder of State	27,101	565,044	4.79	21
State	78,043	972,000	8.02	35
Ayr	2,525	41,529	6.08	27
Bundaberg	2,625	46,421	5.65	23
Cairns	1,232	48,850	2.52	11
Charleville	208	5,067	4.10	19
Gympie	3,770	68,492	5.50	24
Ipswich (ex. Bris.)	9,068	129,964	6.97	31
Longreach	271	5,062	5.35	25
Mackay	1,176	29,065	4.04	18
Maryborough	3,353	53,527	6.26	26
Oakey	5,805	83,064	6.98	33
Rockhampton	4,141	47,944	8.63	38
Toowoomba	10,065	123,059	8.17	37
Townsville	2,537	40,055	6.33	28
Warwick—Q'ld. Sec.	6.172	84,287	7.32	33
N.S.W. Sec.	122	4,052	3.01	11

South Australia.

Locality	Licenses	Population	Popn.	Homes
Adelaide	65,684	394,318	16.65	67
Remainder of State—				
(Inc. Nth. Ter.)	18,799	196,882	9.54	42
State (inc. N.T.)	84,483	591,200	14.29	59
Crystal Brook	6,641	50,128	13.24	57
Port Lincoln	903	7,196	12.54	54
Port Pirie	5,206	43,330	12.01	52
Mt. Gambier—				
S.A. Sec.	1,115	17,181	6.48	27
Vic. Sec.	1,240	7,922	15.65	65
Murray Bridge—				
(exc. Metrop. area)	6,934	72,910	9.51	39
Renmark	2,222	21,501	10.33	44

Western Australia.

Locality	Licenses	Population	Popn.	Homes
Perth	36,002	245,287	14.67	63
Remainder of State	11,651	202,713	5.74	23
State	47,653	448,000	10.63	44
Albany	817	9,416	8.67	33
Bunbury	2,298	33,848	6.78	26
Collie	2,214	35,470	6.24	24
Geraldton	624	9,984	6.25	29
Kalgoorlie	1,295	23,257	5.57	22
Katanning	1,770	14,537	12.24	51
Merredin	1,061	15,031	7.06	30
Narrogin	1,004	15,847	6.33	27
Northam (exc. Perth)	1,924	37,782	5.09	21
Wagin	1,396	17,767	7.85	33

Tasmania.

Locality	Licenses	Population	Popn.	Homes
Hobart	12,536	100,037	12.53	54
Remainder of State	10,362	129,963	7.97	35
	22,898	230,000	9.95	43
Burnie	4,322	48,377	8.93	39
Devonport	8,407	86,597	9.70	42
Kelso	8,545	90,769	9.41	41
Launceston	7,892	82,196	9.60	41
Queenstown	963	9,719	9.90	40
Ulverston	3,999	80,697	4.95	22

Listeners' License Figures in force in areas within 50 miles of Principal Cities and Towns.

Quarter Ending June 30, 1936.

N.S.W. and F.C.T.

Locality	Licenses	Population	Ratio of Licenses to 100 of Popn.	Ratio of Licenses to 100 of Homes
Sydney	225,586	1,448,616	15.57	66
Remainder of State	90,754	1,214,884	7.47	33
State (inc. F.C.T.)	316,340	2,663,500	11.87	51
Albury—				
N.S.W. Section	3,210	30,792	10.42	47
Vic. Section	3,135	38,016	8.25	35
Armidale	1,603	31,562	5.08	22
Bathurst	7,074	93,390	7.57	32
Broken Hill				
(exc. S.A.)	2,508	28,257	8.88	36
Canberra (inc. N.S.W.)	2,869	33,586	8.54	37
Corowa—				
N.S.W. Section	3,274	32,168	10.18	47
Vic. Section	4,000	48,963	8.17	35
Deniliquin—				
N.S.W. Section	1,269	15,954	7.96	35
Vic. Section	1,798	22,271	8.07	35
Dubbo	2,336	31,277	7.47	33
Goulburn	4,619	61,541	7.51	33
Grafton	2,553	42,314	6.03	27
Griffith	2,353	34,831	6.76	31
Gunnedah	2,809	47,214	5.95	27
Katoomba (exc.				
Metro. area)	17,124	168,687	10.15	42
Lismore—				
N.S.W. Section	4,850	90,680	5.35	25
Q'ld. Section	260	5,812	4.47	18
Moss Vale	11,125	114,179	9.74	42
Newcastle	29,287	242,606	12.72	55
Orange	4.405	79,855	5.52	24
Tamworth	3,219	50,312	6.40	29
Wagga	5,305	73,086	7.26	33
Wollongong				
exc. Sydney)	18,143	147,073	12.34	51

Victoria.

Locality	Licenses	Population	Popn.	Homes
Melbourne	206,374	1,206,240	17.11	71
Remainder of State	57,443	636,760	9.02	37
State	263,817	1,843,000	14.31	59
Ballarat	21,069	161,826	13.01	52
Bendigo	11,008	126,454	8.71	34
Birchip	3,545	44,214	8.02	37
Geelong (exc. Melb.)	24,244	156,164	15.53	64
Hamilton	4,874	55,555	8.77	38
Horsham	4,023	44,380	9.06	38
Mildura—Vic. Sec.	2,292	23,976	9.56	41
N.S.W. Sec.	319	3,584	8.90	35
Sale	5,144	49,869	10.31	42
Shepparton—				
Vic. Section	7,035	81,247	8.66	37
N.S.W. Section	329	4,319	7.62	34
Swan Hill—				
Vic. Section	2,312	29,583	7.82	34
N.S.W. Section	293	5,490	5.34	23
Warrnambool	5,196	50,119	10.37	46

Queensland.

Locality	Licenses	Population	Popn.	Homes
Brisbane	54,642	406,956	13.42	58
Remainder of State	28,588	565,044	5.05	22
State	83,230	972,000	8.56	37
Ayr	2,721	41,529	6.55	29
Bundaberg	2,648	46,421	5.74	24
Cairns	1,334	48,850	2.73	12
Charleville	302	5,067	5.96	28
Gympie	3,954	68,492	5.77	25
Ipswich (exc.				
Brisbane)	9,455	129,964	7.27	32
Longreach	305	5,062	6.02	28
Mackay	1,251	29,065	4.30	19
Maryborough	3,712	53,527	6.93	28
Oakey	6,075	83,064	7.30	34
Rockhampton	4,306	47,944	8.97	40
Toowoomba	10,571	123,059	8.59	39
Townsville	2,685	40,055	6.70	30
Warwick—Qld. Sec.	6,652	84,287	7.89	36
N.S.W. Sec.	128	4,052	3.13	11

South Australia.

Locality	Licenses	Population	Popn.	Homes
Adelaide	68,013	394,318	17.24	69
Remainder of State	19,487	196,882	9.89	44
State (inc. N.T.)	87,500	591,200	14.80	61
Crystal Brook	6,816	50,128	13.59	59
Port Lincoln	957	7,196	13.29	57
Port Pirie	5,324	43,330	12.28	54
Mt. Gambier—				
S.A. Section	1,191	17,181	6.93	29
Vic. Section	1,262	7,922	15.93	67
Murray Bridge				
(exc. Metro. area)	7,188	72,910	9.85	40
Renmark	2,235	21,501	10.39	43

Western Australia.

Locality	Licenses	Population	Popn.	Homes
Perth	37,620	245,287	15.33	66
Remainder of State	12,461	202,713	6.14	25
State	50,081	448,000	11.18	46
Albany	894	9,416	9.49	36
Bunbury	2,493	33,848	7.36	29
Collie	2,410	35,470	6.79	26
Geraldton	650	9,984	6.51	30
Kalgoorlie	1,470	23,257	6.32	25
Katanning	1,906	14,537	13.11	55
Merredin	1,145	15,031	7.61	32
Narrogin	1,084	15,847	6.84	29
Northam (exc.				
Perth)	2,057	37,782	5.44	23
Wagin	1,515	17,767	8.52	36

Tasmania.

Locality	Licenses	Population	Popn.	Homes
Hobart	13,238	100,037	13.23	57
Remainder of State	10.930	129,963	8.41	36
State	24,168	230,000	10.50	45
Burnie	4,567	48,377	9.44	42
Devonport	8,940	86,597	10.32	44
Kelso	9,069	90,769	9.99	44
Launceston	8,347	82,196	10.15	44
Queenstown	1,083	9,719	11.14	45
Ulverstone	4.235	80,697	5.25	23

Listeners' License Figures in force in areas within 50 miles of Principal Cities and Towns.

Quarter ending September 30th, 1936.

N.S.W. and F.C.T.

Locality	Licenses	Population	Ratio of Licenses to 100 of Popn.	Ratio of Licenses to 100 of Homes
Sydney	232,698	1,449,175	16.06	68
Remainder of State	98,844	1,226,092	8.06	35
State (inc. F.C.T.)	331,542	2,675,267	12.39	53
Albury—				
N.S.W. Section .	3,311	30,792	10.75	48
Vic. Section	3,263	38,016	8.58	37
Armidale	1,762	31,562	5.58	24
Bathurst	7,461	93,390	7.99	34
Broken Hill (exc. S.A.)	3,166	28,257	11.20	45
Canberra (inc. N.S.W.)	3,032	33,586	9.03	39
Corowa—				
N.S.W. Section ..	3,392	32,168	10.54	47
Vic. Section	4,164	48,963	8.50	36
Deniliquin—				
N.S.W. Section ..	1,351	15,954	8.47	37
Vic. Section	1,894	22,271	8.50	37
Dubbo	2,810	31,277	8.98	40
Goulburn	4,843	61,541	7.87	35
Grafton	2,705	42,314	6.39	28
Griffith	2,426	34,831	6.96	32
Gunnedah	2,972	47,214	6.30	29
Katoomba (exc. Metro. area) ..	17,714	168,687	10.50	44
Lismore—				
N.S.W. Section ..	5,145	90,680	5.67	26
Qld. Section	267	5,812	4.59	19
Moss Vale	11,578	114,179	10.14	44
Newcastle	30,605	242,606	12.62	54
Orange	4,682	79,855	5.86	25
Tamworth	3,353	50,312	6.66	30
Wagga	5,548	73,086	7.59	35
Wollongong (exc. Sydney)	19,190	147,073	13.04	55

Victoria.

Locality	Licenses	Population	Ratio of Licenses to 100 of Popn.	Ratio of Licenses to 100 of Homes
Melbourne	209,626	1,212,774	17.28	72
Remainder of State	61,762	634,070	9.74	41
State	271,388	1,846,844	14.69	61
Ballarat	21,640	161,826	13.37	53
Bendigo	11,511	126,454	9.10	35
Birchip	3,699	44,214	8.34	38
Geelong (exc. Melb.)	25,338	156,164	16.22	67
Hamilton	5,090	55,555	9.16	39
Horsham	4,304	44,380	9.69	41
Mildura—				
Vic. Section	2,302	23,976	9.60	41
N.S.W. Section .	332	3,584	9.26	36
Sale	5,446	49,869	10.92	44
Shepparton—				
Vic. Section	7,180	81,247	8.84	38
N.S.W. Section .	350	4.319	8.10	36
Swan Hill—				
Vic. Section	2,462	29,583	8.32	36
N.S.W. Section .	334	5,490	6.08	27
Warrnambool	5,590	50,119	11.15	49

Queensland.

Locality	Licenses	Population	Ratio of Licenses to 100 of Popn.	Ratio of Licenses to 100 of Homes
Brisbane	56,393	408,585	13.80	59
Remainder of State	32,068	572,265	5.60	24
State	88,461	980,850	9.02	39
Ayr	2,866	41,529	6.90	30
Bundaberg	3,265	46,421	7.03	30
Cairns	1,623	48,850	3.32	14
Charleville	331	5,067	6.53	30
Gympie	4,788	68,492	6.99	30
Ipswich (exc. Brisbane	10,117	129,964	7.78	34
Longreach	372	5,062	7.34	34
Mackay	1,591	29,065	5.47	24
Maryborough	4,155	53,527	7.76	32
Oakey	6.670	83,064	8.02	37
Rockhampton	4,529	47,944	9.44	41
Toowoomba	11,426	123,059	0.28	42
Townsville	2,833	40,055	7.07	31
Warwick—				
Qld. Section ..	7,137	84,287	8.46	38
N.S.W. Section .	134	4,052	3.31	12

South Australia.

Locality	Licenses	Population	Ratio of Licenses to 100 of Popn.	Ratio of Licenses to 100 of Homes
Adelaide	70,392	395,368	17.80	71
Remainder of State	20,205	197,238	10.24	45
State (inc. N.T.) ..	90,597	592,606	15.28	63
Crystal Brook	6,883	50,128	13.73	59
Port Lincoln	962	7,196	13.37	57
Port Pirie	5,352	43,330	12.35	54
Mt. Gambier—				
S.A. Section	1,268	17,181	7.38	31
Vic. Section	1,383	7,922	17.44	73
Murray Bridge (exc. Metro. area) ..	7,426	72,910	10.18	42
Renmark	2,241	21,501	10.42	43

Western Australia.

Locality	Licenses	Population	Ratio of Licenses to 100 of Popn.	Ratio of Licenses to 100 of Homes
Perth	39,479	241,382	16.35	70
Remainder of State	11,633	129,725	8.97	39
State	53,344	450,243	11.84	49
Albany	977	9,416	10.37	39
Bunbury	2,746	33,848	8.11	31
Collie	2,673	35,470	7.53	29
Geraldton	687	9,984	6.88	31
Kalgoorlie	1,798	23,257	7.73	30
Katanning	2,119	14,537	14.57	61
Merredin	1,198	15,031	7.97	34
Narrogin	1,222	15,847	7.71	33
Northam	2,192	37,782	5.80	24
Wagin	1,678	17,676	9.44	40

Tasmania.

Locality	Licenses	Population	Ratio of Licenses to 100 of Popn.	Ratio of Licenses to 100 of Homes
Hobart	13,864	99,725	13.89	60
Remainder of State	11,633	129,725	8.97	39
State	25,497	229,550	11.10	48
Burnie	4.928	48,377	10.19	45
Devonport	9,560	86,597	11.04	47
Kelso	9,708	90,769	10.69	47
Launceston	8,904	82,196	10.83	47
Queenstown	1,165	9,719	11.99	48
Ulverstone	4,606	80,697	5.71	25

Listeners' License Figures in force in areas within 50 miles of Principal Cities and Towns.

Quarter ending December 30th, 1936.

N.S.W. AND F.C.T.

Locality.	Licences.	Population.	Ratio of Licences to 100 of Popn.	Ratio of Licences to 100 of Homes.
Sydney	238,381	1,449,175	16.45	69
Remainder of State	103,112	1,226,092	8.41	37
State (inc. F.C.T.)	341,493	2,675,267	12.76	55
Albury—				
N.S.W. Section .	3,353	30,792	10.89	49
Victorian	3,372	38,016	8.86	37
Armidale	1,843	31,562	5.84	25
Bathurst	7,948	93,390	8.51	36
Broken Hill (excluding S.A.) ..	3,498	28,257	12.38	50
Canberra (including N.S.W.) ..	3,155	33,586	9.39	40
Corowa—				
N.S.W. Section .	3,542	32,168	11.01	50
Victorian Section	4,309	48,963	8.80	37
Deniliquin—				
N.S.W. Section .	1,401	15,954	8.78	39
Victorian Section	1,979	22,271	8.88	39
Dubbo	2,997	31,277	9.58	42
Goulburn	5,077	61,541	8.25	36
Grafton	2,979	42,314	7.04	31
Griffith	2,565	34,831	7.36	34
Gunnedah	3,112	47,214	6.59	30
Katoomba (excluding Metro. area)	18,961	168,687	11.24	47
Lismore—				
N.S.W. Section .	6,028	90,680	6.65	31
Queensland „ .	274	5,812	4.70	19
Moss Vale	12,339	114,179	10.80	46
Newcastle	32,247	242,606	13.29	57
Orange	5,319	79,855	6.66	29
Tamworth	3,574	50,312	7.10	32
Wagga	5,781	73,086	7.91	36
Wollongong (ex-Metro. area) .. .	19,852	147,073	13.49	57

VICTORIA.

Locality.	Licences.	Population.	Ratio of Licences to 100 of Popn.	Ratio of Licences to 100 of Homes.
Melbourne	214,336	1,212,714	17.73	73
Remainder of State	63,008	634,070	9.93	41
State	277,344	1,846,844	15.02	62
Ballarat	22,193	161,826	13.71	55
Bendigo	11,955	126,454	9.45	37
Birchip	3,930	44,214	8.88	41
Geelong (excluding Melbourne)	26,089	156,164	16.70	69
Hamilton	5,267	55,555	9.48	41
Horsham	4,712	44,380	10.61	45
Mildura—				
Vic. Section .. .	2,554	23,976	10.65	45
N.S.W. Section	341	3,584	9.51	37
Sale	5,718	49,869	11.46	46
Shepparton—				
Vic. Section .. .	7,516	81,247	9.25	39
N.S.W. Section .	366	4,319	8.47	38
Swan Hill—				
Vic. Section .. .	2.547	29,583	8.60	37
N.S.W. Section .	348	5,490	6.34	28
Warrnambool .. .	5,768	50,119	11.50	51
Warragul (excluding Metro. area)	16,517	152,760	10.81	43

QUEENSLAND.

Locality.	Licences.	Population.	Ratio of Licences to 100 of Popn.	Ratio of Licences to 100 of Homes.
Brisbane	58,581	408,585	14.33	61
Remainder of State	33,627	572,265	5.88	25
State	92,208	980,850	9.40	41
Ayr	3,129	41,529	7.53	33
Bundaberg	3,418	46,421	7.36	30
Cairns	1,839	48,850	3.76	16
Charleville	348	5,067	6.86	32
Gympie	5,015	68,492	7.32	31
Ipswich (excluding Brisbane	10,507	129,964	8.00	36
Longreach	385	5,062	7.60	36
Mackay	1,708	29,065	5.87	26
Maryborough	4,344	53,527	8.11	33
Oakey	6,856	83,064	8.25	38
Rockhampton .. .	4,635	47,944	9.66	42
Toowoomba	11,606	123,059	9.43	43
Townsville	3,163	40,055	7.89	35
Warwick—				
Q'land Section .	7,273	84,287	8.63	39
N.S.W. Section .	178	4,052	4.39	15

SOUTH AUSTRALIA.

Locality.	Licences.	Population.	Ratio of Licences to 100 of Popn.	Ratio of Licences to 100 of Homes.
Adelaide	72,605	395,368	18.36	73
Remainder of State ..	21,276	197,238	10.78	48
State Inc. N.T.	93,881	592,606	15.84	66
Crystal Brook ..	7,222	50,128	14.40	61
Port Lincoln	1,054	7,196	14.64	63
Port Pirie	5,627	43,330	12.98	57
Mt. Gambier—				
S.A. Section .. .	1,350	17,181	7.85	33
Vic Section .. .	1,454	7,922	18.35	77
Murray Bridge (ex-Metro. area) ..	7,773	72,910	10.66	44
Renmark	2,299	31,501	10.69	44

WESTERN AUSTRALIA.

Locality.	Licences.	Population.	Ratio of Licences to 100 of Popn.	Ratio of Licences to 100 of Homes.
Perth	40,058,	241,382	16.60	71
Remainder of State	15,188	208,861	7.27	29
State	55,246	450,243	12.27	51
Albany	1,023	9,416	10.86	41
Bunbury	2,873	33,848	8.48	33
Collie	2,812	35,470	7.92	30
Geraldton	708	9,984	7.09	32
Kalgoorlie	1,903	23,257	8.18	31
Katanning	2,239	14,537	15.40	65
Merredin	1,256	15,031	8.35	35
Narrogin	1,283	15,847	8.10	34
Northam	2,307	37,782	6.10	26
Wagin	1,778	17,767	10.00	42

TASMANIA.

Locality.	Licences.	Population.	Ratio of Licences to 100 of Popn.	Ratio of Licences to 100 of Homes.
Hobart	14,444	99,825	14.47	62
Remainder of State	12,339	129,725	9.56	41
State	26,843	229,550	11.69	50
Burnie	5,265	48,377	10.88	48
Devonport	10,105	86,597	11.67	50
Kelso	10,258	90,769	11.30	50
Launceston	9.319	82,196	11.34	49
Queenstown	1,222	9,719	12.57	50
Ulverstone	4,947	80,697	6.13	27

New Zealand Broadcasting Stations

As at February, 1937.

1YA: **National Broadcasting Service, Shortland Street, Auckland.** 10 k.w. 650 kc., 461.3 m. Tranmission 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. **National Broadcasting Service, Shortland Street, 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: **National Commercial Broadcasting Service, Queen's Arcade, Auckland.** 350 watts, 1090 k.c., 275.2 m. Transmission hours:—Monday to Friday, 7 a.m.—10.30 a.m., 5—11 p.m.; Saturday, 7 a.m.—10.30 a.m., 5—midnight; Sunday, 7 a.m.—noon, 5—10.30 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.—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: Monday, Tuesday, Thursday, noon to 2 p.m., 7.30—9.30 p.m.

2YA: **National Broadcasting Service, Featherston Street, Wellington.** 60 k.w., 570 k.c., 526 m. Tranmission 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, 1 p.m.—5.15, 6.30—10.30 p.m.; Sunday, 6—10 p.m.

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: **National Broadcasting Service, 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. Sunday, 7—9.30 a.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: **National Broadcasting Service, Gloucester Street, Christchurch.** 10 k.w., 720 k.c., 416.4 m. Transsion 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: **National Broadcasting Service, Gloucester Street, 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.

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: **National Broadcasting Service, 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: **National Broadcasting Service, 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, Inchclutha, 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.

COMPLETE LIST OF BROADCASTING STATIONS IN AUSTRALIA

INCLUDING GOVERMENT STATIONS OPERATED BY THE NATIONAL BROADCASTING SERVICE AND COMMERCIAL STATIONS PRIVATELY OWNED AND OPERATED.

†Denotes Not Yet in Operation.

2AD 278 metres, 1080 kC, 100 watts. New England Broadcasters, Armidale.

2AY 203 metres, 1480 kC, 100 watts. Amalgamated Wireless (A/sia) Ltd., Studio, Temple Court, Dean Street, Albury.

†2BE Bega.

2BH 283 metres, 1060 kC, 100 watts. Radio Silver City Ltd. Studio, Cnr. Cummins and Zebina Streets, Broken Hill.

2BL 405 metres, 740 kC, 3,000 watts. National Broadcasting Service. Studio, 96-98 Market Street, Sydney.

2BS 200 metres, 1500 kC, 100 watts. Bathurst Broadcasters Ltd. Studio, 51a Keppell Street, Bathurst.

2CA 286 metres, 1050 kC, 500 watts. A. J. Ryan Broadcasters Ltd., Symondston, Canberra, F.C.T.

2CH 252 metres, 1190 kC, 1,000 watts. N.S.W. Council of Churches' Service. Studio, Grace Building, York and King Street, Sydney. Station at Dundas.

2CO 448 metres, 670 kC, 7,500 watts. National Broadcasting Service (Relays 3AR and 3LO). Station at Corowa.

2CR 545 metres, 550 kc, 10,000 watts. National Broadcasting Service. Station at Cumnock.

2DU 455 metres, 660 kC, 100 watts. Central Western Radio Services Ltd. Tamworth Street, Dubbo.

2FC 492 metres, 610 kC, 3,500 watts. National Broadcasting Service. Studio, 96-98 Market Street, Sydney.

2GB 345 metres, 870 kC, 1,000 watts. Theosophical Broadcasting Station Ltd., 29 Bligh Street, Sydney. Station at Mosman.

2GF 248 metres, 1210 kC, 100 watts. Grafton Broadcasting Co. Ltd. Station at Turf Street, Grafton.

2GN 216 metres, 1390 kC, 200 watts. Goulburn Broadcasting Co. Ltd., Auburn Street, Goulburn.

2GZ 303 metres, 990 kC, 2,000 watts. Country Broadcasting Services Ltd., Orange.

2HD 263 metres, 1140 kC, 500 watts. Airsales Broadcasting Co., P.O. Box 123, Newcastle.

†2HR Singleton.

2KA 259 metres, 1160 kC, 100 watts. Radio Katoomba Ltd., Katoomba Street, Katoomba.

†2KM Kempsey.

2KO 213 metres, 1410 kC, 500 watts. Newcastle Broadcasting Co. Ltd., 70-74 Hunter Street, Newcastle.

2KY 294 metres, 1020 kC, 1,000 watts. The Labour Council of N.S.W. Studio, 424 George Street, Sydney.

†2LF Young.

2LM 333 metres, 900 kC, 500 watts. Richmond River Broadcasters Ltd., Molesworth Street, Lismore.

2MO 219 metres, 1370 kC, 100 watts. 2MO Gunnedah Ltd., Marquis Street, Gunnedah.

†2MW Murwillumbah.

2NC 244 metres, 1230 kC, 2,000 watts. National Broadcasting Service (Relays 2FC and 2BL). Station at Newcastle.

2NR 429 metres, 700 kC, 7,000 watts. National Broadcasting Service. (Relays 2FC and 2BL.) Station at Lawrence, near Grafton.

2NZ 256 metres, 1170 kC, 2,000 watts. Northern Broadcasters Ltd., Otho Street, Inverell. Station at Little Plain.

2QN 208 metres, 1440 kC, 100 watts. Deniliquin Broadcasting Co. Ltd., End Street, Deniliquin.

2RG 204 metres, 1470 kC, 50 watts. Irrigation Area Newspapers Ltd., P.O. Box 388, Griffith.

2SM 236 metres, 1270 kC, 1,000 watts. Catholic Broadcasting Co., Australia House Wynyard Square, Sydney.

2TM 231 metres, 1300 kC, 2,000 watts. Tamworth Radio Development Co., Peel Street, Tamworth.

2UE 316 metres, 950 kC, 1,000 watts. Radio 2UE Sydney Ltd., 29 Bligh Street, Sydney.

2UW 270 metres, 1110 kC, 750 watts. Commonwealth Broadcasting Corporation Ltd., 49 Market Street, Sydney.

2WG 261 metres, 1150 kC, 1,000 watts. Riverina Radio Broadcasting Co. Ltd., 16 Fitzmaurice Street, Wagga.

2WL 210 metres, 1430 kC, 300 watts. Wollongong Broadcasting Pty. Ltd., Cnr. Church and Edward Street, Wollongong.

†2XL Cooma.

VICTORIA.

3AK 200 metres, 1500 kC, 200 watts. Melbourne Broadcasters Pty. Ltd., 480 Bourke Street, Melbourne, C.1.

3AR 476 metres, 630 kC, 4,500 watts. National Broadcasting Service. Studio, 120a Russell Street, Melbourne, C.1.

3AW 234 metres, 1280 kC, 600 watts. 3AW Broadcasting Co. Pty. Ltd., 382 Latrobe Street, Melbourne, C.1.

Complete List of Australian Broadcasting Stations

3BA 227 metres, 1320 kC, 500 watts. Ballarat Broadcasters Pty. Ltd., 56 Lydiard Street, Ballarat.

3BO 309 metres, 970 kC, 400 watts. Amalgamated Wireless (A/sia) Ltd. Studio, Pall Mall, Bendigo.

3DB 291 metres, 1030 kC, 600 watts. 3DB Broadcasting Co. Pty. Ltd., 36 Flinders Street, Melbourne, C.1.

3GI 361 metres, 830 kC, 7,000 watts. National Broadcasting Service (Relays 3AR and 3LO). Station at Longford, near Sale.

3GL 222 metres, 1350 kC, 100 watts. Geelong Broadcasters Pty. Ltd., National Mutual Buildings, Moorabool Street, Geelong.

3HA 297 metres, 1010 kC, 750 watts. Western Province Radio Pty. Ltd., 37 Gray Street, Hamilton.

3KZ 254 metres, 1180 kC, 600 watts. Industrial Printing and Pubilcity Co., 24 Victoria Street, Carlton, N.3.

3LK 275 metres, 1090 kC, 2,000 watts. 3DB Broadcasting Co. Pty. Ltd. Station at Lubeck.

3LO 390 metres, 770 kC, 3,500 watts. National Broadcasting Service. Studio, 120a Russell Street, Melbourne, C.1.

3LR 31.315 metres, 9580 kC, 1,000 watts. National Broadcasting Service. Station at Lyndhurst.

3MA 221 metres, 1360 kC, 100 watts. Sunraysia Broadcasters Pty. Ltd., 22 Deakin Avenue, Mildura.

3MB 201 metres, 1490 kC, 100 watts. Mallee Broadcasters Pty. Ltd., Cumming Avenue, Birchip.

3SH 226 metres, 1330 kC, 100 watts. Swan Hill Broadcasting Co., Campbell Street, Swan Hill.

3SR 238 metres, 1260 kC, 2,000 watts. "The Argus" Broadcasting Services Pty. Ltd., 365 Elizabeth Street, Melbourne. Station at Shepparton.

3TR 242 metres, 1240 kC, 1,000 watts. Gippsland Publicity Pty. Ltd., Raymond Street, Sale.

†3UL Warragul.

3UZ 323 metres, 930 kC, 600 watts. Nilsen's Broadcasting Service Pty. Ltd., 45 Bourke Street, Melbourne, C.1.

3UW 517 metres, 580 kC, 10,000 watts. National Broadcasting Service. (Relays 3AR and 3LO.) Station at Dooen, near Horsham.

3XY 211 metres, 1420 kC, 600 watts. Station 3XY Pty. Ltd., 4 Bank Place, Melbourne, C.1.

3YB 248 metres, 1210 kC, 100 watts. "The Argus" Broadcasting Services Pty. Ltd., 365 Elizabeth Street, Melbourne. Station at Warrnambool.

Queensland.

4AK 246 metres, 1220 kC, 2,000 watts. Brisbane Broadcasting Pty. Ltd., King House, King Street, Brisbane.

4AY 349 metres, 860 kC, 500 watts. Ayr Broadcasters Pty. Ltd., Airdmillan Road, Ayr.

4BC 268 metres, 1120 kC, 1,000 watts. Commonwealth Broadcasting Corporation (Qld.), Pty. Ltd. Studio, 43 Adelaide Street, Brisbane.

4BH 217 metres, 1380 kC, 1,000 watts. Broadcasters (Aust.), Ltd., Parbury House, Eagle Street, Brisbane.

4BK 233 metres, 1290 kC, 500 watts. Brisbane Broadcasting Pty. Ltd., 47 Charlotte Street, Brisbane.

4BU 203 metres, 1480 kC, 100 watts. Bundaberg Broadcasters Pty. Ltd., 117 Bourbong Street, Bundaberg.

4CA 216 metres, 1390 kC, 100 watts. Amalgamated Wireless (A/sia) Ltd. Station at Cairns.

4GR 300 metres, 1000 kC, 500 watts. Gold Radio Service Pty. Ltd., 43 Adelaide Street, Brisbane.

4IP 208 metres, 1440 kC, 100 watts. Ipswich Broadcasting Co. Pty. Ltd., Brisbane Street, Ipswich.

4LG 273 metres, 1100 kC, 300 watts. Central Western Broadcasting Co. Pty. Ltd., Longreach.

4MB 283 metres, 1060 kC, 100 watts. Maryborough Broadcasting Co. Ltd., 43 Adelaide Street, Brisbane. Station, Kent Street, Maryborough.

4MK 278 metres, 1080 kC, 100 watts. Mackay Broadcasting Service, 64 Nelson Street, Mackay.

4PM 221 metres, 1360 kC, 100 watts. Amalgamated Wireless (A/sia) Ltd. Studio, Musgrave Street, Port Moresby, Papua.

4QG 375 metres, 800 kC, 2,500 watts. National Broadcasting Service. Studio, State Insurance Building, Brisbane.

4QN 500 metres, 600 kC, 7,000 watts. National Broadcasting Service. Station at Clevedon, North Queensland.

4RK 330 metres, 910 kC, 2,000 watts. National Broadcasting Service. Station at Rockhampton.

4RO 226 metres, 1330 kC, 50 watts. Rockhampton Broadcasting Co. Pty. Ltd., 43 Adelaide Street, Brisbane. Station at Rockhampton.

†4SB Kingaroy.

4TO 259 metres, 1160 kC, 200 watts. Amalgamated Wireless (A/sia) Ltd. Station at Townsville.

4VL 210 metres, 1430 kC, 50 watts. Charleville Broadcasting Service Pty. Ltd., Burke Street, Charleville.

4WK 224 metres, 1340 kC, 100 watts. Warwick Broadcasting Co. Pty. Ltd., Cnr. King and Albion Streets, Warwick.

†4ZR Roma.

SOUTH AUSTRALIA.

5AD 229 metres, 1310 kC, 500 watts. Advertiser Newspapers Ltd., Waymouth Street, Adelaide.

5DN 313 metres, 960 kC, 500 watts. Hume Broadcasters Ltd., 29 Rundle Street, Adelaide.

5CK 469 metres, 640 kC, 7,500 watts. National Broadcasting Service Station at Crystal Brook.

Complete List of Australian Broadcasting Stations *(Continued)*

5CL 411 metres, 730 kC, 2,000 watts. National Broadcasting Service. Studio, Hindmarsh Square, Adelaide.

5KA 250 metres, 1200 kC, 500 watts. Sport Radio Broadcasting Co. Ltd., Richards Building, Currie Street, Adelaide.

5MU 207 metres, 1450 kC, 100 watts. Murray Bridge Broadcasting Co. Ltd. Station at Murray Bridge.

5PI 288 metres, 1040 kC, 2,000 watts. Midlands Broadcasting Services Ltd. Station at Crystal Brook.

5RM 353 metres, 850 kC, 1,000 watts. River Murray Broadcasters Ltd. Station at Renmark.

†5SE Mt. Gambier.

WESTERN AUSTRALIA.

6AM 306 metres, 980 kC, 2,000 watts. 6AM Broadcasters Ltd. Station at Northam.

†6— Geraldton.

6GF 417 metres, 720 kC, 2,000 watts. National Broadcasting Service. Station at Kalgoorlie.

6IX 242 metres, 1240 kC, 500 watts. West Australian Newspapers Ltd., St. George's Terrace, Perth.

6KG 248 metres, 1210 kC, 500 watts. Goldfields Broadcasters (1933) Ltd., 209 Hannan Street, Kalgoorlie.

6ML 265 metres, 1130 kC, 500 watts. W.A. Broadcasters Ltd., Lyric House, Murray Street, Perth.

†6NA Narrogin.

†6PM 216 metres, 1390 kC, 100 watts. 6PM Broadcasters Ltd., St. George's House, St. George's Terrace, Perth. Station at Fremantle.

6PR 341 metres, 880 kC, 500 watts. Nicholson's Ltd., 86-90 Barrack Street, Perth.

6WA 536 metres, 560 kC, 10,000 watts. National Broadcasting Service. Station at Minding, near Wagin.

6WB 280 metres, 1070 kC, 2,000 watts. W.A. Broadcasters Ltd. Station at Katanning.

6WF 435 metres, 690 kC, 3,500 watts. National Broadcasting Service. Studio, Stirling Institute, Perth.

TASMANIA.

7BU 455 metres, 660 kC, 100 watts. Findlay's Pty. Ltd., Wilson Street, Burnie.

7HO 349 metres, 860 kC, 100 watts. Commercial Broadcasters Pty. Ltd., 82 Elizabeth Street, Hobart.

7HT 278 metres, 1080 kC, 300 watts. Metropolitan Broadcasters Pty. Ltd., 44 Eilzabeth Street, Hobart.

7LA 273 metres, 110 kC, 300 watts. Findlay and Wills Broadcasters Pty. Ltd., 67 Brisbane Street, Launceston.

†7— Longford.

7NT 423 metres, 710 kC, 7,000 watts. National Broadcasting Service. Station at Kelso.

†7QT Queenstown.

7UV 205 metres, 1460 kC, 300 watts. Northern Tasmania Broadcasters Pty. Ltd., Reibey Street, Ulverstone.

7ZL 484 metres, 620 kC, 1,000 watts. National Broadcasting Service. Studio, Elizabeth Street, Hobart.

Radio Publications of Australia

Australian Radio Publications Ltd. (Established 1930), are publishers of this RADIO TRADE ANNUAL OF AUSTRALIA, also the weekly trade paper "RADIO RETAILER" which is issued every Friday and circulates throughout Australia, New Zealand, Great Britain, U.S.A., and the Continent. Subscription is 15/- p.a., including a copy of this Radio Trade Annual. Also the monthly technical journal "RADIO REVIEW OF AUSTRALIA" which incorporates the Proceedings of the Institution of Radio Engineers (Australia), and other technical matters; subscription 10/- p.a. post free. Also, "BROADCASTING BUSINESS"—a weekly business paper relating to the activities of commercial broadcasting in Australia, is issued every Thursday, and the subscription is only 15/- p.a., including postage, including a copy of the Year Book.

These publications represent all sections of radio and broadcasting fields, and those interested professionally should not fail to be regular subscribers to one or all of these Australian radio publications. Address all correspondence to Box 3765, G.P.O., Sydney.

EXISTING AUSTRALIAN NATIONAL BROADCASTING STATIONS

Station	Location	Frequency kC	Wave-length (m.)	Power Watts	Ultimate Power
2BL Sydney	Coogee, 4½ miles S.E. of G.P.O.	740	405	3,000	
2CO Corowa	3½ miles N.N.E. of P.O., Corowa	448	670	7,500	
2CR Cumnock	Cumnock, N.S.W.	550	545	10,000	60,000
2FC Sydney	Pennant Hills, 11¼ miles N.W. of G.P.O.	610	492	3,500	
2NC Newcastle	Beresfield, 11½ miles W.N.W. P.O., Newcastle	1,230	244	2,000	
2NR Lawrence	Near Grafton, N.S.W.	700	429	7,000	30,000
3AR Melbourne	North Essendon, 8 miles N.W. Elizabeth Street P.O.	630	476	4,500	
3GI Longford	Near Sale, Vic.	830	361	7,000	30,000
3LO Melbourne	Braybrook, 5¾ miles W. Elizabeth Street P.O.	770	390	3,500	
3LR Lyndhurst	5 miles S. by E. of Dandenong	9,580	31.31	1,000	
3WV Doen	Near Horsham, Vic.	580	517	10,000	60,000
4QG Brisbane	25chains S.W. of G.P.O.	800	375	2,500	
4QN Clevedon	Near Townsville, Qld.	600	500	7,000	30,000
4RK Rockhampton	6 miles S.W. of P.O.	910	330	2,000	
5CK Crystal Brook	2½ miles N.E. of P.O.	640	469	7,500	
5CL Adelaide	Brooklyn Park, 3¼ miles W. of G.P.O.	730	411	2,000	
6GF Kalgoorlie	4 miles S.W. of Kalgoorlie P.O., W.A.	720	417	2,000	
6WA Minding	Near Wagin, W.A.	560	536	10,000	60,000
6WF Perth	8 miles N. of G.P.O.	690	435	3,500	
7NT Kelso	29 miles N.W. of Launceston, Tas.	710	423	7,000	30,000
7ZL Hobart	Radio Hill, 1¾ miles S.W. of G.P.O.	620	484	1,000	

Australian Radio Tariff Schedule

In Accordance with the Customs Tariff, 1933-1936

In the following schedules the first duty is British Preference Tariff, the second Intermediate Tariff, and the third, General Tariff. The Intermediate Tariff rates shown are at present inoperative.

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.	Primage Duty. General
Item No. 179 (D) (4) (a)	Free	4%
„ „ 180 (E)	5%	10%
„ „ 180 (G)	5%	10%
„ „ 180 (I)	5%	10%
„ „ 181 (A) (2)	10%	10%
„ „ 404	Free	4%
„ „ 415A	Free	4%

The import duty on goods admissable at the British Preferential Tariff rate under Tariff Items 180 (E) (9), 180 (E) (10), 180 (E) (11), 180 (E) (12) 180 (E) (13), 180 (E) (15), 180 (E) (16), and 180 (G), is subject to a deduction in accordance with the Customs Tariff (Exchange Adjustment) Act, 1933-1936, 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 1921-1936 (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 ness 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, 1921-1936, 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 Custom (other than primage duty and duty imposed by the Customs Tariff (Industries Preservation) Act, 1921-1936, 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."

179. ELECTRICAL MACHINES AND APPLIANCES.—

(D) (4) (a) Elements for electric current rectifier assemblies, other than rectifying valves covered by item 181 (A) (2) ad val. British Preferential Free, Intermediate Tariff 15%, General Tariff 15%.

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); 24/- (Intermediate); 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 2/4. †

2. Condensers, fixed mica, each 3d., 4d., 4½d. †

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/, 2/6, 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., 9d., 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, 1/9, 1/10½d. †

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., 4d., 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., 8d., 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., 3½d., 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, 2/6, 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 incorporated in a wireless receiving set each 15/-, 25/-, 26/6. †

And in respect of paragraph (8)—for each £1 by which the equivalent in Australian currency of £100 sterling is

(Continued Overleaf.)

CUSTOMS TARIFF SCHEDULE

(Continued from Page 73.)

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., 50 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.

† See provision after paragraph (2) of this sub-item for alternative ad valorem rates.

9. Choke coils suitable for use in connection with battery eliminating devices, each 5/-, 10/-. ‡

10. Condensers, variable, of capacities exceeding .0001 microfarad, but not exceeding .001 microfarad—with gang or drum control—per each condenser contained therein, 1/6, 3/-. ‡

Without gang or drum control, each 1/6, 3/-. ‡

11. Condensers, variable, midget, of .0001 microfarad capacity or less, each 1/-, 1/6. ‡

12. Loudspeakers and Parts thereof:

(a) Loudspeakers including transformers, each 10/-, 12/6. ‡

(b) Parts of loudspeakers imported other than in complete loudspeakers, viz.:—

(1) Field coils, each 2/-, 3/-. ‡

(2) Field Coil Cores, each 9d., 1/3. ‡

(3) Field Coil Housings, each 1/-, 1/6. ‡

(4) Cones with or without voice coils, each 1/3, 1/9. ‡

(5) Cone Housings, each 1/9, 2/3. ‡

(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 10/-, 15/-.

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.: ad val. 35 per cent.—55 per cent. ‡

14. Headphones; Parts n.e.i. of wireless receivers, other than cabinets—ad val. 30 per cent., 50 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—12/6, 25/-, 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.

‡ See provision after paragraph (13) of this sub-item (on this page) for alternative ad valorem rates.

(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 20/-, 25/.

And in addition per valve socket excluding sockets for valves forming part of any battery eliminating device—12/6, 25/-.

Or as an alternative to the cumulative fixed rates provided above ad val. 35 per cent.—55 percent.

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.:—

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 parts 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 for 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., 5d., 5¼d., or ad val. 25 per cent., 42½ 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., 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, 2/3, 3/6, or ad val. 20 per cent.—40 per cent.

whichever rate returns the higher duty.

Under the excise tariff for the year 1921-1936, Item 19 provides for valves for wireless telegraphy and telephony, including rectifying valves, but not including metal type valves, 2/- each.

And on and after July 1, 1937, valves for wireless telegraphy and telephony, including rectifying valves, 2/- each.

This means that after July 1, 1937 (subject to any possible alteration that may occur later than March, 1937), all valves made in Australia are subject to a local excise duty of 2/- each.

Item 404, Miscellaneous.

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 are subject to an ad val. duty of —British free, Foreign 15 per cent.

FOR USE IN THE MANUFACTURE OF ALL KINDS OF ELECTRICAL APPARATUS AND APPLIANCES, 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 braiding or sleeving, bakelised paper, porcelain, hard rubber.

Speaker units under security for the manufacture of magnetic type loud speakers.

Permanent magnets under security for the manufacture of loud speakers.

FOR THE MANUFACTURE OF WIRELESS RECEIVING SETS, battery cables (not including terminals), consisting of several flexible cords contained in one braided cover; woven antenna, i.e., aerial tape without terminals, under security; cotton-covered loop antenna wire for inside aerials, under security.

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 strips 3½ ins. wide x 3/16 ins. thick under security for manufacture of Field Coil Housings for Loud speakers.

CUSTOMS TARIFF SCHEDULE

(Continued from Page 74.)

The undermentioned items may be added to the list of articles admissible under tariff Item 404:—

FOR USE IN THE MANUFACTURE OF RADIO "B" BATTERIES, ALKALINE TYPE, TO BE FITTED INTO CABINETS, COMPLETE WITH CHARGING APPARATUS OF AUSTRALIAN MANUFCTURE, connectors, under security, elements, under security, separators, under security.

FOR USE IN THE MANUFACTURE OF CONDENSERS, metal foil, under security, tissue paper, used as a dielectric, under security.

FOR ALL PURPOSES, aluminium sheets, plain, satin finished, and/or polished.

FOR USE IN THE MANUFACTURE OF LEADS OR CABLES, BRAIDED, FOR WIRELESS RECEIVING SETS, cotton yarns or threads, polished, single or 2-ply, dyed or otherwise, under security.

FOR USE IN THE MANUFACTURE OF POTENTIOMETERS AND VARIABLE RESISTANCES, carbon rings, under security.

FOR USE IN THE MANUFACTURE OF WIRELESS VALVES, bakelite valve bases, with metal pins attached; glass, soda or lime bulbs; barium magnesium pellets; pure iron sheets; of gauges Nos. 18 to 46 (S.W.G.), both gauges inclusive; magnesium strips; metal strips, having a nickel content greater than 20 per cent., under security; nickel chromium strips, in rolls, of gauges Nos. 18 to 46 (S.W.G.), both gauges inclusive; fabricated valve parts, of metal or mica, viz.: Caps, eyelets, filament clips and supports, getter cups and tabs, grid collars, grids, heaters and cathodes, mica spacers, plates, top shields, screens, welds and spuds; wire mesh, less than 120 holes per lineal inch, viz.: monel metal, nickel, pure iron; magnesium wire; pure iron wire of gauges Nos. 18 to 46 (S.W.G.) both gauges inclusive.

FOR USE IN THE MANUFACTURE OF WIRELESS RECEIVING SETS, cords with or without terminals affixed thereto whether imported with loud speakers or separately.

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 per cent.

FOR USE IN ELECTRICAL APPARATUS AND APPLIANCES, copper braid made of wire of gauges finer than No. 30 (I.S.W.G.); copper cable, stranded, made of wire gauges finer than No. 30 (I.S.W.G.)

Cotton covered flat laid cords with terminals affixed thereto for use with radio head sets.

Being instruments for testing radio equipment, standard signal generators; beat frequency and low frequency oscillators.

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.

The UNDERMENTIONED ITEMS MAY BE ADDED TO THE LIST OF ARTICLES ADMISSIBLE UNDER TARIFF ITEM 415A (2):—

Insulating boards of a quality of kind which the Minister is satisfied is not being made in Australia, for use in electrical apparatus and appliances (security is required for boards of paper other than Elephantide, Fibreboard, Leatheroid and Presspahn).

The importation of the undermentioned goods from all non-British countries is probihited unless the consent of the Minister has first been obtained, viz.:—

Wireless receivers, parts thereof and accessories therefor.

Valves for wireless telegraphy and telephony, including rectifying valves.

Carbon manufactures of all kinds, including carbon blocks.

Application for permits to import should be made prior to importation to the Collector in the State into which the goods are to be imported.

Radio Valve Importations into Australia

January to December, 1936

New South Wales.

Quantity—	U.K.	Holland	U.S.A.	Total
January	12,940	8,809	131,837	153,646
February	10,004	3,463	41,258	54,726
March	8,225	58,734	38,191	105,150
April	14,307	22,397	83,153	119,969
May	23,343	68,722	93,241	185,414
June	5,347	21,620	77,215	113,182
July	10,835	10,947	66,078	87,982
August	19,779	33,413	66,651	122,849
September	4,154	6,913	64,571	75,638
October	20,505	9,506	41,983	75,455
November	16,188	15,970	36,659	68,817
December	22,065	30,339	18,286	70,690
	167,692	290,833	759,123	1,233,518
Value—				
January	£2,930	£3,336	£16,286	£22,565
February	3,358	1,072	5,903	10,350
March	4,758	11,688	9,152	25,598
April	7,411	7,589	8,548	23,566
May	9,668	21,509	8,513	39,722
June	2,431	7,059	7,898	20,069
July	6,638	3,760	6,835	17,293
August	9,739	9,991	6,248	26,960
September	3,495	2,360	4,592	10,447
October	6,421	3,015	3,898	13,597
November	5,461	3,848	3,412	12,721
December	8,328	7,693	1,786	17,807
	£70,638	£82,920	£83,071	£240,695

Totals in column 4 include the following N.S.W. importation from—

Austria	in June	1936,	9,000	valves, value	£2,681
"	" Aug.	"	3,000	" "	£ 870
Canada	" "	"	6	" "	£ 112
"	" Oct.	"	3,461	" "	£ 263
Germany	" Jan.	"	48	" "	£ 12
"	" May	"	108	" "	£ 32
"	" July	"	114	" "	£ 20
Japan	.. April	"	100	" "	£ 10
New Zealand	" Jan.	"	12	" "	£ 1
" "	" July	"	7	" "	£ 1

Victoria.

Quantity—	U.K.	Holland	U.S.A.	Total
January	1,245	1	23,789	26,440
February	680	41	1,425	2,146
March	216	824	9,763	10,814
April	136	1,035	21,930	23,101
May	6	2,629	8,314	10,949
June	474	3,150	21,379	25,003
July	477	1,763	15,549	17,795
August	196	1,511	17,759	20,210
September	28	166	9,464	9,658
October	2,107	—	5,533	7,750
November	1,091	—	6,116	7,211
December	159	—	7,316	7,486
	6,815	11,120	148,337	168,563
Value—				
January	£789	£36	£2,856	£4,044
February	377	468	223	1,068
March	300	336	933	1,585
April	52	588	1,848	2,488
May	416	1,349	663	2,428
June	422	1,082	1,889	3,393
July	961	1,146	1,345	3,455
August	455	845	1,417	2,930
September	9	172	936	1,117
October	2,114	—	532	2,666
November	827	4	900	1,732
December	381	—	706	1,098
	£7,103	£6,026	£14,248	£28,004

Totals in column 4 include the following importations into Victoria from:—

Austria	in August	1936	720	valves, value	£208
Canada	" January	"	1,400	" "	£362
"	" August	"	24	" "	£ 5
"	" October	"	105	" "	£ 19
"	" November	"	4	" "	£ 1
Germany	" March	"	11	" "	£ 16
"	" July	"	6	" "	£ 3
"	" October	"	5	" "	£ 1
"	" December	"	11	" "	£ 11
Japan	" January	"	5	" "	£ 1

Queensland.

Quantity—				
January	10	5	30	45
February	—	—	9	9
March	—	6	7	13
April	5	—	8	13
May	—	—	11	11
June	—	1	—	1
July	57	4	32	93
August	129	61	—	190
September	20	25	9	54
October	78	—	8	86
November	13	—	—	13
December	3	—	—	3
	315	102	114	531
Value—				
January	£19	£137	£9	£165
February	—	—	2	2
March	—	235	6	241
April	11	—	9	20
May	—	—	2	2
June	—	36	—	36
July	94	51	15	160
August	325	88	—	413
September	382	21	9	412
October	1,333	—	35	1,368
November	473	—	—	473
December	30	—	—	30
	£2,667	£568	£87	£3,322

South Australia.

Quantity—				
January	166	5	27	198
February	—	8	22	30
March	—	6	7	13
April	—	—	20	20
May	150	2	15	167
June	65	—	6	71
July	55	1	6	62
August	116	2	24	142
September	12	19	5	36
October	223	3	—	226
November	8	—	12	20
December	11	—	—	25
	806	46	144	1,010

VALVE IMPORTATIONS, 1936—(Continued)

Value—				
January	£58	£196	£13	£267
February	—	277	4	281
March	—	221	2	223
April	—	—	2	2
May	21	72	4	97
June	87	—	2	89
July	207	38	1	246
August	229	36	13	278
September	495	675	4	1,174
October	238	115	—	353
November	15	—	6	21
December	21	—	—	29
	£1,371	£1,630	£51	£3,060

Totals in column 4 include the following—South Australia imported from Germany in December, 1936, 14 valves, value £8.

Western Australia.

Quantity—				
January	—	—	—	10
February	13	—	11	24
March	13	3	—	116
April	10	—	5	15
May	25	1,005	16	1,046
June	150	27	16	193
July	—	—	12	12
August	155	1	—	156
September	112	24	10	146
October	310	8	—	318
November	2	—	15	17
December	26	4	—	30
	916	1,072	85	2,083
Value—				
January	—	—	—	4
February	£8	—	£2	£10
March	40	85	—	125
April	4	—	1	5
May	8	365	8	381
June	43	64	3	110
July	—	—	2	2
August	277	38	—	315
September	423	13	9	445
October	546	4	—	550
November	154	—	13	167
December	52	5	—	57
	£1,555	£574	£38	£2,171

Totals in column 4 include the following:—Western Australia imported from Germany in January, 1936, 10 valves, value £4.

Tasmania.

Quantity—				
January	7	—	26	33
February	—	—	—	—
March	—	—	—	—
April	—	—	12	12
May	—	—	—	—
June	—	—	12	12
July	130	—	6	136
August	35	—	6	41
September	41	33	5	79
October	—	—	—	—
November	36	—	—	36
December	2	—	—	2
	251	33	67	351
Value—				
January	£4	—	£9	£13
February	—	—	—	—
March	—	—	—	—
April	—	—	2	2
May	—	—	—	—
June	—	—	2	2
July	307	—	5	312
August	79	—	1	80
September	375	34	4	413
October	—	—	—	—
November	15	—	—	15
December	4	—	—	4
	784	34	23	841

Commonwealth.

Quantity—	U.K.	Holland	U.S.A.	Total
January	14,368	8,820	155,709	180,372
February	10,697	3,512	42,725	56,935
March	8,554	59,573	47,968	116,106
April	14,458	23,432	105,128	143,130
May	23,524	72,358	101,597	197,587
June	6,036	24,798	98,628	138,462
July	11,554	12,715	81,683	106,080
August	20,410	34,988	84,440	143,588
September	4,367	7,180	74,064	85,611
October	23,223	9,517	47,524	83,835
November	17,338	15,970	42,802	76,114
December	22,266	30,343	25,602	78,236
	176,795	303,206	877,870	1,406,056
Value—				
January	£3,800	£3,705	£19,173	£27,058
February	3,743	1,817	6,134	11,711
March	5,098	12,565	10,093	27,772
April	7,478	8,177	10,410	26,083
May	10,113	23,295	9,190	42,630
June	2,983	8,241	9,794	23,699
July	8,207	4,995	8,203	21,468
August	11,104	10,998	7,679	30,976
September	5,179	3,275	5,554	14,008
October	10,652	3,134	4,465	18,534
November	6,945	3,852	4,331	15,129
December	8,816	7,698	2,492	19,025
	£84,118	£91,752	£97,518	£278,093

Totals in column 4 include the following:—

Australia Re-imported into

N.S.W.	in Feb.	1936,	1	valve, value	£ 17
"	" April	"	12	valves, value	£ 8
"	" July	"	1	valve, value	£ 39

Miscellaneous Importations.

Austria	" June	"	9000	valves, value	£2681
"	" August	"	3720	" "	£1078
Canada	" January	"	1400	" "	£ 362
"	" August	"	30	" "	£ 117
"	" October	"	3566	" "	£ 282
"	" November	"	4	" "	£ 1
Germany	" January	"	58	" "	£ 16
"	" March	"	11	" "	£ 16
"	" May	"	108	" "	£ 32
"	" July	"	120	" "	£ 23
"	" October	"	5	" "	£ 1
"	" December	"	25	" "	£ 19
Japan	" January	"	5	" "	£ 1
"	" April	"	100	" "	£ 10
New Zealand	" January	"	12	" "	£ 1
" "	" July	"	7	" "	£ 1

Note.—See "Review of Radio Industry" on page 15 for summary of valve position.

See "Review of Radio Industry" on page 15

RADIO APPARATUS IMPORTATIONS INTO AUSTRALIA DURING 1936

NEW SOUTH WALES.

	Battery Eliminators.	Parts N.E.I.	Radio Sets.	Total.
	£	£	£	£
January	64	3,112	235	3,411
February	11	2,327	974	3,312
March	—	3,678	524	4,202
April	2	5,044	1,208	6,254
May	8	3,554	749	4,311
June	27	5,675	600	6,302
July	7	3,127	1,191	4,325
August	4	4,498	977	5,479
September	6	3,215	744	3,965
October	10	2,433	643	3,086
November	31	3,480	779	4,290
December	70	3,139	758	3,967

Battery Chargers Value £11 were imp. into N.S.W. in Jan., 1936
" " " £5 " " " " " Feb. 1936
" " " £12 " " " " " Apl. 1936

VICTORIA.

	£	£	£	£
January	253	646	122	1,021
February	20	549	107	676
March	146	560	368	1,094
April	643	512	84	1,239
May	99	627	160	886
June	14	615	134	763
July	498	602	47	1,147
August	5	1,636	35	1,676
September	6	1,293	51	1,350
October	7	1,386	50	1,469
November	10	584	44	638
December	4	4,903	142	5,049

Battery Chargers value £20 were imp. into Victoria in Mar. 1936
" " " £26 " " " " " Oct. 1936

QUEENSLAND.

	£	£	£	£
January	—	12	40	52
February	4	27	6	37
March	—	37	15	52
April	—	2	7	9
May	—	23	39	62
June	1	54	1	56
July	1	16	21	38
August	—	66	11	77
September	—	3	16	19
October	—	9	—	9
November	—	10	—	10
December	—	14	11	25

SOUTH AUSTRALIA.

	Battery Eliminators.	Parts N.E.I.	Radio Sets.	Total.
	£	£	£	£
January	2	39	1 1	52
February	—	6	15	21
March	2	18	—	20
April	5	5	13	23
May	2	41	7	50
June	—	7	24	31
July	1	11	7	19
August	3	6	7	16
September	17	91	—	108
October	—	44	—	44
November	—	67	434	501
December	—	16	—	16

Battery Chargers value £40 were imp. into S.A. in Jan., 1936
" " " £40 " " " " " June 1936

WESTERN AUSTRALIA.

	£	£	£	£
January	—	52	26	78
February	1	66	8	75
March	—	25	36	61
April	—	22	9	31
May	4	28	6	38
June	—	6	12	18
July	4	4	8	16
August	—	16	—	16
September	3	7	12	22
October	—	—	—	—
November	—	44	245	289
December	—	9	5	14

Battery Chargers value £5 were imp. into W.A. in January, 1936

TASMANIA.

	£	£	£	£
January	29	5	29	63
February	—	—	—	—
March	—	—	—	—
April	—	2	11	13
May	—	—	—	—
June	1	1	6	8
July	—	—	—	—
August	1	1	5	7
September	—	—	9	9
October	—	7	—	7
November	—	13	140	153
December	—	1	—	1

COMMONWEALTH.

	£	£	£	£
January	348	3,866	463	4,677
February	36	2,975	1,110	4,121
March	148	4,318	943	5,409
April	650	5,587	1,332	7,569
May	113	4,273	961	5,347
June	43	5,358	777	6,178
July	511	3,760	1,274	5,545
August	13	6,223	1,035	7,271
September	32	4,618	823	5,473
October	17	3,879	693	4,589
November	41	4,198	1,642	5,881
December	74	8,082	916	9,072

RADIO AND TELEVISION PATENTS

1936 TRANSACTIONS IN AUSTRALIA

MORE CONCERNS INTERESTED

DURING 1936, in keeping with other phases of the industry, radio and television patents in Australia showed increased activity. During the twelve months 370 applications for patents were accepted by the Australian Patent Office for radio and television circuits and apparatus, loudspeakers, valves, cathode ray tubes, direction finding and navigation aiding systems, and other gadgets which have some application in radio and allied undertakings. Last year the number similarly dealt with was 343.

From the point of view of country of origin, the United States was again easily first, although its total (147) was 17 less than in 1935. Germany was again second, raising its total from 80 to 96, and England came third with a substantial jump from 50 to 79. Holland, with 23, had one less than in the previous year, and Australia went back from 24 to 15. The rest of the world brought along only 10.

The United States lost ground in purely radio subjects, dropping back from 96 to 69, but gained in television (23 to 35), and was fairly stationary in miscellaneous matters. In Germany's total, television had the lion's share (56), although it lost two. There were gains in radio, 10 to 18, and in miscellaneous groups, 10 to 22. England showed greatest activity in radio, doubling its previous year's total of 21 in this division and gaining slightly in others. Holland dropped back in radio and television, but gained in other respects, and Australia fell back considerably in radio circuits, remaining fairly steady in other directions.

On the score of ownership, the principal characteristic was a more even distribution and an increase in the number of owners that have acquired substantial holdings. The Marconi Company was at the head of the list, but with a slightly reduced total (128), and again with a substantially reduced percentage. It showed progress in television and miscellaneous, but a loss in radio.

Radioaktiengesellschaft D. S. Loewe, which, in 1935 made a vigorous debut, more than doubled its holdings and came into second place with 63. All but a few of these were concerned with television, and cathode ray tubes.

Telefunken total (25) was less than half of that of the previous year, falling away heavily in television, but gaining a few in radio. Philips were practically the same, and the only other owner to reach double figures was the Neutrodyne-Hazeltine Group, with 14, a drop of 3. Quite a number of concerns who, in previous years, have only had an odd application or two, have become more regular in their activities, thus tending to spread patent interests more evenly than in the past.

Television continues to expand, the applications in this division increasing appreciably, and much of the increase in the miscellaneous group being due to several items which, although not specifically mentioning television, are obviously suitable for it. Germany, in point of numbers, is an easy first, having as many applications as the rest of the world put together. This position is practically all due to the Loewe people with their cathode ray tubes and other special circuits and apparatus.

The policy of covering everything, apparently without much regard for their present or future utility, is still vigorously pursued by many of the patent holders. Overseas technical interests still dominate the position. Last year only 15 out of 370 inventions originated in Australia, a result much worse than that of 1935, when 24 out of 343 came from the Continent.

These figures would tend to show that Australia does not hold the high position in commercial research that some would have us believe. In fact, in view of these figures, the less said on this subject the better.

In the industry there were no disputes on patent matters. There were a few rumblings, and with the approach of another "zero hour" next year, there will probably be increasing interest in patents during the current period.

OWNERSHIP.

Name	Radio	Television	Miscellaneous	Total
Marconi Co.	65	38	25	128
Telefunken	14	2	9	25
Philips	8	—	12	20
Neutrodyne Group	10	4	—	14
Philco	6	—	1	7
S.T.C.	6	—	3	9
I.G.E. (U.S.A.) .	5	—	3	8
Johnson Lab.	4	—	4	8
Gen. Electric Co. .	4	2	3	9
D. S. Loewe	2	50	11	63
Television Lab. .	1	6	—	7
Baird	—	3	—	3
Farnsworth Tel. ..	1	2	4	7
Sundry	22	7	33	62
Total	148	114	108	370

SUMMARY.

COUNTRIES OF ORIGIN.

	U.S.A.	England	Germany	Holland	Australia	Others	T'l.
Radio	69	42	18	8	6	5	148
Televasion .	35	20	56	—	2	1	114
Miscellaneous	43	17	22	15	7	4	108
Total ..	147	79	96	23	15	10	370

PATENTS

RADIO CIRCUITS

Marconi Wireless Telegraph Co. Ltd.

NO.	Subject and Country of Origin.
20637/34	Antennae. U.S.A.
20840/35	Modulated carrier wave receivers. U.S.A.
20867/35	Modulated carrier wave transmitters. U.S.A.
20888/35	Electrical oscillation generators. U.S.A.
20889/35	Frequency discriminating circuits. U.S.A.
20988/35	Aerial systems for use on short waves. England.
21067/35	Directional Radio Systems. England.
21068/35	Radio receiving installations. England.
21220/35	High frequency electrical oscillator. U.S.A.
21305/35	Electrical relay and oscillator system. U.S.A.
21442/35	Oscillation Generator U.S.A.
21444/35	Electron discharge device amplifiers. U.S.A.
21537/35	High frequency oscillators. U.S.A.
21649/35	Electrical power supply circuits. U.S.A.
21715/35	Thermionic valve apparatus. England.
21764/35	Resonators for use in high frequency systems. U.S.A.
21956/35	Receiving antenna systems. U.S.A.
22184/35	Radio antenna systems. U.S.A.
22282/35	Navigation aiding radio systems. U.S.A.
22372/35	Very short wave radio transmitting. England.
22393/35	Radio receivers and like. England.
22393/35	Modulated carrier wave receivers. England.
22394/35	Radio and modulated carrier wave receivers. England.
22453/35	Modulated carrier wave receivers. U.S.A.
22497/35	Thermionic oscillation systems. U.S.A.
22628/35	Radio receiving systems. U.S.A.
22794/35	Radio receivers. England.
22872/35	Modulated carrier wave transmitters. England.
22873/35	Radio receivers. England.
22999/35	Micro wave signalling systems. England.
23003/35	Radio receivers. U.S.A.
23012/35	Magnetron oscillation generators. England.
23096/35	High frequency valve amplifiers. England.
23251/34	Radio direction finding. England.
23539/35	Electron discharge device. U.S.A.
23650/35	Oscillation generators. U.S.A.
23805/35	Remotely controlled radio receivers. England.
23806/35	Directional wireless system. England.
23880/35	Radio receivers. England.
23965/35	Valve circuit arrangement. England.
24065/35	Oscillatory circuit arrangements. U.S.A.
24130/35	Electrical tuned circuit arrangements. England.
24160/35	Very high frequency receivers. England.
24210/35	Radio receivers. England.
24271/35	Oscillatory circuit arrangements. U.S.A.
24400/35	High frequency coupling arrangements. U.S.A.
24401/35	Modulated carrier wave systems. U.S.A.
24423/35	Receiving apparatus. England.
24435/35	Obviating ignition disturbances in receivers. England.
24617/35	Electrical oscillation generators. England.
24647/35	Oscillating circuit arrangements. England.
24818/35	Thermionic valve circuit arrangements. England.
24796/35	Thermionic valve circuit arrangements. England.
24818/35	Thermonic valve circuit arrangements, England.
24962/35	Radio transmitting systems. U.S.A.
25067/35	Oscillation generators. U.S.A.
25227/35	Remote control feeder arrangements. England.
25228/35	Oscillation generator. England.
25244/35	Tuning dial. U.S.A.
25340/35	Modulated carrier wave transmitters. Germany.
25446/35	Radio communication systems. U.S.A.
25447/35	Directional antennae. U.S.A.
25548/35	Radio receiving for motor vehicles. U.S.A.
25549/35	Aerial arrangements for aircraft. U.S.A.
25550/35	Electrical transmission line. U.S.A.
25551/35	Short wave radio transmitters. U.S.A.

Telefunken Gesellschaft Fur Drahtlose Telegraphie m.b.H.

20952/35	Navigation aiding radio transmitting. Germany.
21630/35	Modulation. Germany.
21765/35	Modulated carriers wave systems. Germany.
23155/35	Directional radio systems. Germany.
23157/35	High frequency oscillation. Germany.
23158/35	Directional radio installations. Germany.
23159/35	Discharge devices. Germany.
23160/35	Radio transmitters. Germany.
24064/35	Magnetron tube circuit arrangements. Germany.
24166/35	Oscillators. U.S.A.
24270/35	Circuit externally controlled. U.S.A.
25169/35	Magnetron Circuit arrangements. Germany.
25170/35	Electron tubes. Germany.
25338/35	Modulated carrier wave signalling. Germany.

N. V. Philip's Gloeilampenfabrieken.

22714/35	Intermediate frequency amplifiers. Holland.
22857/35	Resonance indication in superheterodyne receiving sets. Holland.
23526/35	Amplifying. Holland.
23527/35	Band filters. Holland.
13/36	Indicator devices for radio apparatus. Holland.
261/36	Receiving sets. Holland.
1059/36	Suppressing disturbances in receiving sets. Holland.
1111/36	Tone frequency oscillation. Holland.

Hazeltine Corporation.

21667/35	Superheterodyne receiver. U.S.A.
21669/35	High frequency coupling systems. U.S.A.
21687/35	Heterodyne signalling systems. U.S.A.
21686/35	Automatic volume control. U.S.A.
21830/35	Tuning control. U.S.A.
21923/35	Amplification control. U.S.A.
24495/35	Tuning and band width control. U.S.A.
573/36	Automatic volume control. U.S.A.

Philadelphia Storage Battery Co.

22698/35	High fidelity radio receivers. U.S.A.
24392/35	Ignition noise suppressor system. U.S.A.
24536/35	Variable band coupling for superheterodynes. England.
25785/35	Antenna. England.
3105/35	Noise suppression means. U.S.A.
48/36	Providing instantaneous regulation of an output voltage. England.

Standard Telephones and Cables.

21266/35	High frequency electric signalling. England.
21267/35	High frequency electric oscillations. France.
22136/35	Wave signalling system. New South Wales.
22745/35	Carrier frequencies. U.S.A.
23116/35	Modulating systems. U.S.A.
25835/35	Amplifiers. U.S.A.

PATENTS—(Continued).

International General Electric Co. Inc.

21961/35 High frequency oscillators. U.S.A.
22770/35 Antennae. U.S.A.
22771/35 Antennae. U.S.A.
24714/35 Carrier wave modulation systems. U.S.A.
25583/35 Antennae and coupler systems. U.S.A.

Johnson Laboratories Incorporated.

22149/35 Coupling device. U.S.A.
22150/35 Coupling devices. U.S.A.
22151/35 Adjustable coupling for i.f. transformers. U.S.A.
22595/35 Variable selectivity receivers. U.S.A.

The General Electric Co. Ltd.

21907/35 Modulating and demodulating apparatus. England.
23162/35 Electrical signals. England.
23868/35 Magnetically controlled oscillators. England.
23869/35 Ultra high frequency. England.

Solar Manufacturing Corporation.

23172/35 Electrolytic condensers. U.S.A.
23174/35 Electrodes for electrolytic devices. U.S.A.
23175/35 Electrolytic condensers. U.S.A.

Compagnie Generale de Telegraphie Sans Fil.

20868/35 Radio or like receivers and transmitters. France.
22717/35 Radio aerials. France.

Radioaktiengesellschaft D. S. Loewe.

19763/34 High frequency transformer Germany.
20814/35 Aerial for ultra short waves. Germany.

Amalgamated Wireless (A/sia) Ltd.

23435/34 Thermionic valve circuit arrangements. Poland.
24333/35 Receivers. Victoria.

Neutrodyne Pty. Limited.

21685/35 High frequency coupling systems. U.S.A.
25390/35 Automatic frequency coupling systems. U.S.A.

Sundry Applicants.

NO. Subject, Name and Country of Origin.

19626/34 Tuning apparatus. E. Cohen, Germany.
20746/35 Frequency modulation. W. G. Gordon, R. E. B. Makinson, N.S.W.
21611/35 Oscillation generator. Television Laboratories, U.S.A.
21654/35 Signalling system. Robinson, England.
22162/35 Telephone systems. D. Mastini, Rome.
22485/35 Radio receiving. D. Campbell, N.S.W.
22882/35 Headphones. A. Poliakoff, England.
22964/34 Tuning coils. S. G. Brown, England.
23973/35 Signalling systems. F. E. Ryall, England.
24722/35 Radio receiving. Radio Corporation Pty. Ltd., Victoria.
24934/35 Radio tube grids. Sovereign Machinery Co., U.S.A.
25378/35 Radio communication. N. S. Gilmour, N.S.W.
25440/35 Equalizing potential fluctuations in amplifiers. Siemens & Halske Aktiengesellschaft, Germany.
25482/35 Radio receivers. N. J. Pritchard & N. S. Gilmour, U.S.A.
25492/35 Indicating device. Philco Radio & Television Corporation, U.S.A.
719/36 Tuning element. Allgemeine Elektricitats Gesellschaft, Germany.
1300/36 Modulating. Farnsworth Television Inc., U.S.A.

TELEVISION

Radioaktiengesellschaft D. S. Loewe.

NO. Subject and Country of Origin.

18847/34 Television screen projection. Germany.
18660/34 Simultaneous reception of picture and sound. Germany.
19571/34 Television system. Germany.
19572/34 Safeguarding Cathode ray tubes. Germany.
19573/34 Television rectifier. Germany.
19761/34 Cathode ray tube. Germany.
19764/34 Deflecting method for Cathode ray tubes. Germany.
20063/35 Television rectifiers. Germany.
20225/34 Electronic tube and circuits thereof. Germany.
20226/34 Television tube. Germany.
20409/34 Synchronization of television receivers. Germany.
20813/35 High frequency transformer. Germany.
21024/35 Television receiver. Germany.
21025/35 Producing parallel light rays. Germany.
21132/35 Television method and arrangement. Germany.
21134/35 Connextion system for television tubes. Germany.
21289/35 Tilting oscillation apparatus. Germany.
21290/35 Television synchronised according to the amplitude method. Germany.
21291/35 Rectifier connexion for television. Germany.
21514/35 Television tube. Germany.
21515/35 Television tube. Germany.
21516/35 Synchronization method for television. Germany.
22323/35 Transmission method for television. Germany.
22325/35 Television detector. Germany.
22396/35 Amplitude filter. Germany.
22397/35 Television receiver. Germany.
22541/35 High vacuum television tube. Germany.
22542/35 Television amplifiers. Germany.
22639/35 Mains connection for television tubes. Germany.
22875/35 Optical phase regulation. Germany.
22877/35 Transformer coupling for television amplifiers. Germany.
22941/35 Synchronisation of television receiving by the transmitter. Germany.
22942/35 Producing synchronisation impulses. Germany.
22943/35 Highly sensitive cascade amplifiers. Germany.
23008/35 Ultra short wave receiving devices. Germany.
23596/35 Relaxation apparatus. Germany.
23597/35 Television transmitter. Germany.
23852/35 Television modulated systems. Germany.
24147/35 Television scanning method. Germany.
24798/35 Television transmission method. Germany.
24799/35 Propagation of television images. Germany.
24968/35 Television. Germany.
24969/35 Correcting distortion in television. Germany.
24970/35 Correcting trapezoidal distortion in a television image. Germany.
25276/35 Scanning method. Germany.
25366/35 Television receiving connection.
25367/35 Relaxation connections for alternate lines. Germany.
25457/35 Television receiving connection system. Germany.
25853/35 Television transmitter. Germany.
1631/36 A detector arrangement for television purposes. Germany.

Marconi Wireless Telegraph Co. Ltd.

20887/35 Cathode ray tubes. U.S.A.
20950/35 Photo electrically sensitive means. U.S.A.
21045/35 Cathode ray tube. England.
21219/35 Television systems. U.S.A.
21330/35 Television amplifiers. U.S.A.
21443/35 Separating synchronising pulses. U.S.A.
21485/35 Cathode ray modulation. England.
21911/35 Scanning device. England.
21920/35 Pictures and like telegraph systems. England.
21995/35 Television and like receivers. England.
21996/35 Thermionic valve circuit arrangements. England.

PATENTS—(Continued).

21997/35 Time base oscillator. England.
22185/35 Television receiver synchronising. U.S.A.
22452/35 Television and like transmitting systems. U.S.A.
22489/35 Supply circuits. Canada.
22561/35 Iconoscope television. U.S.A.
22562/35 Television receivers. U.S.A.
22563/35 Oscillators for facsimile systems. U.S.A.
22629/35 Television and like transmitters. U.S.A.
22680/35 Television systems. U.S.A.
22796/35 Electro-optical devices for controlling light. England.
22961/35 Television circuit arrangements. England.
23011/35 Time base and circuit arrangements. England.
23153/35 Cathode ray tube oscillograph apparatus.
24167/35 Electrical oscillation generators. U.S.A.
24402/35 Cathode ray tube apparatus. U.S.A.
24632/35 Cathode ray tube oscillograph arrangements. England.
24715/35 Electrical oscillation generator arrangements. U.S.A.
24870/35 Cathode ray tube arrangements. U.S.A.
24872/35 Television transmitters. U.S.A.
24897/35 Television scanning systems. U.S.A.
24961/35 Television systems. U.S.A.
24963/35 Modulated carrier wave receivers. U.S.A.
25243/35 Television and like transmitters. U.S.A.
25339/35 Facsimile Telegraph systems. U.S.A.
25444/35 Cathode ray tube apparatus. U.S.A.
25773/35 Cathode ray tube television reproducing. England.
25774/35 Cathode ray tube oscillograph. England.

Television Laboratories Ltd.

21655/35 Luminescent screen. U.S.A.
21656/35 Luminescent screen and mounting. U.S.A.
21657/35 Luminescent screen method of use. U.S.A.
21658/35 Picture transmission. U.S.A.
22019/35 Scanning means and method. U.S.A.
22324/35 Switch-on arrangement for Braun tube. Germany.

Hazeltine Corporation.

24496/35 Wave generator. U.S.A.
24497/35 Wave generator for use in television. U.S.A.
24498/35 Television system. U.S.A.
442/36 Electric wave generator. U.S.A.

Allgemeine Elektricitats Gesellschaft.

24779/35 Scanning with electric rays. Germany.
24978/35 Scanning with a ray of light. Germany.
24979/35 Amplifier for picture transmission. Germany.

Telefunken Gesellschaft fur Drahtlose.

23154/34 Colour television. Germany.
23774/35 Methods of effecting television. Germany.

Baird Television.

24033/35 Separating synchronising impulses. England.
24034/35 Television and like systems. England.
258/36 Ilumination control for television. England.

The General Electric Co. Ltd.

23777/35 Television. England.
23778/35 Cathode ray television receiver. England.

Farnsworth Television.

25133/35 Television transmission. U.S.A.
372/36 Method of apparatus for television. U.S.A.

Sundry Applicants.

NO. Subject Name of Country of Origin.

21433/35 Television systems. I. L. Maguire, Victoria.
23560/35 Television apparatus. W. A. Priess, U.S.A.
23968/35 Light modulating device. Scophony Ltd., England.
24113/35 Television systems. G. W. Walton, England.

MISCELLANEOUS

Marconi Wireless Telegraph Co. Ltd.

NO. Subject and Country of Origin.

20833/35 Electrolytic condensers. U.S.A.
20869/35 Loud speakers. U.S.A.
20951/35 Induction heating apparatus. U.S.A.
21154/35 Cooling valves. England.
21957/35 Piezo electric crystals. U.S.A.
22454/35 Flourescent screens. U.S.A.
22793/35 Magnetic. U.S.A.
22795/35 Electron emitting cathodes. England.
22913/35 Electron discharge device. U.S.A.
22914/35 Electron discharge device. U.S.A.
22915/35 Electric discharge devices. U.S.A.
22998/35 Peizo-electric crystals. U.S.A.
23064/35 Magnetic recorders. England.
23065/35 Telegraphones and like magnetic recording or pick up apparatus. England.
23388/35 Volt meter arrangements. England.
23651/35 Photographic developing and treating. U.S.A.
24209/35 Cathode ray tubes. England.
24399/35 Mounting devices for electron. U.S.A.
24472/35 Electron discharge devices. U.S.A.
24871/35 Making stems of electron discharge devices. U.S.A.
25065/35 Stems of electron discharge devices. U.S.A.
25068/35 Valves for ultra high frequency oscillation. U.S.A.
25171/35 Alloys. U.S.A.
25445/35 Mounting of loud speakers. U.S.A.
25552/35 Electron multipliers. U.S.A.

N. V. Phillips.

21873/35 Cathodes. Holland.
2223/35 Condensers. Holland.
22275/35 Cathode ray discharge tubes. Holland.
23235/35 Grids for electric discharge. Holland.
23236/35 Electric discharge tubes. Holland.
23381/35 Electric discharge tubes. Holland.
23549/35 Flourescent screens. Holland.
23599/35 Resistances having negative temperature coefficient. Holland.
24556/35 Electric discharge tubes. Holland.
25113/35 Incandescent cathodes. Holland.
25354/35 Electric discharge tube. Holland.
1157/36 Flourescent screens. Holland.

Radioaktiengesellschaft D. S. Leowe.

17874/35 Braun tube. Germany.
18419/34 Braun tube. Germany.
21133/35 Magnetic correction of cathode ray tubes. Germany.
20082/34 Television tube. Germany.
20890/35 Braun tube. Germany.
22326/35 Gas filled television tube. Germany.
22398/35 Braun tube. Germany.
22640/35 Photo cell layers. Germany.
22876/35 Finely divided metallic layers. Germany.
23310/35 Braun tubes and other manufacture. Germany.
25320/35 Television tube. Germany.

Telefunken Gesellschaft Drathlose.

20866/35 Ultra short wave valves. Germany.
21069/35 Cathode structures. Germany.
21875/35 Conductively coated insulated bodies for short waves. Germany.
22718/35 Loud speaker arrangements. Germany.
23156/35 Cathode ray tubes. Germany.

PATENTS—(Continued).

23161/35 Cathodes for electron discharge devices. Germany.
24063/35 Magnetron tubes. Germany.
23652/35 Electron discharge devices. Germany.
23653/35 Electron discharge devices. Germany.

Farnsworth Television.

1294/36 Cathode ray oscilloscope. U.S.A.
1297/36 Flourescent material. U.S.A.
1301/36 Gutter cartridge. U.S.A.
1302/36 Flourescent screen. U.S.A.

Johnson Laboratories Incorporated.

20118/34 Intermediate frequency transformers. U.S.A.
20309/34 High frequency inductances U.S.A.
20754/34 Iron cores. U.S.A.
23524/35 High frequency indicators. U.S.A.

Standard Telephones and Cables.

21579/35 Microphones and like acoustic devices. U.S.A.
25749/35 Acoustic devices. U.S.A.
25751/35 Cables for wide frequency bands. England.

Electrical Research Products Inc.

21554/35 Sound reproducing systems. U.S.A.
21555/35 Vibration translating devices. Holland.
24404/35 Phonograph reproducer. U.S.A.

International General Electric Co. Inc.

24455/35 Glass to metal seals for thermionic devices, of the metal type. U.S.A.
24713/35 Glass to metal seals. U.S.A.
25311/35 Cathode structures. U.S.A.

The General Electric Co. Ltd.

20633/34 Cathode ray tubes. England.
22560/35 Thermionic cathodes. England.
23866/35 Cathode ray tubes. England.

Radio Corporation of America.

25565/35 Reproduction of sound U.S.A.
593/36 Cathodes for electron discharge devices. U.S.A.

Siemens Brothers and Co. Ltd.

25657/35 Microphones.. England. ...
435/36 Improvements in or relating to microphones. England.

Associated Electric Laboratories Incorporated.

23126/35 Magnetic cores. U.S.A.
23974/35 Magnetic wires methods for producing them. U.S.A.

Sundry Applicants.

No.	Subject, Name and Country of Origin.
20192/34	Thermionic valves. Compagnie Generalede Telegraphie Sans Fil. France.
20924/35	Baffle chamber for loud speakers. R. M. Beale. N.S.W.
20948/35	Valve construction. Allgemeine Elikricitats. Germany.
21555/35	Vibration translating. N. V. Cleary. Holland.
22086/35	Cabinet construction. James Manufacturing Co. Ltd. N.S.W.
22134/35	Photoelectric Cell Construction. M.O. Valve Co. England.
22709/35	Loud speakers. Jinsen Radio Manufacturing Co. U.S.A.
22711/35	Screening means. D. E. Huber. Switzerland.
22876/35	Dust excluding means for loud speakers. Magnavox Ltd. N.S.W.
22911/35	Recording mechanism. Musikon Ltd. England.
23173/35	Electrolytic. Solar Manufacturing Co. U.S.A.
23345/35	Sound reflectors and baffle boards. T. B. D'Arcy. N.S.W.
23544/35	Radio valve. Dynotron Ltd. New Zealand.
23624/35	Variable condensers. Stromberg-Carlson (A'sia) Ltd. N.S.W.
24087/35	Sound reproducing. Philadephia Storage Battery Co. England.
24115/35	Electrical Musical Instrument. A. R. Betteridge. South Australia.
24334/35	Automatic morse transmitter. E. G. Beard. U.S.A.
24465/35	Electrostatic condensers. Ducon Condenser Pty. Ltd. N.S.W.
25493/35	Sound pick-up devices. S. C. McLean and S. S. McDermott. Victoria.
25525/35	Sound reproducing devices. R. C. Barker. England.
25823/35	Electrolytic condenser electrodes. N. V. Maatschappij Tot Exploiteatie van Uitvindingen. Holland.
337/36	Electrodynamic apparatus. E. Hanesdorf. Germany.
575/36	Condenser. Philco Radio and Television. U.S.A.
767/36	Variable resistor. H. G. Richles. U.S.A.
893/36	Wireless receiving. W. Reid Lethbridge. N.Z.
1110/36	Thermionic valves. The Mullard Radio Valve Co. Ltd. England.

Australian Radio Patent Licence

In previous issues of the "Radio Trade Annual" have been published details of Licence No. 1 issued by Australian Radio Technical Services and Patents Co. Ltd., the company which comprises in Australia, Amalgamated Wireless A/sia Ltd., Standard Telephones and Cables A/sia Ltd., Philips Ltd., and Neutrodyne Pty. Ltd., wherein they agree to licence radio manufacturers under certain terms and conditions.

A copy of this licence will be supplied by A.R.T.S. and P. Ltd., 47 York Street, Sydney, or Australian Radio Publications Ltd., 30 Carrington Street, Sydney, N.S.W.

Australian Radio Manufacturers Patents Association Ltd. (A.R.M.P.A.L.)

President, L. P. R. BEAN; Vice-President, L. C. HARGREAVES; Secretary-Accountant, FRANK F. KRAEGEN.

Australian Radio Manufacturers Patents Association Ltd., 3rd Floor, Assembly Hall, Margaret Street, Sydney. 'Phone B3388. Cables and 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 and 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, A. W. Scott. Patent Attorneys: Messrs. T. C. Allen and 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 Electricial and Radio Federation (Qld.)

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 1936-37.

President:—L. G. Hinwood, Australian General Electric Limited, Adelaide Street, Brisbane. B 2151.

Vice-President:—B. C. Percy, The Lawrence & Hanson Electrical Co. (Q.) Ltd., Elizabeth Street, Brisbane. B 1407.

Past President:—R. F. Galloway, W. T. Henley's Teleg. Works Co. Ltd., Elizabeth Street, Brisbane. B 1636.

Treasurer:—P. S. Trackson, Trackson Bros. Ltd., Elizabeth Street, Brisbane. B 2804.

Secretary:—E. C. Fernandez, 334 Queen Street, Brisbane. B 8626.

Merchants:—N.B. Harper, Noyes Bros. (Sydney) Ltd., Elizabeth Street, Brisbane. B 3186.
G. A. Handyside, Engineering Supply Co. of Aust.. Edward Street Brisbane. B 1171.

Radio Traders:—C. Binnie, Australian General Electric Limited, Adelaide Street, Brisbane. B 2151.
J. Boulton, G. J. Grice Ltd., Queen Street, Brisbane. B 1674.

Australian Manufacturers:—C. G. Faine, Electric Construction Co. of Australia Ltd., Petrie Bight, Brisbane. B 2059.

Manufacturers' Agents:—T. H. Martin, T. H. Martin and Sons, Wilson House, Charlotte 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 Ltd.
Norman Bell & Co. Ltd.
J. R. Blane, Esq.
J. B. Chandler & Co.
Engineering Supply Co. of Aust.
Intercolonial Boring Co. Ltd.
The Lawrence & Hanson Elect. Co. (Q.) Ltd.
Noyes Bros. (Sydney) Ltd.
W. E. Peterman, Esq.
Siemen's (Aust.) 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 Australia.

Radio Traders' Section.

Australian General Electric Ltd.
W. O. Barber, Esq.
J. B. Chandler & Co.
A. E. Harrold, Esq.
E. V. Hudson Ltd.
Bush & Co.
The Lawrence & Hanson Elect. Co. (Q) Ltd.
National Radio Co.
Noyes Bros. (Sydney) Ltd.
Trackson Bros. Ltd.
Eclipse Radio Co. Ltd.
Irvine Electrical & Radio Co.
G. J. Grice, Ltd.
J. R. Foster, Esq.
F. Tritton Pty. Ltd.
Air-Master Radio Co.
Music Masters Radio Co.
Crammond Radio Co. Ltd.
Radio Corporation Ltd.
J. T. Greenlees and Co.
W. A. Malloy, Esq.
Vesta Battery Co. Ltd.
King & King.

Manufacturers' Agents Section.

V. J. Griffiths.
H. Maddick.
T. H. Martin.
A. H. Hills.
R. J. Norris.
P. H. Phillips.
C. F. Willers.
E. J. Hallt.

Radio Traders' Association of W.A.

14, A.N.A. House, St. George's Terrace, Perth, W.A. Tel.: B9201.

Chairman: J. G. Pritchard, c/o J. G. Pritchard Ltd., W.A. Bank Chambers, William Street, Perth.

Committee: H. R. Howard, C. S. Southcott, H. E. Pead, P. Plowman, A. Pidgeon, F. L. Buhler.

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 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. R. Gibson, British General Elec. Co. 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, G. C. Beardsmore, P. L. Boswell, C. Crome, J. G. Brown, G. Davidson, G. K. Dunbar, J. R. Gibson, R. P. Godfrey, A. Grundy, A. E. Kaleski, J. N. Parry, A. Waddel, W. J. J. Wing.

Sectional Chairmen.

Section 1. Electrical and Radio Development Association (ERDA)—C. Crome.
Section 2. Electricity Supply Undertakings—J. 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—G. C. Beardsmore.
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—J. G. Brown.
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 the 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 stablising 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.

The Electrical and Radio Development Association, or, as it is usually known by its initials, ERDA, is the Development Section of the Electrical and 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: C. Crome (Australian General Electric Ltd.).
Committee: F. Ainsworth (Lawrence & Hanson Elec. Co. Ltd.), E. P. Bennett (Hecla Electrics (Sydney) Ltd.), G. Davidson (Philips Lamps A/sia Ltd.), J. F. Guthrie (British General Electric Co. Ltd.), R. P. Godfrey (Godfrey Ltd.), G. K. Herring (Ever Ready Co. (Aust.) Ltd.), W. J. J. Wing (Amalgamated Wireless A/sia Ltd.), W. Wright (Standard Telephones and Cables A/sia Ltd.).
Secretary: Andrew F. O. Brown.

Radio Retailers' Association of N.S.W.

Registered Office:
Sixth Floor, Australia House, Carrington Street, Sydney. 'Phones: BW 6673 and B 2490.

Office Bearers:

Officers and Councillors are not included, as meeting is to take place on May 10, at which new officers and councillors are to be elected. This was too late for inclusion in the "Radio Trade Annual."

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.

Allied Radio Limited

Registered office, 3rd Floor, Castlereagh House, 2b Castlereagh Street, Sydney, Secretary, W. J. Bowman. Auditors, Messrs. W. F. Allworth and Sons, Chartered Accountants (Aust.), 2b Castlereagh Street, Sydney. Solicitors, Norman C. Oakes and Sagar, Spring Street, Sydney.

Directors: Claude Plowman (Airzone Ltd.), Norman S. Gilmour (Lekmek Radio Labs.), J. I. Carroll (New System Telephones and Emmco), A. E. Kaleski (Lawrence and Hanson Elec. Co. Ltd.), Otto Raz (Bloch and Gerber Ltd.), S. G. Cook (David Jones 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.)

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.

INSTITUTION OF RADIO ENGINEERS (AUSTRALIA)

Head Office:
30 CARRINGTON STREET, SYDNEY.
B 7188.

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.

The following conditions govern applications for admission to the Institution:—

Full Members—Shall be persons of not less than 25 years of age and who, over a period of not less than five years, have acquired experience by invention or practice in radio arts or radio literature and thereby merit, in the opinion of the Council, appointment as Full Members and/or who have passed such examination or complied with such conditions as are prescribed by Council. (Application fee £1/1/-, annual subscription from date of election £3/3/-).

Associate Members—Shall be persons not less than 21 years of age, who, in the opinion of Council, have been engaged in radio or associated industry for a period of 3 years, and who possess such technical knowledge and/or passed such examination as is acceptable to Council. (Application fee £1/1/-, annual subscription from date of election £2/2/-.)

Associates—Shall be not less than 21 years of age and shall be acceptable persons who, in the opinion of Council, are connected with the application of radio science or the radio arts. (Application fee £1/1/-, annual subscription from date of election, £1/11/6).

Juniors—Shall be persons (16-20 years of age) registered as students in a university, technical school or place of recognised standing, who are pursuing a regular course of study in the science of radio, and/or are engaged in technical application of radio. (Annual subscription £1/1/-, no entrance fee.)

The actual grade to which candidate is allotted is determined by Council.

Officers and Council, 1936-1937.

President: E. T. Fisk.
Vice-Presidents: L. P. R. Bean and N. S. Gilmour.
Hon. Treasurer: C. H. Norville.
Hon. Asst. Treasurer: S. V. Colville.
Hon. Secretary: O. F. Mingay.
Hon. Asst. Secretary: K. H. M. Denny.
Councillors: W. T. S. Crawford, L. A. Hooke, A. S. McDonald, 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, D. G. Wyles, C. W. Tyrrell.
Qualifications Board: A. S. McDonald (Chairman), D. G. Wyles, F. W. P. Thom and W. T. S. Crawford.
Examination Board: J. N. Briton (Chairman), E. G. Bailey, R. R. Chilton, M. H. Stevenson, A. W. Scott.
Lectures and Papers Board: C. W. Tyrrell (Chairman), F. Langford Smith, J. Moyle.
Social Committee: L. A. Hooke (Chairman).

Melbourne Division Committee.

Chairman: J. Malone.
Vice-Chairmen: S. H. Witt and F. J. Henderson.
Hon. Secretary: R. R. Mackay.
Hon. Asst. Secretary: J. M. Dobbyn.
Hon. Treasurer: C. W. Evans.
Welfare Officer: R. K. Crow.
Councillors: Commander F. G. Cresswell, W. Conry, F. G. Canning, R. Kendall, N. W. V. Hayes, R. R. Binnion, F. C. Draffin, C. W. Smith, G. F. Williams, J. M. Johnson, G. Apperley.

Adelaide Division Committee.

Chairman: Professor Kerr Grant.
Vice-Chairman: H. Harrington.
Hon. Secretary and Treasurer: A. H. Garth.
Councillors: S. F. Ackland, D. M. Gooding, W. W. Honnor, E. J. Risely, R. Parasiers, C. E. Moule, H. B. Wilson, R. Oakley.
Programme and Papers Committee: H. W. Harrington, W. W. Honnor, D. M. Gooding, E. J. Risely.
Qualifications Committee: H. W. Harrington, W. W. Honnor, D. M. Gooding.
Publicity Officer: H. B. Wilson.

Officers and Council, 1937-38

President: E. T. Fisk.
Vice-Presidents: L. P. R. Bean and N. S. Gilmour.
Hon. Treasurer: C. H. Norville.
Hon. Asst. Treasurer: P. S. Parker.
Hon. General Secretary: O. F. Mingay.
Councillors: Messrs. R. Allsop, J. N. Briton, S. V. Colville, T. P. Court, W. T. S. Crawford, L. A. Hooke, Major R. Kendall, R. J. W. Kennell, A. S. McDonald, F. W. P. Thom, C. W. Tyrrell and D. G. Wyles.

(Continued on Page 90.)

I.R.E. AUSTRALIA *(Continued)*

Qualifications Board: Messrs. A. S. McDonald, D. G. Wyles, F. W. P. Thom, and W. T. S. Crawford.

Examination Board: Messrs. J. N. Briton, A. W. Scott, R. R. Chilton, E. G. Bailey and M. H. Stevenson.

Lectures and Papers Board: Messrs. C. W. Tyrrell, F. Langford Smith and J. Moyle.

Social Committee: L. A. Hooke (Chairman).

Awards Committee: Messrs. A. S. McDonald, D. G. Wyles, F. W. P. Thom, W. T. S. Crawford, C. W. Tyrrell, F. Langford Smith and J. Moyle.

Library Board: Messrs. L. N. Schultz (Chairman), Major Kendall, W. T. S. Crawford and D. G. Wyles.

Constitutional Committee: Messrs. L. P. R. Bean, N. S. Gilmour, and O. F. Mingay.

Sydney Division Committee.

Chairman: D. G. Wyles.
Vice-Chairman: T. P. Court.
Hon. Secretary: J. R. Edwards.
Hon. Treasurer: K. H. M. Denny.
Committee: Messrs. V. H. Dudman, A. W. De Courcy Browne, R. M. Huey, E. E. Tree and C. W. Tyrrell.

Melbourne Division Committee.

Chairman: S. H. Witt.
Vice-Chairmen: Major R. Kendall and F. J. Henderson.
Past-Chairman: J. Malone.
Hon. Secretary: R. R. Mackay.
Hon. Asst. Secretary: J. M. Dobbyn.
Hon. Treasurer: C. Evans.
Welfare Officer: R. K. Court.
Committee: Messrs. E. F. Greig, W. A. Wilson, W. Conry, F. Stevens, J. M. Johnson, R. Binnion, G. F. Chilton and N. W. V. Hayes.

Adelaide Division Committee.

Chairman: Professor Kerr Grant.
Vice-Chairman: H. W. Harrington.
Hon. Secretary and Treasurer: A. H. Garth.
Committee: Messrs. S. F. Ackland, D. M. Gooding, W. W. Honnor, C. E. Moule, R. Oakley, R. Parasiers, E. J. Risely and H. B. Wilson.
Programme and Papers Committee: Messrs. H. W. Harrington, W. W. Honnor, D. M. Gooding and E. J. Risely.
Qualifications Committee: Messrs. H. W. Harrington, W. W. Honnor, and D. M. Gooding.
Publicity Officer: Mr. H. B. Wilson.

LIST OF MEMBERS as at May 1st, 1937
of the Institution of Radio Engineers (Australia)

FELLOW MEMBER:

Fisk, E. T., Chairman of Directors, A.W.A., 47 York Street, Sydney, N.S.W.

HON. LIFE MEMBER:

Renshaw, W. P., c/o Box 1857K, G.P.O., Sydney, N.S.W.

FULL MEMBERS:

Ackland, S. F., 196 Prospect Road, Prospect, S.A.
Allsop, R. C., Chief Engineer, Raycophone Ltd., 62 Booth Street, Annandale, N.S.W.
Apperley, G., C/o A.W.A., Queens Street, Melbourne, Victoria.
Austin, S. C., O.I.C. Wireless Branch, Central Police Station, Perth, W.A.
Bradley, F. R., Supt. of Telegraphs, G.P.O., Sydney, N.S.W.
Briton, J. N., C/o Briton Elec. and Radio Pty. Ltd., 152 Parramatta Road, Petersham, N.S.W.
Burbury, E. A., C/o A.W.A., 47 York Street, Sydney, N.S.W.
Bailey, E. G., 11 Ocean Street, Kogarah, N.S.W.
Bean, L. P. R., Managing Director, Stromberg-Carlson (A/sia) Ltd., 118 Bourke Road, Adexandria, N.S.W.
Beard, E. G., C/o Ace Amplifiers, 10 Grosvenor Street, Neutral Bay, N.S.W.
Brooker, V. M., C/o A.W.A., 47 York Street, Sydney, N.S.W.
Bushby, T. R. W., 2 "Davellen," Oakley Road, North Bondi, N.S.W.
Builder, G., C/o A.W.A., 554 Parramatta Road, Ashfield, N.S.W.
Baker, W. R., C/o Airmaster Radio Co., Brunswick Road, Brunswick, V.
Buring, R., C/o Station 3BA, 56 Lydiard Street North, Ballarat, V.
Bland, W. J., C/o Bland Radio, Coramandel Place, Adelaide, S.A.
Canning, F. G., C/o The Gramophone Co. Ltd., 2 Parramatta Road, Homebush, N.S.W.
Colville, S. V., Radio Engineer, 8 Smail Street, Broadway, Sydney, N.S.W.
Cookson, J. G., 57 Fitzroy Street, Burwood, N.S.W.
Court, T. P., C/o Standard Telephones and Cables Ltd., 258 Botany Road, Alexandria, N.S.W.
Crawford, W. T. S., Senior Radio Inspector, Haymarket Post Office, Sydney, N.S.W.
Chilton, G. F., Engineer-in-Charge, Beam Station, Rockbank, Vic.
Conry, W. H., Radio Inspector, P.M.G.'s Department, Melbourne, V.
Cresswell, Com. F. G., Electrical Commander, R.A.N., Melbourne, V.
Cooper, S. A. B., Beam Wireless Station, Rockbank, V.
Chapman, W. G., C/o Radio Station, Applecross, W.A.
Denny, K. H. M., 26 Olola Avenue, Vaucluse, N.S.W.
Dudman, V. H., C/o Philips Lamps (A/sia) Ltd., 67 Clarence Street, Sydney, N.S.W.
Draffin, J. C., C/o Engineering Department, A.W.A., 47 York Street, Sydney, N.S.W.
Dobbyn, J. M., Radio Inspector, Treasury Gardens, Melbourne, V.
Dunne, P. E., Radio Inspector, Treasury Gardens, Melbourne V.
Dixon, A. L., C/o Station 4BK, Queen Street, Brisbane, Queensland.
Edwards, A. C., 83 Old South Head Road, Waverley, N.S.W.
Emmelhainz, A. E., 93 Todman Avenue, Kensington, N.S.W.
Elliott, S., "Grendow," Bristol Street, Canterbury, V.
Evans, C. W., 13 Enfield Road, Brighton, V.
Forsythe, L. E., Schnapper Island, C/o Drummoyne P.O., Drummoyne, N.S.W.
Fitts, A. R., C/o Station 3HA, 37 Grey Street, Hamilton, V.
Groeneveld, Y. B. F. J., 131J, Aalstersveg, Eindhoven, Holland.
Gilmour, N. S., C/o Lekmek Radio Laboratories, 75 William Street, Sydney, N.S.W.
Green, Dr. A. L., Research Labs., A.W.A. Radio-Electric Works, 554 Parramatta Road, Ashfield, N.S.W.
Graham, Virgil M., Director Tube Application Department, Hygrade Sylvania Corp., Emporium, Pennsylvania, U.S.A.
Gray, A. C., 111 The Righi, Heidelberg, N.22, V.
Gooding, D. M., Chief Engineer, Station 5AD, Weymouth Street, Adelaide, S.A.
Greer, N. C., C/o Station 6WB, Box 46 P.O., Katanning, W.A.
Greig, E. L., Radio Inspector, Treasury Gardens, Melbourne, V.
Hooke, L. A., C/o A.W.A., 47 York Street, Sydney, N.S.W.
Huckell, E. D. W., 285 Military Road, Cremorne, N.S.W.
Harris, H. W., 20 Chelmsford Avenue, Lindfield, N.S.W.

LIST OF MEMBERS OF I.R.E. AUSTRALIA

Hosking, A. P., C/o A.W.A., 47 York Street, Sydney, N.S.W.
Hill, R., C/o Western Electric Co., 49a King Street, Sydney, N.S.W.
Hull, A. G., C/o "Wireless Weekly," 60 Elizabeth Street, Sydney, N.S.W.
Hayes, N. W. V., 9 Ocean Street, Hampton, V.
Henderson, F. J., South Lodge, Brighton Beach, V.
Hopton, A. T.
Hale, J. P., C/o Newton McLaren Ltd., Box 1339, G.P.O., Adelaide, S.A.
Harrington, H. W., Senior Radio Inspector, Post Office Place, Adelaide S.A.
Honnor, W. W., C/o S.A. School of Mines, Adelaide, S.A.
Israel, M. S., C/o Station 3GL, Little Malop Street, Geelong, V.
Johnson, J. M., 632 Glenhuntly Road, Caulfield, V.
Kennell, R. J. W., C/o Philco Radio and Television Corpn., 276 Castlereagh Street, Sydney, N.S.W.
Kendall, Major R., General Staff Signals, A.M.F., Melbourne, V.
Kauper, H. A., 227 Lennox Street, Richmond, V.
Kappe, Capt. C. H., C/o Staff College, Quetta, India.
Kerr Grant, Prof., Professor of Physics, Adelaide University, Adelaide, S.A.
Lovett, H. F., 14 Summerhill Road, West Hobart, Tas.
Lindberg, E. R., C/o National Radio Corporation, 96 Pirie Street, Adelaide, S.A.
Leslie, J. R., Research Labs., P.M.G.'s Dept., 59 Lt. Collins Street, Melbourne, V.
Manley, P. J. C/o Amplion Ltd., 70 Clarence Street, Sydney, N.S.W.
Mingay, O. F., 30 Carrington Street, Sydney, N.S.W.
Murray, L. C., 19 Milner Crescent, Wollstonecraft, N.S.W.
Marshall, H. A., 94 Francis Street, Bondi, N.S.W.
Mulholland, J. L., C/o A.W.A., 47 York Street, Sydney, N.S.W.
Martin, L. T., 6 Alton Avenue, Concord, N.S.W.
Moore, E. J. T., Room 65, 14 O'Connell Street, Sydney, N.S.W.
McDonald, A. S., C/o A.W.A., 47 York Street, Sydney, N.S.W.
McPhee, S., C/o Standard Telephones and Cables Ltd., 258 Botany Road, Alexandria, N.S.W.
MacNee, D. H., C/o The Gramophone Co., 2 Parramatta Road, Homebush, N.S.W.
Mackay, R. R., C/o Melbourne Technical College, Latrobe Street, Melbourne, V.
McKay, R. V., Engineers' Central Office, Treasury Gardens, Melbourne, V.
Malone, J., Chief Wireless Inspector, Treasury Gardens, Melbourne, V.
Mathews, S. A., C/o 108 Francis Street, Perth, W.A.
Norville, C. H., C/o Breville Radio, 486 Elizabeth Street, Sydney, N.S.W.
Newman, S. M., 11 Kissing Point Road, Turramurra, N.S.W.
Otty, W., Toronto, N.S.W.
Olle, J. D., 17 Eccles Avenue, Ashfield, N.S.W.
Parker, P. S., Works Manager, Airzone (1931) Ltd., 16 Australia Street, Camperdown, N.S.W.
Phillips, W. H. C., C/o A.W.A., 47 York Street, Sydney, N.S.W.
Pringle, A. Y., C/o A.W.A., Queen Street, Melbourne, V.
Rowland, W. J., 22 Belmont Road, Mosman, N.S.W.
Ryan, A. J., C/o Station 2CA, Kingston, Canberra, F.C.T.
Ryan, J. W., C/o Station 3AW, Latrobe Street, Melbourne, V.
Risely, E. J., C/o Western Electric Co., Paringa Bldgs., Hindley Street, Adelaide, S.A.
Scott, A. W., C/o Stromberg-Carlson A/sia Ltd., Box 3971 V, G.P.O., Sydney, N.S.W.
Southey, R. V., C/o Columbia Graphophone Co. Ltd., 2 Parramatta Road, Homebush, N.S.W.
Spinks, W. C., 6 Dover Road, Rose Bay, N.S.W.
Schultz, L. N., Engineer-in-Charge, Station 2GB, Clifton Gardens, N.S.W.
Salmon, W. E., "La Paloma," Frederick Street, North Bondi, N.S.W.
Stevenson, M. H., C/o Station 2UE, 29 Bligh Street, Sydney, N.S.W.
Skene-Smith, A., 9 Wilfield Avenue, Vaucluse, N.S.W.
Seccombe, L. M., 4 Hayburn Avenue, Rockdale N.S.W.
Smith, F. Langford, C/o A. W. Valve Co. Ltd., 47 York Street, Sydney, N.S.W.
Stevens, F. H., Radio Engineer, Station 3LO, Melbourne, V.
Toombs, Capt. S., C/o A.W.A., 47 York Street, Sydney, N.S.W.
Trenam, H. C., C/o Standard Telephones and Cables Ltd., 258 Botany Road, Alexandria, N.S.W.
Tyler, M., Rosedale Road, Gordon, N.S.W.
Thom, F. W. P., C/o Thom and Smith Ltd., Box 2596, G.P.O., Sydney, N.S.W.
Thorrington, L., C/o Stromberg-Carlson Ltd., Box 3971 V, G.P.O., Sydney, N.S.W.
Turner, O. C., 122 Newington Road, Petersham, N.S.W.
Tyrell, C. W., C/o Philips Lamps A/sia Ltd., 69 Clarence Street, Sydney, N.S.W.
Traynor, P. B., Asst. Radio Inspector, Wireless Branch, C'wealth Offices, Post Office Place, Adelaide, S.A.
Whitaker, J. R., C/o The Gramophone Co., 2 Parramatta Road, Homebush, N.S.W.
Wilson, J. F., C/o Amalgamated Wireless A/sia Ltd., 47 York Street, Sydney, N.S.W.
Wyles, D. G., C/o Philips Lamps A/sia Ltd., 67 Clarence Street, Sydney, N.S.W.
Wedgner, N. T., 353 Penshurst Street, Willoughby Junction, N.S.W.
Wood, H. B., 225 Old South Head Road, Bondi, N.S.W.
Wiggins, C. S., R.A.A.F. Headquarters, Victoria Barracks, Melbourne, V.
Williams, G. F., Radio Eng., Eclipse Radio, 111 Queensbridge Street, Melbourne, V.
Witt, S. H., P.M.G.'s Research Labs., 59 Lt. Collins Street, Melbourne, V.
Wilson, Warne A., C/o Station 3BA, Sturt Street, Ballarat, V.
Wellington, S. H., 2 Arthur Avenue, Brighton, Melbourne, S.5, V.
Walters, G., C/o A.W.A., Radio Station, Thursday Island, Q'land.

ASSOCIATE MEMBERS.

Arms, A., 15 Mile P.O., Newnes Junction, N.S.W.
Ash, B., Box 81, P.O., Quirindi, N.S.W.
Allison, C. M., 33 Arnold Street, Carlton North, N.4, V.
Allen, G. U., 126 Riversdale Road, Camberwell, E.6, V.
Baker, R. C., 10 Captain Pipers Road, Vaucluse, N.S.W.
Boothman, R. C., "Alberta," Walsham Parade, North Bondi, N.S.W.
Butterworth, C., 19 Thomas Street, Wallsend, Newcastle, N.S.W.
Bell, R. A., 29 Woodland Street, Marrickville, N.S.W.
Bodkin, H. B., 290 Unwin's Bridge Road, St. Peters, N.S.W.
Barkley, D. A., 1 Constitution Road, Dulwich Hill, N.S.W.
Boxall, H., H.M.A.S. "Stuart," C/o G.P.O., Sydney, N.S.W.
Betts, E. G., 24 Kerferd Street, North Essendon, W.6, V.
Busch, R. T., "Stratford," 20 Wordsworth Street, Moonee Ponds, V.
Binnion, R. R., 29 Tooronga Road, Hawthorn, E.3, V.
Batt, C. H., "Woodlands," Melton Mowbray, Tasmania.
Burmester, O. C., Stanley Terrace, East Brisbane, Q'land.
Butterfield, G. W., C/o Station 6IX, Lyric House, Murray Street, Perth, W.A.
Cameron, R. M., C/o Station 2UE, 29 Bligh Street, Sydney, N.S.W.
Crouch, E. C., C/o Station 2GZ, Hosking Bldgs., Hosking Place, Sydney, N.S.W.
Chilton, R. R., Chilton Avenue, Warrawee, N.S.W.
Crowley, C., C/o Electricity Dept., Parkes, N.S.W.
Chittock, K. H., C/o Airzone (1931) Ltd., 16 Australia Street, Camperdown, N.S.W.
Choules, G. H., C/o The Gramophone Co., 2 Parramatta Road, Homebush, N.S.W.
Crow, R. K., 14 Parker Setreet, Ormond, S.E.9, V.
Clarke Cottrell, L. L., C/o Station 3AR, 120a Russell Street, Melbourne, V.
Coate, E. F., C/o Metropolitan Elec. Supply, Green Street, Richmond, V.
Cox, H. E., Manager, Station 4TO, Townsville, Q'land.
Collins, C. H. J., C/o Supt. Engineer's Branch, P.M.G.'s Dept., Adelaide, S.A.

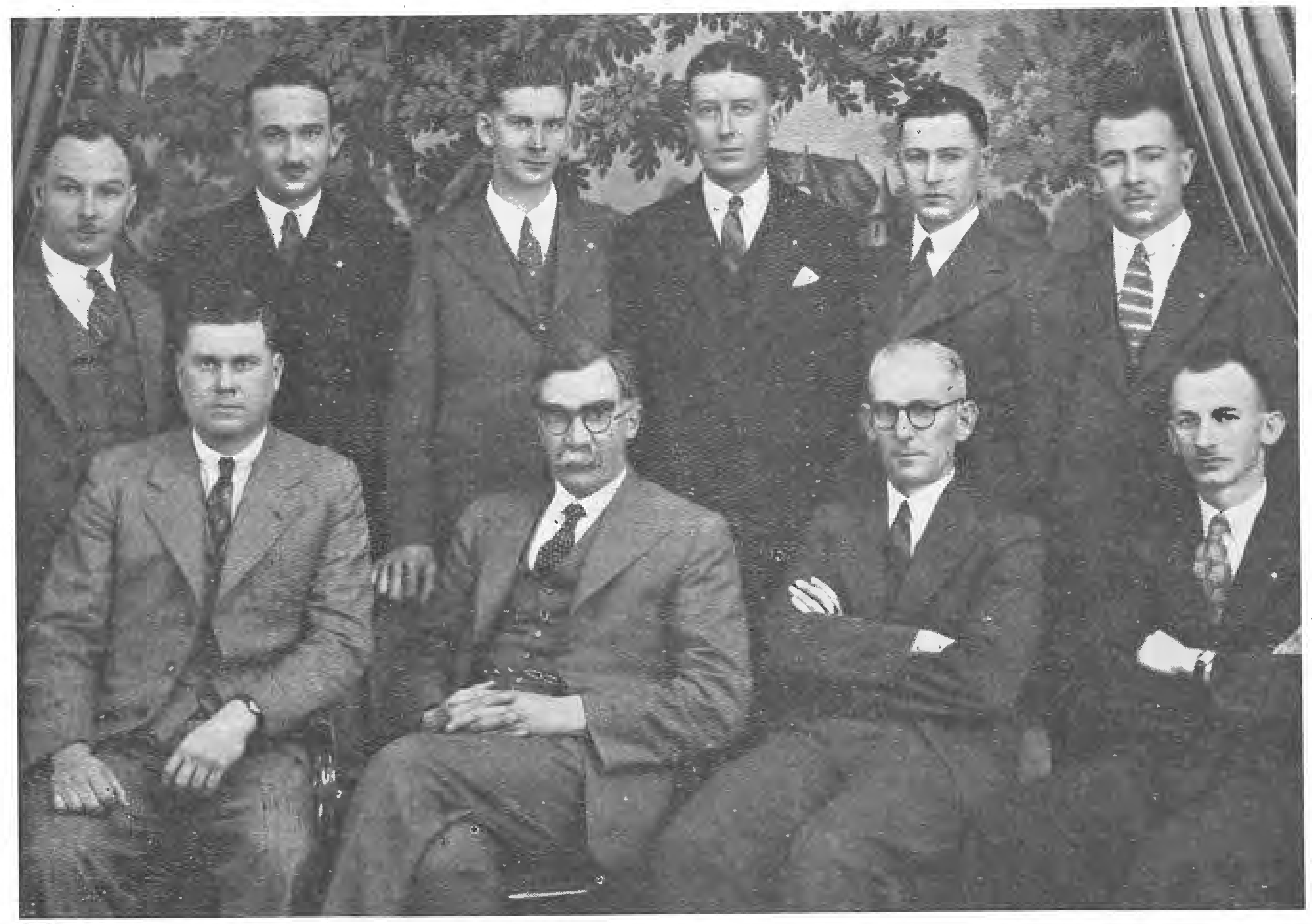
Coate, E. F. C/o Metropolitan Elec. Supply, Green Street, Richmond, V.
Cox, H. E., Manager, Station 4TO, Townsville, Q'land.
Collins, C. H. J., C/o Supt. Engineer's Branch, P.M.G.'s Dept., Adelaide, S.A.
Dennis, L. C., 22 Tessa Street, Chatswood, N.S.W.
De Courcey Brown, A. W., 32 Palmer Street, Rose Bay North, N.S.W.
Della Pietra, J., 198 Glenhuntly Road, Elsternwick, S.4, V.
Dunstan, C. B. C/o J. B. Chandler, 43 Adelaide Street, Brisbane, Q'land.
Edgerton, C. L., 50 Dolphin Street, Coogee, N.S.W.
Ebrall, H. N., C/o Station 2HD, Box 123, P.O., Newcastle, N.S.W.
Edwards, H. S., 110 Lyons Road, Drummoyne, N.S.W.
Everitt, A. R., C/o Borthwick Everitt and Co., 33 Mountain St., Sydney, N.S.W.
Edwards, J. R., C/o Australian Radio Publications Ltd., 30 Carrington Street, Sydney, N.S.W.
Enticknap, L. E., 117 Coward Street, Mascot, N.S.W.
Errey, R. A., 48 Macgregor Street, East Malvern, V.
Fidden, K. F. E., C/o R.C.A. Photophone Ltd., 221 Elizabeth Street, Sydney, N.S.W.
Fraser, J. H., 8 Deakin Avenue, Haberfield, N.S.W.
Fitzpatrick, W. P., 205 Coppen Street, Richmond, E.1, V.
Fox, A. E. R., C/o Marine Dept., A.W.A., 167 Queen Street, Melbourne, V.
Ferrar, L. H., C/o Newton McLaren Ltd., Leigh Street, Adelaide, S.A.
Gee, C. W., Llewellyn Street, Oatley, N.S.W.
Goddard, N. M., 350 George Street, Sydney, N.S.W.
Greenhalgh, K. N., C/o Station 2KO, 8 Bond Street, Newcastle, N.S.W.
Gilchrist, J. D., "Amesbury," 78 Alt Street, Ashfield, N.S.W.
Garth, A. H., Box 52, G.P.O., Perth, W.A.
Hatton, H. C., 18 Irene Street, Abbotsford, N.S.W.
Henriques, F. L., "Alwood," Mount Street, Hunter's Hill, N.S.W.
Hodder, G. H., 5 Barwon Street, Forbes, N.S.W.
Hooker, B. W., 183 Burwood Road, Burwood, N.S.W.
Halley, D. S., 26 Knox Street, Randwick, N.S.W.
Hibbert, C. T., 20 Cowles Road, Mosman, N.S.W.
Huey, R. M., 7 Arthur Street, Cronulla, N.S.W.
Hoare, P. M., 17 Cathcart Street, Lismore, N.S.W.
Hannam, H. W., 34 Seymour Street, South Hurstville, N.S.W.
Hall, B. M., 6 Billong Avenue, Vaucluse, N.S.W.
Hall, G. G., C/o A.W.A. Radio-Electric Works, Parramatta Road, Ashfield, N.S.W.
Harradence, J. W., C/o Metropolitan Elec. Supply, Green Street, Richmond, V.
Hehir, W. J., 14 Raven Street, Kew, E.4, V.
Hogg, W. D., 7 Willowbank Road, North Fitzroy, V.
Hooper, S. M., 223 Auburn Road, Auburn, E.3, V.
Hoe, F., Jnr., C/o Edgar V. Hudson Pty. Ltd., Box 522H, G.P.O., Brisbane, Q'land.
Hepple, W. B., C/o The Electric Shop Ltd., 57 Russell Street, Toowoomba, Q'land.
Hope, R. S., Engineer, Station 7HO, Hobart, Tasmania.
Jordan, J., C/o Broadcasting Station 4BU, Bundaberg, Q'land.
Kelso, A. J. B., C/o Mrs. Willis, 25 Walker Avenue, Haberfield, N.S.W.
Kerr, A. D., C/o Station 3BA, 56 Lydiard Street, Nth., Ballarat, V.
Lackey, R., 3 Meryla Street, Burwood, N.S.W.
Lindsay, D. G., Burgoyne Street, Gordon, N.S.W.
Mason, V. O., 34 Palmer Street, Rose Bay North, N.S.W.
Mitchell, J. A. J., 169 Morgan Street, Wagga Wagga, N.S.W.
Moore, B., 5 Ryan's Road, Willoughby, N.S.W.
Moyle, J. M., C/o "Wireless Weekly," 60 Elizabeth Street, Sydney, N.S.W.
McKeown, R. H., No. 8 King's Lynn, Kirribilli Ave., Kirribilli, N.S.W.
McLean, A., C/o I.C.S., 140 Elizabeth Street, Sydney, N.S.W.
Mackenzie, C. A., 11 Cradley Avenue, Kew, E.4, V.
Maddicks, H., Victoria Street, Daylesford, V.
Missen, J. A., 22 Denmark Street, Kew, V.
Molan, A., 79 Gipps Street, East Melbourne, V.
Morrison, G. M., C/o A.W.A., 167 Queen Street, Melbourne, V.
Minchin, W. A., Radio Engineer, 63 William St., Rockhampton, Q'land.
Moule, C. E., 146 Young Street, Parkside, Adelaide, S.A.
North, W., Robertson Crescent, Marrickville, N.S.W.
Nottingham, H. A. J., "Eden Park," Lane Cove Road, North Ryde, N.S.W.
Nannelli-Dawson, S. A. R., "New Cottage," Cnr. Macarthur and Victoria Roads, Parramatta, N.S.W.
Nolte, G. E., C/o Station 3AW, 382 Latrobe Street, Melbourne, V.
Nicholson, R. M., C/o Station 4LG, Box 107, P.O., Longreach, Q'land.
Nicholas, W. R., C/o Station 7HO, 82 Elizabeth Street, Hobart, Tas.
Oakley, R. A., C/o Station 5KA, Currie Street, Adelaide, S.A.
Oppenheim, O. G., 33 Saturn Street, Caulfield, V.
Parr, A. K., Radio Trader, Collaroy Beach, N.S.W.
Parker, M. J., 180 Nelson Bay Road, Bronte, N.S.W.
Persson, A. H., C/o Ducon Condenser Pty. Ltd., 73 Bourke Street, Waterloo, N.S.W.
Pickerill, J. P., Main Road, Ravensbourne, Dunedin, New Zealand.
Paget, J. R., No. 1 Squadron, R.A.A.F., Laverton, V.
Phillips, A. J., 122a North Road, Brighton, V.
Plummer, D. K., 16 Orford Street, Moonee Ponds, W.4, V.
Parasiers, R., 102 Flinders Street, Adelaide, S.A.
Parker, N. A., Sea View Terrace, Kalamunda, W.A.
Phipps, W. R., 56 Coode Street, South Perth, W.A.
Ratcliffe, S. T., 94 Evans Street, Rozelle, N.S.W.
Robinson, W. H. R., Asst. Engineer, Station 2UE, 29 Bligh Street, Sydney, N.S.W.
Read, E. W. H., Maloney's Road, E. Camberwell, E.6, V.
Scarlett, H. J., C/o Broadcasting Station 2GZ, Orange, N.S.W.
Selman, N. H. G., 165 Ramsay Road, Haberfield, N.S.W.
Sherwood, S. R. D., 117 Milson Road, Cremorne, N.S.W.
Symons, C. J., Capel Street, Young, N.S.W.
Schmidt, R. F., C/o Station 3TR, Raymond Street, Sale, V.
Smith, E. J., La Motte, Bright, V.
Smith, C. W.,
Shortell, R. C., C/o Station 3WR, Congrepna Road, P.O., via Shepparton, Vic.
Stevens, J. P., 23 Riddell Parade, Elsternwick, S.4, V.
Sleep, M. L., 10 Waverley Street, Essendon, W.5, V.
Sydow, J. F., C/o P. and L. Wireless Pty. Ltd., 11 Hardware Street, Melbourne, V.
Searle, A. B., C/o Station 4BC, 45 Adelaide Street, Brisbane, Q'land.
Simon, L. K., 11 Cudmore Street, Somerton, Adelaide, S.A.
Simons, N. W., C/o Station 6KG, Kalgoorlie, W.A.
Taylor, T. G., Box 38, P.O., Cessnock, N.S.W.
Thomas, H. K. R., C/o Station 2GB, 29 Bligh Street, Sydney, N.S.W.
Tree, E. E., 128 Willoughby Road, Crow's Nest, N.S.W.
Torr, N., 49 Rowe Street, Eastwood, N.S.W.
Thompson, H. A., Chief Telegraphist, H.M.A.S. "Sydney," C/o G.P.O., Sydney, N.S.W.
Tiller, G. G., 152 Dandenong Road, Frankston, V.
Turner, R. R., 102 Flinder Street, Adelaide, S.A.
Tapper, J. R., C/o Station 6ML, Lyric House, Murray Street, Perth, W.A.
Taylor, H. A., Engineer-in-Charge, 6KG Transmitting Station, Parkestown, W.A.
Waters, R. T. A., Surf Road, Cronulla, N.S.W.
Watson, T. W., 70 Calero Street, Lithgow, N.S.W.
Wilson, G. H., C/o E. F. Wilks and Co., 52 Shepherd Street, Chippendale, N.S.W.
Wearne, T. S. P., 36 Mitford Street, Elwood, S.3, V.
Walther, E. L., C/o R.C.A. Photophone, Box 536H, G.P.O., Brisbane, Q'land.
Weddell, J. A., 26 Kandahar Crescent, Reade Park, Adelaide, S.A.
White, G. J., Galway Avenue, Broadview, Adelaide, S.A.
Wilson, H. B., Maintenance Engineer, Station 5AD, Weymouth Street, Adelaide, S.A.
Walch, C. A., 100 Elizabeth Street, Hobart, Tasmania.
Wolff, H. A., 107 St. John Street, Launceston, Tasmania.

ASSOCIATES.

Allan, A. J., 12 Torrens Road, Ovingham, S.A.
Bennett, A. N. Mc., 7 Silva Street, Bondi, N.S.W.
Brown, A. J., 12 Gretchen Avenue, Earlwood, N.S.W.
Colebrook, W. A. E., 30 Macpherson Street, Waverley, N.S.W.
Collins, A. K., Elizabeth Street, Albany, W.A.
Conlon, S. M., 26 Kippax Street, Sydney, N.S.W.
Dare, E., C/o Mullard Radio, 26 Clarence Street, Sydney, N.S.W.
Gibson, L., Box 39, P.O., Alstonville, N.S.W.
Griffith, R. M., 156 Edwin Street, Croydon, N.S.W.
Hume, G. V., No. 6 Flat, "Corinthia," Mosman Street, Mosman, N.S.W.
Limbert, C. C., 49a Grenfell Street, Adelaide, S.A.
Lorenzen, L. P., Emerald, Q'land.
Maidment, V. F., 32 Haig Street, Bexley, N.S.W.
Merryfull, A. E., C/o Russell Radio, Goulburn, N.S.W.
Menzel, W. E. B., Box 196, P.O., Hamilton, V.
Morgan, A. S., 212 Bay Street, Brighton, V.
Murphy, W. T., C/o Pike Bros. Ltd., Townsville, Q'land.
Olle, P. D., 17 Eccles Avenue, Ashfield, N.S.W.
Paton, J. W. A., 260 Pacific Highway, Artarmon, N.S.W.
Proust, J. L., Box 154, P.O., Grafton, N.S.W.
Reed, J. G., 26 Kennilworth Street, Croydon, N.S.W.
Webb, R. H., Watson Street, Cunnamulla, Q'land.
Whatmuff, C. W., 26 George Street, Parramatta, N.S.W.
Wood, E. T. G., 5 Judge Street, Randwick, N.S.W.

JUNIORS.

Askins, F. D., C/o National Radio Corpn., 96 Pirie Street, Adelaide, S.A.
Beaumont, J. F., 18 Riley St., Kogarah, N.S.W.
Boud, W. E., 515 Kooyong Road, Garden Vale, S.4, V.
Boylan, C., 93 Fuller's Road, Chatswood, N.S.W.
Chamberlain, W. R., 43 Beaconsfield Parade, Croxton, N.16, V.
Christopher, J. T., 108 Greville Street, Chatswood, N.S.W.
Croke, C. M., Koorawatha, N.S.W.
Dalziel, K. E., C/o Royal Ausn. Air Force, Richmond, N.S.W.
Daly, T. J., 209 Bridport Street, Albert Park, V.
Dorsett, R. J., 15 Bath Street, Glenelg, S.A.
Fisher, A. W., 152 Osborne Street, Williamstown, W.16, V.
Gray, J. T., 16 Canberra Street, Moreland, N.10, V.
Hannam, E. H., 19 Dickson Street, Waverley, N.S.W.
Hood, I. A. F., C/o Mrs. McCall, 15 Glenville Ave., Giffnock, Glasgow, Scotland.
Lamont, J. M., 48 Princess Street, Kew, E.4, V.
McManus, F. A., C/o Huckell Radio, 285 Military Road, Cremorne, N.S.W.
Moeser, E. H., 176 Croydon Road, Croydon, N.S.W.
Mackenzie, G. H., 109 Cochrane Street, Elsternwick, V.
Pearce, C. A., 385 High Street, Glen Iris, S.E.6, V.
Potter, J. S. R., 132 Drummoyne Street, Wentworthville, N.S.W.
Perrott, R. W., C/o A.W.A. Radio-Electric Works, Parramatta Road, Ashfield, N.S.W.
Simpson, J., 3 St. George's Crescent, Drummoyne, N.S.W.
Smith, J. F., 280 Old Canterbury Road, Summer Hill, N.S.W.
Stender, L. F.
Stone, R. N., 16 Queensville Street, West, Footscray, W.12, V.
Thompson, M. M., C/o Station 3AW, 382 Latrobe Street, Melbourne, V.
Thomson, D. C., 23 Charlbury Road, Medindie Gardens, S.A.
Tremlett, R. W., 25 Robert Street, Ashfield, N.S.W.



I.R.E. (Aust.) ADELAIDE DIVISION COMMITTEE.—Front row (seated): Mr. W. W. Honnor; Professor Kerr Grant, Chairman; Mr. H. W. Harrington; Vice-Chairman; Mr. A. H. Garth, Secretary and Treasurer.
Back row (standing): Messrs. S. F. Ackland, E. J. Risely, C. E. Moule, D. M. Gooding, R. Oakley, and H. B. Wilson.

1937 Annual Report of the Institution of Radio Engineers (Australia)

Presented at the Annual General Meeting held at Science House, Gloucester and Essex Streets, Sydney, Wednesday, April 21, 1937

THE past financial year of the Institution of Radio Engineers (Australia), beginning April 1, 1936, and ending March 31, 1937, has been one of the most eventful years in the brief history of this Institution.

During that period the Adelaide Division of the Institution was formed, and is now functioning very successfully.

The Institution was responsible for the establishing of Radio Foudation Day on December 12, in honour of the radio pioneers. That particular day was chosen because it was the day on which Marconi first successfully transmitted wireless signals across the Atlantic, in 1901.

The Institution also began organising in respect to the holding of a World Radio Convention during April, 1938, coinciding with Australia's 150th Anniversary Celebrations.

Another important development was the centralising at head office in Sydney, of all membership rolls and arrangements for the collection of all fees direct from head office. It was found necessary in that direction to arrange for the services of a full-time stenographer to help in carrying on the work.

Boards and Committees.

The respective boards and committees appointed to carry out various phases of work during the year performed excellent service.

QUALIFICATIONS BOARD.
(Chairman, Mr. A. S. McDonald.)

The Qualifications Board, consisting of Messrs. A. S. McDonald (chairman), D. G. Wyles, W. T. S. Crawford and F. W. P. Thom, attended many meetings, and carried out the functions of their office in accordance with the Rules of the Institution.

During the year, in respect to the qualifications of applicants, Council decided to inaugurate a new membership grade, that of Associate, interspersing it between the Junior and Associate membership grades. This now makes the grades as follows:—Fellow, Full Member, Associate Member, Associate and Junior.

The Qualifications Board found that due to the increased wide-spread knowledge of the I.R.E. activities in all parts of Australia, it was necessary to admit into its ranks many people engaged in radio who wished to be associated with engineers. In this direction it was found that it was rather difficult for the Radio Society to function as such, and it was therefore decided to discontinue the Radio Society and to transfer all members thereof to the grade of Associate of the Institution.

Quite a number of applications for admission to the Institution were requested to sit for examination, which is held on the first Saturday in November of each year.

EXAMINATION BOARD
(Chairman, Mr. J. N. Briton.)

The annual examination of the Institution was held in November, 1936, when eight candidates sat for the grade of Associate membership. There were no Junior applicants. Seven of the eight applicants gained passes.

The chairman of the Examination Board particularly records the excellent co-operation he received from his colleagues on the Board during the year.

LECTURES AND PAPERS BOARD.
(Chairman, Mr. C. W. Tyrrell.)

The chairman of the Lectures and Papers Board reports that the Institution was favoured with a number of interesting lectures and papers during the period under review. There were 12 lectures and 3 outside functions, viz., a visit to the Radio-Electric Works, Ashfield, by courtesy of A.W.A., a demonstration of new sound developments by Raycophone Theatrette, by courtesy of the Directors of Raycophone, and the Radio Foundation Day Dinner. The list of lectures is as follows:—

General meeting, 7/4/'36—Discussion: "Who Sets the Standard—the Valve Engineer or the Set Designer?"

General meeting, 1/5/'36—Illustrated Lecture by Dr. A. L. Green (Radio Research Board): "Non-Fading, Noise-free Broadcasting Services."

General meeting, 30/6/'36—Address to members on the introduction of radio to the Army by Major T. J. Farrow, Australian Instructional Corps: "The Development of Signals."

General meeting, 20/7/'36—Illustrated lecture by Mr. F. Langford Smith: "Tone Compensation in Broadcast Receivers."

General meeting, 12/8/'36—Illustrated lecture by Mr. V. H. Dudman, Manager Transmitting Department, Philips Lamps, on "Some Observations on Transmitter Design" (Part 1).

General meeting, 9/9/'36.—Illustrated lecture by Mr. R. R. Mackay, Supervisor, Melbourne Technical College, on "The Theory and Design of Audio Beat-Note Oscillators."

September 12th, 1936—Visit to Radio-Electric Works of Amalgamated Wireless A/sia Ltd., Ashfield, to inspect the new 60 k.w. broadcast transmitter for New Zealand.

General meeting, 21/9/'36—Illustrated Lecture by Mr. J. G. Reed, radio engineer, Amalgamated Wireless A/sia Ltd., on "Modern High Powered Broadcasting Transmitter Development."

General meeting, 14/10/'36—Illustrated lecture by Mr. V. H. Dudman, manager Transmitting Department, Philips Lamps, on "Some Observations on Transmitter Design" (Part 2.)

General meeting, 29/10/'36—Illustrated lecture by Dr. G. Builder, Research Laboratories, A.W.A., on "Noise Interference in Radio Receivers."

General meeting, 18/11/'36—Illustrated lecture by Mr. E. G. Beard, Director, Ace Amplifiers Ltd., on "Advanced Receiver Design."

General meeting, 1/12/'36—Illustrated lecture by Mr. F. Langford Smith, Development Engineer, A.W. Valve Co. Ltd., on "A Discussion on Sound Output Systems."

Annual dinner, 12/12/'36—Annual Dinner and Radio Foundation Day Function in honour of Marconi and Wireless Pioneers.

General meeting, 24/2/'37—Lecture by Mr. E. G. Beard on "Distance Measuring by Electrical Means."

March 17, 1937—Visit to Raycophone Theatrette—General technical outline of the new Raycophone Panophonic Sound System given by Mr. Ray Allsop, Chief Engineer and Director of Raycophone Ltd.

ANNUAL AWARD.

The annual award by way of plaques for the various grades has not been determined for the period under review, but the new Council will have this matter in hand immediately. This is an annual award of a plaque for each grade of membership.

INTERSTATE DIVISIONS.

During the year the Council arranged with the Hon. General Secretary to visit Adelaide and form the Adelaide Branch. This was duly attended to.

In respect to Brisbane and Perth, time has not permitted finalisation of the foundation of these Divisions, but it is hoped this will be arranged before the end of 1937.

Victorian Division: Considerable progress has been made by the Victorian Division, under the Chairmanship of Mr. J. Malone.

I must place on record the excellent work done by the Hon. Secretary of the Melbourne Branch, Mr. R. R. Mackay, and the Hon. Secretary of the Adelaide Branch, Mr. A. H. Garth, both of whom have been a tower of strength in handling matters in their respective States.

I.R.E. (Aust.) Annual Report (Continued)

WORK OF COUNCIL.

On behalf of the President, Mr. E. T. Fisk, the various officers and Council are duly commended for their assistance and co-operation during the past year: Vice-Presidents, Messrs. Bean and Gilmour; Hon. Treasurer, C. H. Norville; Hon. Assistant Treasurer, S. V. Colville; Hon. Assistant Secretary, K. H. M. Denny, and Councillors Allsop, Briton, Court, Crawford, Hooke, Kennell, McDonald, Parker, Schultz, Thom, Tree, Tyrrell and Wyles.

RADIO FOUNDATION DAY.

Most members of the Institution are now well aware of the success of the inauguration of the Radio Foundation Day function on December 12. On that occasion, a dinner was held at the Hotel Australia, Sydney. A combined function was also held in Melbourne, the Adelaide branch held a dinner in Adelaide, and the Brisbane radio trade also organised a dinner in honour of the occasion.

Council of the Institution is extremely grateful to the various people who assisted in making these functions so successful.

Messages were exchanged from overseas, particularly from the I.R.E. in America and from Colonel Angwyn on behalf of the Wireless Section of the Institution of Electrical Engineers, England. Messages from Marconi and other well-known figures were also received.

The Institution intends to organise this function as an annual affair throughout the world, and it is hoped that in a very short time practically every country will be celebrating the pioneers of wireless on December 12 of each year.

I must record my appreciation of the assistance rendered by Mr. Hooke, Chairman of the Social Committee, in respect to this Radio Foundation Day function.

HON. LIFE MEMBER.

During the year under review the first Honorary Life Member of the Institution was appointed by a general meeting of members under recommendation of Council. Mr. W. Phil. Renshaw was duly elected an Honorary Life Member of the Institution in recognition of the valuable assistance rendered by him to the Institution and to radio in Australia, in the past.

GROWTH OF MEMBERSHIP.

At the beginning of the period under review, viz., April 1, 1936, there were 256 members of all grades, but this number increased to 314 during the 12 months, representing an increase of 22.6 per cent. N.S.W. membership increased by 17 from 164 to 181; Victoria by 9 from 64 to 73; Queensland by 8 from 10 to 18; South Australia by 16 from 9 to 25; Western Australia by 8 from 3 to 11, whilst Tasmania remained at 6.

In the various grades Full Members increased by 18 from 101 to 119, Associate Members increased by 32 from 104 to 136 and Junior by 3 from 24 to 27. There are also other grades as follows: Fellow 1; Hon. Life Member 1; Associates 9 and Radio Society 21. This latter grade will be merged into the Associate Grade as from April 1 this year.

I.R.E. PROCEEDINGS.

The Council of this Institution has made new arrangements in regard to the publication of the proceedings of the I.R.E. It has now been arranged for the papers to be printed separately to be posted, and to be available only to members of the Institution. In this way members will have an advantage over non-members.

LENDING TECHNICAL LIBRARY.

Council has been giving consideration to the inauguration of some form of lending library for technical books, etc. This matter is receiving careful investigation with a view to bringing in some practical scheme.

TECHNICAL APPARATUS.

Council has arranged to hand back to the Wireless Institute of Australia (N.S.W. Division), certain technical instruments which were taken over in the transfer of the Wireless Institute to the I.R.E. a few years ago, and also has arranged for the amateur body in N.S.W. to officially take over the name and the old registration certificate of the Wireless Institute. This will then permit the recognised amateur body in N.S.W. to function under the name of the Wireless Institute of Australia (N.S.W. Division) and remain as an amateur body.

WORLD RADIO CONVENTION.

As previously reported, arrangements are well in hand for the holding of a World Radio Convention in Sydney on April 4th to April 14th, 1938. The Committee appointed by Council to carry out the arrangements for the Convention, has been meeting during the past year, successfully obtained the support of the N.S.W. Government and the sympathetic consideration of the Commonwealth Government. Invitations have been extended, to be official guests during April of next year, to the Marchese Marconi, Sir John Reith, Dr. A. F. Philips (Eindhoven), Baron Togo (Japan), and Mr. David Sarnoff (America).

Members will be pleased to hear that the Marchese Marconi has accepted, on behalf of himself and his wife, and also Mr. David Sarnoff has accepted on behalf of himself and his wife. Dr. Philips has requested time to give the matter attention to see whether he can definitely accept the invitation, and be away from Holland during that time. Sir John Reith regrets he cannot accept the invitation to be in Australia at that time, but as our President, Mr. Fisk, will be in England during the next few weeks, the matter will be discussed with Sir John on that occasion. Advice from Baron Togo of Japan has yet to come to hand.

The fact that the Marchese Marconi and other gentlemen have accepted the invitation will undoubtedly ensure the complete success of this very important event next year.

In connection with this World Radio Convention, intensive organisation is in hand to spread propaganda throughout the world, both per medium of broadcasting stations and the press. The aid of the amateurs and of the Wireless Institute of Australia has also been obtained, with the idea of spreading further propaganda to all parts of the world. Arrangements are in hand for bringing delegates from each State on behalf of the I.R.E. to attend in Sydney, and also in co-operation with the Wireless Institute for the holding of their Convention in Sydney at that time.

It is confidently anticipated that April, 1938, will be a very memorable period in the history of wireless in Australia.

SYDNEY DIVISION.

Council has made the necessary arrangements for the inauguration in the coming period of a Sydney Division, to operate similar to the Melbourne and Adelaide Divisions. In this way the Sydney operations will be more or less divorced from the main Council, and a committee will be appointed to carry on the Sydney activities. This will then relieve Council, and make it a Commonwealth body.

FINANCE.

The growth of the Institution is very readily reflected in the financial report, and now that the financial reports of all Divisions are in future to be incorporated in the Institution's main balance sheet, the question of accounting, auditing and collection of subscriptions, etc., will be much simpler. The Treasurer will deal with the financial statement in his report.

GENERAL PROGRESS.

As Hon. Secretary of the Institution since its inception, it is very gratifying for me to record the continued progress of same. The amount of secretarial work has increased to such an extent, as noted above, that Council found it necessary to appoint a full time stenographer.

Members from many parts of Australia have been assisted in many ways with information, and I want to assure all members, irrespective of their location, that if I, as Hon. Secretary, or the Institution generally, can be of any assistance to them, they have only to communicate with me or any member of Council, and we will do our best to help them in every direction.

It has been a very pleasing period, and a very satisfactory amount of work has been concluded, with every indication that the forthcoming year will be a most memorable one.

(Signed) O. F. MINGAY,
Hon. General Secretary.

Victorian Division Annual Report 1936-37

THE Honorary Secretary reports that during the year ending March 31, 1937, steady progress has been made by the Victorian Division in providing suitable lectures on subjects of interest to members and in maintaining a high standard of membership.

The total membership of the Victorian Division is ninety (90) members of all grades, and is made up of 34 Full members, 44 Associate members, 10 Juniors, and 2 members of the Radio Society. There have been two resignations, one being an Associate member and one a member of the Radio Society.

It is also worth noting the number of our members who have been transferred to the Sydney roll, they having changed their business affiliations and now permanently residing there These changes now total 14. One member has transferred to Adelaide and three are in England temporarily.

GOVERNMENT OF THE INSTITUTION.

Because of the constant changes in location of members and the subsequent difficulties encountered in keeping membership records, it has been decided by the Council that all fees, irrespective of a member's location, shall be paid direct to the Hon. General Secretary at the headquarters of the Institution in Sydney. Future applications for membership together with application fees will also be dealt with as mentioned above. The applications will then be sent to the Victorian Qualifications Board for their attention and recommendations.

QUALIFICATIONS BOARD ACTIVITIES.

The Qualifications Board has met on numerous occasions during the year and has spent a considerable amount of time in examining the qualifications of the applicants who have applied for membership in the various grades. Six persons have been recommended for the grade of Member, twelve for the grade of Associate member, and six for Junior grade. Four applications are still being dealt with.

It has been decided by Council that the standard of entry for the various grades shall be raised considerably, and since this would have the effect of unduly restricting an applicant for membership to the Radio Society section, it has been decided to create a new grade. The grade will be known as Associate and will rank in seniority as follows: Fellow, Full member, Associate member, Associate and Junior. The new grade will be open to all persons engaged in the radio profession.

With the extension of the Institution's activities in forming a division in South Australia, and possibly in Queensland and Western Australia in the very near future, the method of government of the Institution has become a matter of importance.

As in the case of other professional institutions, it appears necessary to have some form of Federal controlling body to which will be responsible the divisions in each State. The committee of the Melbourne division has already reported to Council along these lines, and it is expected that in a very short time the necessary changes will be introduced. Under the new arrangement, the New South Wales members will be governed directly by a Divisional Committee in the same way as in Melbourne. The Council will then deal with matters of general policy affecting members as a whole.

The Council has also arranged that the proceedings of the Institution will be published separately and sent to members only, instead of being printed in the "Radio Review" as previously. This new arrangement will enable members to obtain details of discussions of the various divisions and should prove a definite aid to those members (like our Tasmanian members) who, because of their location, are unable to attend meetings.

LECTURES AND PAPERS SUB-COMMITTEE REPORT.

The Lectures and Papers sub-committee have endeavoured to provide a series of lectures covering widely diverging sections of the profession and their success can best be judged by the large attendance which was present at each. The following lectures took place during the year under review:—

May 7th, 1936.—"Technical Description of Gippsland Regional Station 3GI." S. H. Witt, P.M.G.'s Department.

June 16th, 1936.—"Factors Influencing Design of Loud Speakers." A. C. Webb, Rola Coy.

July 7th, 1936.—"Demonstration of Sound Waves and Films." Archibald, Ampro Films.

August 11th, 1936.—"Electrical Interference with Radio Reception." W. H. Conry, P.M.G.'s Department.

September 8th, 1936.—"Aids to Marine Navigation." H. M. Lamb, A.W.A.

October 13th, 1936.—"Technical Aspects of Inspection of Wireless Installations on Ships as Conducted by P.M.G.'s Department." E. Greig, P.M.G.'s Department.

November 23rd, 1936.—"Special Film of State Electricity Scheme."

The Committee has drawn up a programme of lectures for the ensuing six months, and the titles are listed as follows:—

"Receiving Aerial Design in Theory and Practice."

"The Application of Radio to Police Work."

"Modern Valve Design and Production."

"Research into the Upper Ionosphere."

"General Principles of Television."

"Design of Army Wireless Equipment."

"Modern Direction Finding Equipment for Aircraft."

"Technique of Broadcast Studio Design."

The Committee hopes that by arranging dates as far as possible to fall on the second Tuesday of each month, members will be able to keep the dates free.

In September last, members were notified that the Committee was arranging for Junior and Associate members to compete for a prize of £3 for each grade. The prizes were to be awarded for the best paper or thesis submitted as the original work of the member concerned on any subject of use in Radio Engineering. No papers were received, however, and the Lectures and Papers Sub-committee feels that the failure of Juniors and Associates to submit papers for consideration was due mainly to the fact that no lead was given as to suitable subjects. It is therefore suggested that similar awards again be offered for a paper submitted on either of the two subjects:—

(a) "Thermionic Valves and their general or any special application in Radio Engineering."

(b) "Condensers and their general or any special application in Radio Engineering."

Further details will be sent by circular letter as soon as the Council has agreed to the new proposals.

Two social functions were arranged during the year; the first was the special dinner held at Menzies Hotel in conjunction with the Victorian Radio Traders' Association. The dinner was held in honour of the Founders of Radio, and during the dinner speeches were received from overseas extending greetings to the Institution. It has been suggested that such a dinner as well as the Annual Smoke Night, which is purely an informal evening for members, should be repeated this year.

Although it cannot be regarded as purely a social event, mention should

ANNUAL REPORT VICTORIAN DIVISION I.R.E.

—(Continued).

be made of the World Radio Convention which is to be held in Sydney next year as part of the Sesqui Centennial Celebrations in New South Wales. Representatives from overseas will be invited to deliver papers on special sections of their work, and it is hoped that the Victorian members will be able to join in the activities if possible.

The Treasurer has provided a Statement of Receipts and Expenditure in place of the usual Balance Sheet. This change has been caused by the new arrangement whereby all subscriptions are paid to the central fund, hence one balance sheet will be issued for the Institution as a whole, and not one for each Division as previously.

The following nominations have been received for the Committee and Office-bearers. As there are no excess of nominations over vacancies, no election is required and it is only necessary for this meeting of members to formally approve of the nominations.

Adelaide Division Annual Report

Presented by Chairman, Professor Kerr Grant

AT a preliminary meeting of members of the Institution of Radio Engineers resident in South Australia, held on May 27, 1936, at the Hotel Richmond, Mr. D. F. Mingay, Honorary General Secretary of the Institution, gave an address outling the present situation of the I.R.E. in Australia, and describing its aims and objects. He advocated the formation of an Adelaide Division of the Institution. It was resolved to form this Division, and the following officers were elected:—

Chairman, Professor Kerr Grant; Vice-Chairman, Mr. H. W. Harrington; Secretary and Treasurer, Mr. A. H. Garth; Committee, Messrs. S. F. Ackland, D. M. Gooding, W. W. Honnor, C. E. Moule, R. Oakley, R. Parasiers, E. J. Risely, H. B. Wilson.

The first meeting of the Adelaide Division was held on June 1, 1936, at the Hotel Richmond, when 72 persons interested in radio, either from a technical or commercial aspect, were present.

Professor Kerr Grant was in the chair. Mr. Mingay addressed the meeting, explaining again the aims and objects of the I.R.E., and the advantages of membership.

A recorded address by Mr. E. T. Fisk, President of the Institution, specially composed for this occasion, in which Mr. Fisk congratulated South Australian members on the formation of a local Division, was reproduced.

A congratulatory message was also received from Mr. J. Malone, Chairman of the Melbourne Division.

MEETINGS.

Four subsequent general meetings have been held as under:—

September 14, 1936—Address by Professor Kerr Grant on "Secondary Electron Multipliers."

November 16, 1936—General discussion on present-day radio receivers.

January 18, 1937—Lecture by Mr. F. P. O'Grady, Transmission Engineer, P.M.G.'s Dept., "Adelaide on Developments in Australian Broadcasting."

March 10, 1937—Lecture by Mr. W. W. Honnor on "Wireless Abroad."

On December 12, 1936, the Division held a dinner at the Oriental Hotel to commemorate as Radio Foundation Day, the first trans-Atlantic communication by wireless, when Marchese Marconi was successful in receiving in Newfoundland a message sent out from Poldhu in Cornwall. The dinner was attended by 16 members and six guests.

MEMBERSHIP.

The number of members now enrolled stands at 25, which includes 10 Full Members, 10 Associate Members, 2 Associates and 3 Juniors.

SUB-COMMITTEES.

The following sub-committees have been appointed:—

Programme and Papers Committee—Messrs. H. W. Harrington, W. W. Honnor, D. M. Gooding and E. J. Risley.

Qualifications Committee—Messrs. H. W. Harrington, W. W. Honnor, D. M. Gooding.

Publicity Officer—Mr. H. B. Wilson has been appointed.

The Council of the Adelaide Division is considering the possibility of establishing a technical library for radio in Adelaide for the use of S.A. members.

The Council has appointed a delegate, the Vice-President Mr. H. W. Harrington, and a vice-delegate, Mr. D. M. Gooding, to the Council of the S.A. Division of the Australian Aerial Medical Service.

Mr. A. R. Persson, Vice-President.

The Radio and Telephone Manufacturers' Association

A Section of the Chamber of Manufactures of N.S.W., 12 O'Connell St., Sydney, N.S.W.

Formed 11th November, 1927.

Mr. L. P. R. Bean, President.

President: L. P. R. Bean (Stromberg-Carlson (A/sia) Ltd.

Vice-Presidents: A. R. Persson (Ducon Condenser Pty. Ltd.), F. Thom (Thom and Smith Ltd.).

Secretary: Percy S. Edwards.

(Officers are subject to annual election in July).

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 effort 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 and 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.

MEETINGS.

The association meets on the second Monday of each month.

During the year the Association increased its membership by 30%, and at the various meetings the Association dealt with the following matters:—

SALES TAX ON AIDS TO MANUFACTURE.

The Association through its parent body, the Chamber of Manufactures of N.S.W., continued its fight against dual taxation in the form of Sales Tax on tools and machinery used by Radio Manufacturers.

Although unsuccessful, the Association will again make representations to the Government for relief.

RADIO USED IN TAXI CABS.

The Commissioner for Road Transport prohibited the use of auto radio receivers in taxi cabs in N.S.W. The Association negotiating with the Minister to revoke the prohibition.

Mr. F. W. P. Thom, Vice-President.

NEW ZEALAND TRADE.

Steps were taken by the Association to ensure that both the Commonwealth and New Zealand Customs Department use a uniform formula for assessing the percentage of local manufacture, and also the current domestic value of exported goods.

RADIO EXHIBITION.

Members decided that radio exhibitions were not advantageous to the industry, and they agreed not to exhibit in the 1936 Exhibition. Subsequently the exhibition was cancelled.

Discussion also took place on the effect of the Government's prohibition of imports from America, and investigations were made into charges for electrical power as used by the industry.

TARIFF MATTERS.

The Association co-operated with the manufacturers of fixed resistance in their efforts to secure trade protection. It also dealt with the contemplated trade agreement with Japan.

RIF CLUB OF SYDNEY

(Radio Industry Functions Club)

Formed February, 1937.

Chairman: J. L. Mulholland.
Deputy-Chairman: A. L. Freedman.
Treasurer: G. Davidson.
Hon. Secretary: O. F. Mingay.
Committee: C. F. Marden, W. Godley, A. R. Allen, E. Dare, C. Gittoes, A. P. Hosking, R. Jennings, G. Anderson.

POLICY AND OBJECTS:

The Club is composed of members engaged in radio and broadcasting in all its phases, and is formed for the purpose of carrying out social functions in the entire radio field, in so doing, any residue of funds to be used for such charitable and other purposes as the Board, at its discretion, deems advisable.

Luncheons are held fortnightly in Sydney.

The RIF Club of Sydney conducts the Radio Ball and the Xmas Radio Golf Outing.

Membership is open to all persons of good standing directly engaged in radio and broadcasting.

Subscription is 5/- p.a., and the financial year commences January 1 of each year.

Hon. Secretary's address is 30 Carrington Street, Sydney, 'phone B7188.

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, 422 Collins 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 Simplifed 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.

Chairman of Committees.

Electrical Sectional Committee:
Northern Section (Sydney): Mr. W. S. Corner.
Southern Section (Melbourne): Mr. E. Bate.
Wireless Components and Accessories: Mr. M. J. Lacey.
Wiring Rules Sectional Committee: Mr. V. J. F. Brain.
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.

VICTORIAN RADIO ASSOCIATION

The Victorian Radio Association is a body representative of the Victorian 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

(Continued on Page 100.)

VICTORIAN RADIO ASSOCIATION (Cont.)

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 Exhibitions held in Melbourne.

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**, A. S. Duke; **Vice-President**, A. F. Brash; **Past President**, R. H. Begg; **Hon. Treasurer**, E. H. Williams; and representatives of various Sections of the Association:—**Manufacturers:** Messrs. R. Walker, F. Henderson, S. Brown and J. W. D. Bain; **Merchants:** Messrs. H. V. Prior, K. Nicholls, W. Hill and A. Steward; **Retailers:** Messrs. G. Sharwood, E. H. Williams, J. Carnegie and A. Steward. **Broadcasting Stations:** Representatives of the Australian Broadcasting Commission, and Messrs. S. Morgan and D. Worrall representing the Commercial Stations.

VICTORIAN SHOPS BOARD No. 23

ELECTRICAL AND RADIO GOODS

THERE has been an alteration in the Victorian Wages Board Determination as the result of which certain classes of commission agents have been excluded from the benefits of the Electrical and Radio Goods Determination. This result was achieved by an arrangement with the employees' representatives and the Trades Hall.

If any retailer abuses the privilege which has been thus conferred, it may cause difficulties for the whole of the trade at some future date when the Determination is again considered.

Traders therefore should not continuously retain the services of any commission agent who does not receive a reasonable income from his efforts.

A copy of the new Determination, together with (see below) a draft agreement which should be signed by all commission agents employed by the electrical and radio trades if they desire to pay on commission only.

Suggested Form of Agreement.

I confirm the arrangement under which I am entitled on your behalf to make contracts for the sale of your goods and to obtain offers to take such goods on hire. I shall not be entitled to make sales or obtain such offers on your premises. Such sales and/or offers shall be made and obtained only on printed forms supplied by you or a finance company approved of by you. I shall not alter the said forms and shall not make any sales or offers to hire without obtaining the purchaser's signature to the same. I am not authorised to make any representations or give any warranty other than those appearing on the said forms or to make any arrangement regarding a trade-in and any such arrangement made by me shall be a separate contract between myself and the purchaser or hirer. My sole and exclusive remuneration shall be a commission of ....per centum on the Company's current cash price for all sales made by me and all such offers to take on hire which may be accepted. Such commission will be paid weekly in respect of the said goods actually sold, and the said offers to hire actually accepted during the preceding week. I shall have no authority to collect any moneys or trade-ins on your behalf and shall be the agent of the purchaser or hirer with respect to all moneys paid to me by them. You may withold payment of commission upon any sales and/or hiring if in your opinion the said sale or the ability of the hirer to pay is doubtful. I shall not be subject to your control or direction in any way in making the said sales and/or obtaining the said offers and shall be entitled to make sales and/or obtain offers for hiring and/or otherwise act as servant or agent of any other manufacturer or merchant. This agency may be determined forthwith and without notice.

DATED this................ day of.............. One thousand nine hundred and thirty.

....

Determination of the Victorian Shops Board, No. 23 (Electrical and Radio Goods).

NOTE.—This Determination of October 2nd, 1936, applied 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 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.

On May 18, 1932, the Shops Board No. 18 (Miscellaneous Shops) was deprived of the power to determine the lowest prices or rates which may be paid to any person or persons or classes of person employed in the business of a seller of—(a) Electrical goods; (b) Wireless (radio) sets, parts or accessories; and such power was conferred exclusively on the Shops Board No. 23 (Electrical and Radio Goods.)

In accordance with the provisions of the Factories and Shops Act, 1928 (No. 3677), 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 business of a seller of—(a) Electrical goods; (b) Wireless (radio) sets, parts or accessories"—has made the following determination, namely:—

This Determination came into force and was operative on and after October 2nd, 1936.

Apprentices and Improvers.—Wages per Week of 47 Hours

Experience	Commencing Age: 15 years or under		16 years		17 years		18 years		19 years		20 years	
Males—	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
1st year	15	0	15	0	20	0	30	0	40	0	50	0
2nd year	20	0	22	6	27	6	35	0	50	0	62	6
3rd year	27	6	30	0	37	6	50	0	65	0	—	
4th year	35	0	40	0	50	0	65	0	—		—	
5th year	45	0	50	0	—		—		—		—	
6th year	55	0	—		—		—		—		—	
And thereafter the minimum wage.												
Females—												
1st year	13	3	13	3	18	3	18	3	22	0	22	0
2nd year	18	3	22	0	24	3	25	9	31	3	—	
3rd year	22	0	25	9	31	3	36	3	—		—	
4th year	25	9	31	3	36	3	—		—		—	
5th year	31	3	36	3	—		—		—		—	
6th year	36	3	—		—		—		—		—	
And thereafter the minimum wage.												

Proportion (within any shop) Apprentices

MALES.

One male apprentice to every three or fraction of three workers receiving not less than 70/- per week.

(Turn to Page 101.)

VICTORIAN SHOPS BOARD.

(Continued from Page 99)

FEMALES.

One female apprentice to every three or fraction of three workers receiving not less than 47/6 per week.

Improvers

MALES.

One male improver to every two or fraction of two workers receiving not less than 86/ per week.

FEMALES.

One female improver to every two or fraction of two workers receiving not less than 47/6 per week.

OTHER EMPLOYEES.

Wages per week of 47 hours.

	Within the Met. District.		Outside the Met. District wherever this Detm. applies.	
Males—	s.	d.	s.	d.
Person in charge of a branch shop	97	6	93	6
canvassers, travellers, collectors, installers, and all others who are in any way connected with the sale of goods on a merchant's premises, but excluding those selling off such premises if they are paid exclusively by commission and have the right to sell goods for more than one merchant—				
21 years of age	72	6	70	0
22 years of age	82	6	80	0
23 years of age or over ..	90	0	86	0
Females.				
Females	50	0	47	6

(3) **Penal Rate:** Any person who works less than 36 hours in any week shall be paid for such work at the rate of 3/- per hour. Provided that no employee shall be entitled to receive more than the rate fixed for his particular class of work for a week of 47 hours.

(4) **Times of Beginning and Ending Work—**

	Time of Beginning.	Time of Ending.
Friday	7.45 a.m.	9 p.m.
Saturday	7.45 o.m.	1 p.m.
On the other working days of the week	7.45 a.m.	6 p.m.

(5) **Meal Interval:** No employer shall require any employee to take a longer interval than one hour for a meal.

(6) **Overtime:**

Outside the hours fixed in Clause 4 .. .. .. Within the hours fixed in Clause 4 in excess of the number of hours as fixed for an ordinary week's work .. .. } Time and a half.

(7) **Special Rate for Public Holidays:** Time and a half shall be paid for all work done on New Year's Day, 26th January (Australia Day), Good Friday, Easter Saturday, Easter Monday, 21st April (Labour Day), King's Birthday, Christmas Day, Boxing Day, or after 12.30 p.m. on Show Day (in localities mentioned in Royal Agricultural Show Act). If any other day be by Act of Parliament or Proclamation substituted for any of the abovenamed holidays, the special rate shall be payable only for work done on the day so substituted.

(8) **Termination of Employment:** Except in a case where an employee has been guilty of a misdemeanour, seven days' notice of termination of employment shall be given by either employer or worker.

(9) **Allowance:** When, in conformity with the custom of the trade, an employee wears, when at work, a washable outer garment the laundering of which is not paid for by the employer, such employee shall be paid 2/6 per week, in addition to the ordinary rate.

Victorian Scale of Wages

Applicable to the Sales Staff of the 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.

Person in charge of a branch shop, canvassers, travellers, collectors, installers, and all others who are in any way connected with the sale of goods on a merchant's premises, but excluding those selling of such premises if they are paid exclusively by commission and have the right to sell goods for more than one merchant:—

	Within Metropolitan Area	Outside Metropolitan Area
21 years of age	72/6	70/-
22 years of age	82/6	80/-
23 years of age or over	90/-	86/-

Penal Rate.—Any person who works less than 36 hours in any one week shall be paid for such work at the rate of 3/- per hour, provided that no employee shall be entitled to receive more than the rate fixed for his particular class of work for a week of 47 hours.

FEMALES.

Within metropolitan area, £2/10/-; outside metropolitan area, £2/7/6.

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.

N.S.W. Factories and Shops Act

ABSTRACT ACT AND REGULATIONS.

To be kept posted in factories in which steam or other mechanical power is used, or in which any boy under 16 years of age or any female is employed.

REGISTRATION.

All factory premises must be registered and the fee paid annually. (See Schedule Four to Act.)

EMPLOYMENT.

No child under fourteen years of age shall be employed in any factory unless by special permission of the Minister.

No person under sixteen years of age shall be employed without a certificate of fitness. Application for the certificate should be made to the Department.

No boy under sixteen years of age and no female shall be employed for more than 48 hours in any week except in the case of overtime. (The daily hours must be set out in the Time Sheet.)

(Continued on Next Page.)

N.S.W. FACTORIES ACT ABSTRACTS

(Continued.)

No boy under eighteen years of age and no female shall be employed for more than five hours without an interval of at least half-an-hour for a meal.

The parent or guardian of a boy under sixteen years of age or a girl under eighteen is liable to a penalty if he allows such boy or girl to work in a factory contrary to the provisions of the Act.

MINIMUM WAGE.

No person shall be employed unless in receipt of a weekly wage of at least four shillings.

An amount of not less than sixpence as tea money must be paid to any boy under sixteen years of age or any female who is employed after six o'clock in the evening of any day.

The tea money must be paid on the day the overtime is worked.

OVERTIME.

Overtime may be worked—

For not more than three hours on any day.

On not more than three consecutive days.

On not more than thirty days in the year.

All time worked beyond the ordinary hours as shown in the time sheet must be recorded and paid for as overtime.

All time worked after six o'clock in the evening must be recorded and paid for as overtime.

Overtime must be paid for at the rate of time and a half—the minimum rate to be not less than threepence per hour.

A record of overtime must be kept in the prescribed form. (Books may be obtained at the Government Printing Office.)

A notice of having worked overtime must be sent to the Department within fourty-eighty hours of the working of the overtime.

MACHINERY.

All dangerous parts of machinery must be securely fenced or guarded.

All emery wheels must be fenced or guarded, and shall not be run before any door or entrance.

All fencing must be maintained in an efficient state.

No boy under eighteen years of age and no female shall

(a) Clean machinery whilst it is in motion;

(b) Be in charge of any engine or boiler;

(c) Attend to any engine or boiler unless under the direct supervision of a competent person.

No boy under sixteen years of age and no female shall have the care or working of any lift.

The opening of every hoist-way or lift must be protected at each floor.

No boy under sixteen years of age and no female shall while the machinery is in motion—

(a) Oil or grease any portion of the mill-gearing;

(b) Put on or off, or adjust, tighten, or lace any belt;

(c) Go on and remain on any overhead staging erected for the service of any mill-gearing.

No female shall be employed at or near any machinery whilst her hair is not covered, or closely fastened to her head, or whilst she is wearing loose neck ribbons, or laces, or such loose articles of dress.

ACCIDENTS.

An accident causing loss of life; or due to any machinery moved by mechanical power or to molten metal, hot liquid, or other hot substance, explosion, escape of gas or steam, or to electricity, and so disabling the injured person for forty-eight hours; or any other accident disabling a person for seven days, must forthwith be reported in writing to the Chief Inspector of Factories. When an accident so notified subsequently proves fatal, written notice of the death must also be forwarded immediately.

SANITATION.

All factories shall be kept in a cleanly state and free from effluvia, and must be periodically painted or varnished, papered or limewashed.

Four hundred cubic feet of air space, and twelve square inches of both inlet and outlet ventilation must be provided for each person employed in a factory, or any room therein.

If, in the opinion of an Inspector, the employees are grouped too closely together in any room, he may require a re-arrangement of such grouping.

Every heating appliance must be provided with flues and hoods, as approved by the Inspector.

Every part of a factory must be efficiently lighted.

Every factory must be provided with proper closet accommodation.

Where persons of both sexes are employed, separate closet accommodation must be provided for each sex.

GENERAL.

No woman or young person shall be permitted or required to lift or carry heavy weights. (See Section 37.)

Unless exempted by the Minister, a first aid ambulance chest, appliances and requisities, must be installed, equipped and maintained.

Wearing apparel must not be made, cleaned, or repaired in any factory or shop, nor materials issued from any building, whether a factory or not, in which any person is suffering from an infectious disease.

The doors of rooms in which persons are at work shall not be locked, bolted or barred during working hours.

Provision must be made for extinguishing FIRE, and means of escape, approved by the Board of Fire Commissioners, must be provided in certain factories for persons working in such factories. (See Section 39, Sub-sec. 3.)

An Inspector may question any employee alone on any subject in connection with the Factories and Shops Act.

Any person who refuses to answer questions, or who wilfully delays an Inspector in the exercise of any powers under this Act, is liable to be proceeded against for obstruction.

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, Phillips Street, Sydney.

No. 2732—18th November, 1932.
No. 2789—23rd December, 1932.
No. 4189—14th June, 1935.
No. 5282—20th November, 1936.

The last of these (No. 5282) covers the conditions at present (April, 1936) 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—£3/16/- per week; 1/9⁹/₁₁ per hour.
Testers—£3/19/- per week; 1/10⁷/₁₁ 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: £5 per week; 2/4⁷/₁₁ per hour.

(Continued on Page 103.)

N.S.W. ELECTRICIANS' AWARD (Continued.)

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	1	1
At 16 years of age	1	7	7
At 17 years of age	1	15	0
At 18 years of age	2	5	1
At 19 years of age	2	12	7
At 20 years of age	3	0	1

(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	7	0
At 19 years of age	2	15	1
At 20 years of age	3	3	0

(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	2	0	0
Others	2	4	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	1	0	1
At 16 years of age	1	2	8
At 17 years of age	1	5	1
At 18 years of age	1	12	7
At 19 years of age	1	16	1
At 20 years of age	2	0	0

FEDERAL WAGES AWARD

Covering members of the Metal Trades' Employers Association and other firms specifically cited in the award made by his Honor, Judge Beeby, on 15th May, 1935, and subject to variation made since that date.

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:			
Weekly employment, N.S.W.	2	2	9
Weekly employment, Queensland	2	1	6
Hourly employment, N.S.W.	2	5	9
Hourly employment, Queensland	2	4	6
If of 12 months' or more experience:			
Weekly employment, N.S.W.	2	9	0
Weekly employment, Queensland	2	7	6
Hourly employment, N.S.W.	2	12	6
Hourly employment, Queensland	2	11	0

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:—

	£	s.	d.
1st year's experience:			
Weekly employment, N.S.W.	0	13	6
Weekly employment, Queensland	0	13	6
Hourly employment, N.S.W.	0	14	6
Hourly employment, Queensland	0	14	6
2nd year's experience:			
Weekly employment, N.S.W.	0	18	0
Weekly employment, Queensland	0	18	0
Hourly employment, N.S.W.	0	19	3
Hourly employment, Queensland	0	19	3
3rd year's experience:			
Weekly employment, N.S.W.	1	5	9
Weekly employment, Queensland	1	5	0
Hourly employment, N.S.W.	1	7	9
Hourly employment, Queensland	1	6	9
4th year's experience:			
Weekly employment, N.S.W.	1	12	6
Weekly employment, Queensland	1	11	6
Hourly employment, N.S.W.	1	14	9
Hourly employment, Queensland	1	13	9
5th year's experience:			
Weekly employment, N.S.W.	1	17	3
Weekly employment, Queensland	1	16	0
Hourly employment, N.S.W.	2	0	0
Hourly employment, Queensland	1	18	9
Thereafter until reaching 21 years of age:			
Weekly employment, N.S.W.	2	1	3
Weekly employment, Queensland	2	0	0
Hourly employment, N.S.W.	2	4	3
Hourly employment, Queensland	2	3	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:			
Weekly employment, N.S.W.	0	15	0
Weekly employment, Queensland	0	15	0
Hourly employment, N.S.W.	0	16	0
Hourly employment, Queensland	0	16	0
2nd year's experience:			
Weekly employment, N.S.W.	1	0	9
Weekly employment, Queensland	1	0	0
Hourly employment, N.S.W.	1	2	3
Hourly employment, Queensland	1	1	6
3rd year's experience:			
Weekly employment, N.S.W.	1	8	6
Weekly employment, Queensland	1	7	6
Hourly employment, N.S.W.	1	10	6
Hourly employment, Queensland	1	9	6

FEDERAL WAGES AWARD—(Continued).

	£	s.	d.
4th year's experience:			
Weekly employment, N.S.W.	1	18	9
Weekly employment, Queensland	1	17	6
Hourly employment, N.S.W.	2	1	6
Hourly employment, Queensland	2	0	3
5th year's experience:			
Weekly employment, N.S.W.	2	9	0
Weekly employment, Queensland	2	7	6
Hourly employment, N.S.W.	2	12	6
Hourly employment, Queensland	2	11	0
6th year's experience:			
Weekly employment, N.S.W.	2	16	9
Weekly employment, Queensland	2	15	0
Hourly employment, N.S.W.	3	0	9
Hourly employment, Queensland	2	19	0
7th year's experience:			
Weekly employment, N.S.W.	3	0	3
Weekly employment, Queensland	2	18	6
Hourly employment, N.S.W.	3	4	6
Hourly employment, Queensland	3	2	9

Thereafter, until reaching 21 years of age, a junior under the above classification shall be paid full adult rates.

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.

West Australia Serviceman's Award

Agreement No. 19 of 1935.

(Registered 28/11/'35.)

1.—AREA. This Agreement shall operate over the area within a radius of twenty-five (25) miles from the G.P.O., Perth.

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.

(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.

(e) 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.

W.A. SERVICEMAN'S AWARD—(Cont.)

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.

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 calender 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

	Male junior workers:	Per week. % of Basic Wage
(c)	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

(Continued on Page 106.)

W.A. Serviceman's Award *(Cont.)*

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 rates, 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 parties 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.

(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 endorsed 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.

AUSTRALIAN VALVE MERCHANTS ASSOCIATION

Assembly Hall Building, 1 Jamieson Street, Sydney. Tel.: B 1046.

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.

Metal Trades Employers' Association

Head Office: Fourth Floor, 7 Wynyard Street, Sydney. Tel.: 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 1937-38.

President: J. Heine (John Heine and Sons Ltd.)

Vice-Presidents: W. S. Clegg (Commonwealth Steel Co. Ltd.), W. Ferguson (Sydney Steel Co. Ltd.), N. Frazer (Cockatoo Docks and Eng. Co. Pty. Ltd.)

Hon. Treasurer: J. F. Clack (Commonwealth Oxygen and Acetylene Ltd.)

Councillors: W. Courtney (Courtney and Bohlsen Ltd), A. Duly (Duly and Hansford Ltd.), R. B. Hipsley (Hipsley's Ltd.), E. A. Horner (Amalgamated Wireless A/sia. Ltd.), J. H. Meiklejohn (Austral Bronze Co. Ltd), L. Sonnerdale (Sonnerdale Ltd), H. L. Spring (Metters Ltd), C. W. Squires (Malleable Castings Ltd), L. Napier Thomson (Andrew Thomson and Scougall Ltd.), T. W. Thorney (W. Thorney and Sons Ltd.), and H. Weymouth (Clyde Engineering Co. Ltd.)

Electricity Supply Voltages throughout Australia

THE TOWN OR DISTRICT IS GIVEN FIRST, THEN VOLTAGE AND FREQUENCY. THE SUPPLIERS TO THE VARIOUS DISTRICTS ARE NOT SHOWN, AS GENERALLY THE RADIO INDUSTRY IS CHIEFLY INTERESTED IN THE VOLTAGE AND FREQUENCY FOR POSSIBLE BUSINESS. THIS LIST HAS BEEN COMPILED AND CHECKED AT GREAT TROUBLE AND COST, AND IS 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.

A

ABERDARE, N.S.W., 240v., 50c.
ABERDEEN, N.S.W., 240v. 50c.
ABERDEEN, Tas., 240v., 50c.
ABERMAIN, N.S.W., 240v., 50c.
ABERNETHY, N.S.W., 240v., 50c.
ADAMSTOWN, N.S.W., 240v. 50c.
ADELAIDE, S.A., 240v. 50c. (Portions are still being changed from 210v. 50c., and application to Adel. Elec. Supply Co. is advisable for voltage at any particular point. This excludes North Adelaide, which is to remain at 210v. 50c.
ADELONG, N.S.W., 240v. 50c.
AIREYS INLET, Vic., 230v. 50c.
ALBANY, W.A., 220v. D.C.
ALBION PARK, N.S.W., 240v. 50c.
ALBURY, N.S.W., 240v. 50c.
ALDGATE, S.A., 210v. 50c.
ALEXANDRA, Vic., 230v. 50c.
ALEXANDRIA, N.S.W., 240v. 50c.
ALLANSFORD, Vic., 230v. 50c.
ALLORA, Q'ld., 240v. 50c.
ALTONA, Vic., 230v. 50c.
ALVIE, Vic., 230v. 50c.
AMBLESIDE, S.A., 210v. 50c.
ANGASTON, S.A., 210v. 50c.
ANGLESEA, Vic., 230v. 50c.
ANLABY, S.A., 240v. 50c.
ANNANDALE, N.S.W., 240v. 50c.
ANTHIL PONDS, Tas., 240v. 50c.
APOLLO BAY, Vic., 230v. D.C.
APPLECROSS, W.A., 250v. 40c.
ARARAT, Vic., 240v. 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.
ARMAGH, S.A., 240v. 50c.
ARNCLIFFE, N.S.W., 240v. 50c.
ARUNDEL, Vic., 230v. 50c.
ASHFIELD, N.S.W., 240v. 50c.
ASHTON, S.A., 210v., 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

BABINDA, Q'ld., 240v. 50c.
BACCHUS MARSH, Vic., 230v. 50c.
BADAGINNIE, Vic., 230v. 50c.
BAGDAD, Tas., 240v. 50c.
BAIRNSDALE, Vic., 230v. 50c.
BALAKLAVA, S.A., 210v. 50c.
BALGOWNIE, N.S.W., 240v. 50c.
BALHANNAH, S.A., 240v. 50c.
BALINGUP, W.A., 220v. D.C.
BALLAN, Vic., 230v. 50c.
BALLARAT, Vic., A.C. 230v. 50c., D.C. 220v.
BALLINA, N.S.W., 240v. 50c.
BALMAIN, N.S.W., 240v. 50c.
BALMORAL, Qld., 340v. 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., 240v. 50c.
BARMEDMAN, N.S.W., 240v. 50c.
BARHAM, N.S.W., 230v. 50c.
BARMERA, S.A., 240v. 50c.
BARNWARTHA, Vic., 230v. 50c.
BARRON FALLS, Qld., 240v. 50c.
BARRABA, N.S.W., 240v. D.C.
BARWON HEADS, Vic., 230v. 50c.
BASKET RANGE, S.A., 210v. 50c.
BASSENDEAN, W.A., 250v. 40c.
BASKERVILLE, W.A., 250v. 40c.
BATHURST, N.S.W., 240v. 50c.
BATLOW, N.S.W., 240v. 50c.
BAULKHAM HILLS, N.S.W., 240v. 50c.
BAYLES, Vic., 230v. 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.
BEENLEIGH, Qld., 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, Vic., 230v. 50c. and 220v. D.C.
BENA, Vic., 230v. 50c.
BENALLA, Vic., 230v. 50c.
BENCUBBIN, W.A., 220v. D.C.
BENDIGO, Vic., 230v. 50c. 220v. D.C.
BERRI, S.A., 230v. D.C.
BERRIGAN, N.S.W., 240v. 50c.
BERRIMA, N.S.W., 220v. D.C.
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., 210v 50c.
BIREGURRA, Vic., 230v. 50c.
BIRRDALE, Qld., 240v. 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., 210v. 50c.
BLYTH, S.A., 210v. 50c.
BOAT HARBOUR, Tas., 240v. 50c.
BOISDALE, Vic., 230v. 50c.
BOGGABRI, N.S.W., 240v. 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., 230v. 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.
BOULDER, W.A., 220v. D.C.
BOWEN, Qld., 240v. 50c.
BOWENFELS, N.S.W., 240v. 50c.
BOWNING, N.S.W., 240v. 50c.
BOWRAL, N.S.W., 240v. 50c.
BOWRAVILLE, N.S.W., 240v. 50c.
BOWSER, Vic., 230v. 50c.
BOWTHORNE, N.S.W., 240v. 50c.
BOX HILL, Vic., 230v. 50c.
BOYA, W.A., 250v. 40c.
BOYUP BROOK, W.A., 220v. D.C.
BRACKNELL, Tas., 240v. 50c.
BRAESIDE, Vic., 230v. 50c.
BRAIDWOOD, N.S.W., 240v. 50c.
BRANXTON, N.S.W., 240v. 50c.
BREWARRINA, N.S.W., 240v. D.C.
BRIAGOLONG, Vic., 230v. 50c.
BRIAR HILL, Vic., 230v. 50c.
BRICKENDON, Tas., 240v. 50c.
BRIDGETOWN, W.A., 220v. D.C.
BRIDGEWATER, S.A., 210v 50c.
BRIDGEWATER, Tas., 240v. 50c.
BRIGHT, Vic., 230v. 50c.
BRIGHTON, Tas., 240v. 50c.
BRIGHTON, S.A., 210v. 50c.
BRINKWORTH, S.A., 210v. 50c.
BRISBANE, Qld., 240v. 50c.
BROADFORD, Vic., 230v. D.C.
BROADMEADOWS, Vic., 230v. 50c.
BROKEN HILL, N.S.W., 115v. 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. 40c.
BRUTHEN, Vic., 230v. 50c.
BUCKLAND HILL, W.A., 250v. 40c.
BULLI, N.S.W., 240v. 50c.
BULLOCK SWAMP, Vic., 230v. 50c.
BULN BULN, Vic., 230v. 50c.
BUNBURY, W.A., 220v. D.C.
BUNDABERG, Qld., 240v. D.C.
BUNDANOON, N.S.W., 240v. 50c.
BUNDOORA, Vic., 230v. 50c.
BUNYIP, Vic., 230v. 50c.
BURNIE, Tas., 240v. 50c.
BURNSIDE, S.A., 210v. 50c.
BURRA, S.A., 230v. 50c.
BURRADOO, N.S.W., 240v. 50c.
BURRAMINE, Vic., 230v. 50c.
BURRAWA, N.S.W., 240v. 50c.
BURRAWANG, N.S.W., 240v. 50c.
BURRINJUCK, N.S.W., 240v. 50c.
BURWOOD, N.S.W., 240v. 50c.
BUSSELTON, W.A., 220v. D.C.
BUTE, S.A., 240v. D.C.
BYFORD, W.A., 250v. 40c.
BYRON BAY, N.S.W., 240v. 50c.

C

CABRAMATTA, N.S.W., 240v. 50c.
CAIRNS, Qld., 240v. 50c.
CALTOWIE, S.A., 210v. 50c.
CALDERMEADE, Vic., 230v 50c.
CAMBERWELL, Vic., 200v. 50c.
CAMBRIDGE, Tas., 240v. 50c.
CAMDEN, N.S.W., 240v. 50c.
CAMPANIA, Tas., 240v. 50c.
CAMPBELL FIELD, Vic., 230v. 50c.
CAMPBELLTOWN, N.S.W., 240v. 50c.
CAMPBELLTOWN, Tas., 240v. 50c.
CAMPERDOWN, Vic., 230v. 50c.
CANBERRA, F.C.T., 240v. 50c.
CANLEYVALE, N.S.W., 240v. 50c.
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.
CANUNGRA, Qld., 240v. 50c.
CAPFL, W.A., 220v. D.C.
CARDIFF, N.S.W., 240v. 50c.
CARDUP, W.A., 250v. 40c.
CARLINGFORD, N.S.W., 240v. 50c.
CARMEL, W.A., 250v. 40c.
CARNAMAH, 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., 210v. 50c.

ELECTRIC SUPPLY VOLTAGES THROUGHOUT AUSTRALIA.

C

CASINO, N.S.W., 240v. 50c.
CASTERTON, Vic., 230v. D.C.
CASTLE FORBES BAY, Tas., 240v. 50c.
CASTLEREAGH, N.S.W., 240v. 50c.
CASTLEMAINE, Vic., 230v. 50c. and 230v. 50c.
CATANI, Vic., 230v. 50c.
CAULFIELD, Vic., 200v. 50c. and 230v. 50c.
CAVERSHAM, W.A., 250v. 40c.
CEDUNA, S.A., 220v. D.C.
CENTRAL ILLAWARRA, N.S.W., 240v. 50c.
CESSNOCK, N.S.W., 240v. 50c.
CHAIN OF PONDS, S.A., 210v. 50c.
CHARLESTON, N.S.W., 240v. 50c.
CHARLESTON, S.A., 240v. 50v.
CHARLEVILLE, Qld., 240v. D.C.
CHARLTON, Vic., 230v. D.C.
CHARTERS TOWERS, Qld., 240v. 50c.
CHELTENHAM, N.S.W., 240v. 50c.
CHELTENHAM, Vic., 200v. 50c.
CHELSEA, Vic., 230v. 50c.
CHILDERS, Qld., 230v. D.C.
CHILTERN, Vic., 230v. 50c.
CHINCHILLA, Qld., 240v. 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.
CLERMONT, Qld., 240v. 50c.
CLEVE, S.A., 230v. D.C.
CLEVELAND, Qld., 240v. 50c.
CLIFTON, N.S.W., 240v. 50c.
CLONCURRY, Qld., 240v. 50c.
CLOVERLEA, Vic., 230v. 50c.
CLYDEBANK, Vic., 230v. 50c.
COALCLIFF, N.S.W., 240v. 50c.
COCKBURN, N.S.W., 240v. 50c.
COBAR, N.S.W., 240v. 50c.
COBDEN, Vic., 230v. 50c.
COBRAM, Vic., 230v. D.C.
COBURG, Vic., 230v. 50c.
COCKBURN, S.A., 220v. D.C.
COFF'S HARBOUR, N.S.W., 240v. 50c.
COHUNA, Vic., 230v. D.C.
COLAC, Vic., 230v. 50c.
COLBINABBIN, Vic., 110v. D.C.
COLEDALE, N.S.W., 240v. 50c.
COLDSTREAM, N.S.W., 240v. 50c.
COLDSTREAM, Vic., 230v. D.C.
COLERAINE, Vic., 230v. D.C.
COLLAROY, N.S.W., 240v. 50c.
COLLARENEBRI, N.S.W., 240v. D.C.
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.
CONGUPNA, Vic., 230v. 50c.
CONNISTON, N.S.W., 240v. 50c.
COOLAH, N.S.W., 240v. 50c.
COOEE, Tas., 240v. 50c.
COOLAMON, N.S.W., 240v. 50c.
COOLANGATTA, Qld., 240v. 50c.
COOLGARDIE, W.A., supply being inaugurated.
COOMA, N.S.W., 240v. D.C.
COOMERA, Qld., 240v. 50c.
COONABARABRAN, N.S.W., 240v. 50c.
COONAMBLE, N.S.W., 240v. 50c.
COOROW, W.A., 220v. D.C.
COORPAROO, Qld., 240v. 50c.
COOTAMUNDRA, N.S.W., 240v. 50c.
COPMANHURST, N.S.W., 240v. 50c.
CORA LYNN, Vic., 230v. 50c.
CORAMBA, N.S.W., 240v. 50c.
CORAKI, N.S.W., 240v. 50c.
CORAGULAC, Vic., 230v. 50c.
CORDEAUX DAM, N.S.W., 240v. 50c.
CORNWALL, Tas., 240v. 50c.
COROMANDEL VALLEY, S.A., 210v. 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.
COWES, Vic., 230v. 50c.
COWRA, N.S.W., 240v. 50c.
COWWARR, Vic., 230v. 50c.
CRAFERS, S.A., 210v. 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.
CROW'S NEST, Qld., 240v. 50c.
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. D.C.
CYGNET, Tas., 240v. 50c.

D

DALBY, Qld., 240v. 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., 230v. D.C.
DAYBORO, Qld., 240v. 50c.
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.
DENILIQUIN, N.S.W., 240v. 50c.
DENMAN, N.S.W., 240v. 50c.
DENMARK, W.A., 220v. D.C.
DENNINGTON, Vic., 230v. 50c.
DERBY, Tas., 240v. 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., 200v. 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., 230v. 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.
DUMBALK, Vic., 230v. 50c.
DUMBLEYUNG, W.A., 220v. D.C.
DUNDAS, N.S.W., 240v. 50c.
DUNGOG, N.S.W., 240v. 50c.
DUNOLLY, Vic., 230v. 50c.
DYSART, Tas., 240v. 50c.

E

EAGLEHAWK, Vic., 230v. D.C.
EAGLE HEIGHTS, Qld., 240v. 50c.
EAST CANNINGTON, W.A., 250v. 40c.
EAST OAKLEIGH, Vic., 230v., 50c.
EASTWOOD, N.S.W., 240v. 50c.
EAST GRETA, N.S.W., 240v. 50c.
EAST MAITLAND, N.S.W., 240v. 50c.
ECHUCA, Vic., 230v. 50c.
EDEN HILLS, S.A., 200v. 50c.
EDENHOPE, Vic., 230v. D.C.
EDMONTON, Qld., 240v. 50c.
EDITHBURG, S.A., 200v. D.C.
EILDON WEIR, Vic., 230v. 50c.
ELDORADO, Vic., 230v. 50c.
ELECTRONA, Tas., 240v. 50c.
ELLIMINYT, Vic., 230v. 50c.
ELLINBANK, Vic., 230v. 50c.
ELLIOTT, Tas., 240v. 50c.
ELMORE, Vic., 230v. D.C.
ELTHAM, Vic., 230v. 50c.
ENOGGERA, Qld., 240v. 50c.
ENFIELD, N.S.W., 240v. 50c.
EMERALD, Qld., 240v. 50c.
EMERALD, Vic., 230v. 50c.
EPPING, N.S.W., 240v. 50c.
EPPING, Vic., 230v. 50c.
ERINA SHIRE, N.S.W., 240v. 50c.
ERMINGTON, N.S.W., 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.
EUGENANA, Tas., 240v. 50c.
EUROA, Vic., 230v. D.C.
EVANDALE, Tas., 240v. 50c.
EVELYN, Vic., 230v. 50c.
EXETER, N.S.W., 240v. 50c.
EXTON, Tas., 240v. 50c.

F

FAIRFIELD, N.S.W., 240v. 50c.
FAIRHAVEN, Vic., 230v. 50c.
FAIRY MEADOW, N.S.W., 240v. 50c.
FAULCONBRIDGE, 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., 210v. 50c.
FOREST, Tas., 240v. 50c.
FORREST, W.A., 220v. D.C.
FORTH, Tas., 240v. 50c.
FORSTER, N.S.W., 230v. 50c.
FRANKLIN, Tas, 240v. 50c.
FRANKSTON, Vic., 230v. 50c.
FREELING, S.A., 210v. 50c.
FREMANTLE, W.A., 250v. 40c.
FRESHWATER, Qld., 240v. 50c.

G

GALONG, N.S.W., 240v. 50c.
GARDNERS BAY, Tas., 240v. 50c.
GARFIELD, Vic., 230v. 50c.
GAWLER, S.A., 210v. 50c.
GAWLER, Tas., 240v. 50c.
GAWLER RIVER, S.A., 210v. 50c.
GAYNDAH, Qld., 240v. D.C.
GEELONG, Vic., 230v. 50c. and 220v. D.C.
GEEVESTON, Tas., 240v. 50c.
GEORGETOWN, S.A., 210v. 50c.
GEORGETOWN, Tas., 240v. 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. and 240v. 50c.
GLADSTONE, S.A., 210v. 50c.
GLADSTONE, Tas., 200v. 50c.
GLEBE, N.S.W., 240v. 50c.
GLENELG. S.A., 210v. 50c.
GLEN EWIN, S.A., 210v. 50c.
GLENFIELD. N.S.W., 240v. 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.
GLENREAGH, 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.
GOLDEN SQUARE, Vic., 230v. 50c.
GOOLWA, S.A., 240v. 50c.
GOOMALLING. W.A., 220v. D.C.
GOONDIWINDI, Qld., 240v. D.C.
GOOSEBERRY HILL, W.A., 250v. 40c.
GORDON, Tas., 240v. 50c.
GORDONVALE, Qld., 240v. 50c.
GORMANSTON, Tas., 230v. 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., 240v. 50c.
GREAT MARLOW, N.S.W., 240v. 50c.
GREENBUSHES, W.A., 220v. D.C.
GREENMOUNT, W.A., 250v. 40C.
GREENOCK, S.A., 210v. 50c.
GREEN PONDS, Tas., 240v. 50c.
GREENSBOROUGH, Vic., 230v.

ELECTRICITY SUPPLY VOLTAGES THROUGHOUT AUSTRALIA.

GRENFELL, N.S.W., 240v. 50c.
GRETA, N.S.W., 240v. 50c.
GRETNA, Tas., 240v. 50c.
GRIFFITH, N.S.W., 240v. 50c.
GROVE, Tas., 240v. 50c.
GROVEDALE, Vic., 230v. 50c. and 220v. D.C.
GUILDFORD, N.S.W., 240v. 50c.
GUILDFORD, W.A., 250v. 40c.
GULGONG, N.S.W., 240v. 50c.
GUMERACHA, S.A., 210v. 50c.
GUNDAGAI, N.S.W., 240v. 50c.
GUNDURIMBA, N.S.W., 240v. 50c.
GUNNEDAH, N.S.W., 240v. 50c.
GUNNING, N.S.W., 240v. D.C.
GUYRA, N.S.W., 240v. 50c.
GYMPIE, Qld., 240v. D.C.

H

HABERFIELD, N.S.W., 240v. 50c.
HACKHAM, S.A., 210v. 50c.
HAGLEY, Tas., 240v. 50c.
HALBURY, S.A., 210v. 50c.
HAITON, N.S.W., 240v. 50c.
HAMILTON, Vic., 230v. D.C.
HAMILTON, N.S.W., 240v. 50c.
HAMILTON, S.A., 240v. 50c.
HAMILTON, Qld., 240v. 50c.
HAMLEY BRIDGE, S.A., 210v. 50c.
HAMPDEN, S.A., 240v. 50c.
HARBORD, N.S.W., 240v. 50c.
HARCOURT, Vic., 230v. 50c.
HARDEN, N.S.W., 240v. 50c.
HARRIS PARK, N.S.W., 240v. 50c.
HARROW, Vic., 110v. D.C.
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.
HAZELWOOD, Vic., 230v. 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.
HENLEY, S.A., 210v. 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., 210v. 50c.
HILLSIDE, Vic., 230v. 50c.
HILLSTON, N.S.W., 240v. 50c.
HINDMARSH, S.A., 210v. 50c.
HOBART, Tas., 240v. 50c. (in centre of city area 480v D.C. is available for motive power)
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., 210v. 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

INGHAM, Qld., 240v. 50c.
INGLEBURN, N.S.W., 240v. 50c.
INGLEWOOD, S.A., 210v. 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., 220v. 50c.
IRREWARRA, Vic., 230v. 50c.
ITHACA, Qld., 240v. 50c.

J

JAMBUNNA, Vic., 230v. 50c.
JAMBEROO, N.S.W., 240v. 50c.
JAMESTOWN, S.A., 210v. 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.
JOHNSONVILLE, Vic., 230v. 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., 240v. D.C.
KALAMUNDA, W.A., 250v. 40c.
KALGOORLIE, W.A., 220v. D.C. also 110v. 40c.
KALIMNA, Vic., 230v. 50c.
KALLISTA, Vic., 230v. 50c.
KALDRAMA, Vic., 230v. 50c.
KANDOS, N.S.W., 240v. 50c.
KANGAROO FLAT, Vic., 230v. 50c.
KANIVA, Vic., 230v. 50c.
KAPUNDA, S.A., 210v. 50c.
KARANGI, N.S.W., 240v. 50c.
KAROONDA, S.A., 220v. D.C.
KATANNING, W.A., 220v. D.C.
KATOOMBA, N.S.W., 240v. 50c.
KATUNGA, Vic., 230v. 50c.
KEARSLEY, N.S.W., 240v. 50c.
KEILOR, Vic., 230v. 50c.
KEDRON, Qld., 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. 50c.
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. 50c.
KERSLEY, N.S.W., 240v. 50c.
KETTERING, Tas., 240v. 50c.
KEW, Vic., 200v. 50c.
KIAMA, N.S.W., 240v. 50c.
KILLARNEY, Qld., 240v. 50c.
KILMORE, Vic., 230v. D.C.
KILSYTH, Vic., 230v. 50c.
KINGAROY, Qld., 240v. D.C.
KINGBOROUGH, Tas., 240v. 50c.
KINGSTON, Tas., 240v. 50c.
KINGSTON, Qld., 240v. 50c.
KITCHENER, N.S.W., 240v. 50c.
KOGARAH, N.S.W., 240v. 50c.
KOJONUP, W.A., 230v. 50c.
KOLORA, Vic., 110v. 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.
KOYUGA, Vic., 230v. 50c.
KULIN, W.A., 220v. D.C.
KUNONOPPIN, W.A., 220v. D.C.
KURANDA, Qld., 240v. 50c.
KURING-GAI, N.S.W., 240v. 50c.
KURRAGONG, 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.
LANCASTER, Vic., 230v. 50c.
LANCEFIELD, Vic., 230v. 50c.
LANE COVE, N.S.W., 240v. 50c.
LANG LANG, Vic., 230v. 50c.
LANGWARRIN, Vic., 230v. 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., 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.
LILLICO, Tas., 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., 210v. 50c.
LIVERPOOL, N.S.W., 240v. 50c.
LOCH, Vic., 230v. 50c.
LOCKHART, N.S.W., 240v. D.C.
LOCKINVAR, N.S.W., 240v, 50c.
LONGFORD, Tas., 240v. 50c.
LONGLEY, Tas., 240v. 50c.
LONGREACH, Qld., 240v. D.C.
LONGWARRY, Vic., 230v. 50c.
LORN, N.S.W., 240v. 50c.
LORNE, Vic., 230v. 50c.
LOWER FERNTREE GULLY, Vic., 230v. 50c.
LOWER LONGLEY, Tas., 240v. 50c.
LOWER PLENTY, Vic., 230v. 50c.
LOXTON, S.A., 220v. D.C.
LUCASTON, Tas., 240v. 50c.
LUCKNOW, Vic., 230v. 50c.
LYMINGTON, Tas., 240v. 50c.
LYNDOCH, S.A., 210v. 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.
MALDON, Vic., 230v. 50c.
MALLALA, S.A., 210v. 50c.
MALVERN, Vic., 200v. 50c. and 230v. 50c.
MANANGATANG, Vic., 230v. D.C.
MANDURAH, W.A., 220v. D.C.
MANDOWA SHIRE, N.S.W., 240v. 50c.
MANILDRA, N.S.W., 240v. 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., 220v. D.C.
MANSFIELD, Vic., 230v. 50c.
MARGATE, Tas., 240v. 50c.
MARRABEL, S.A., 240v. 50c.
MAREEBA, Qld., 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.
MAUDSLAND, Qld., 240v 50c.
MAYFIELD, N.S.W., 240v. 50c.
McLAREN VALE, S.A., 210v. 50c.
McLAREN FLAT, S.A. 210v. 50c.
MECKERING, W.A., 220v. D.C.
MEDLOW BATH, N.S.W., 240v. 50c.
MEEKATHARRA, W.A., 220v. D.C.
MEENIYAN, Vic., 230v. 50c.
MELBOURNE CITY, Vic., 230v. 50c. and 230v. D.C.
MELTON MOWBRAY, Tas., 240v. 50c.
MELVILLE, W.A., 250v. 40c.
MENTONE, Vic., 200v. 50c.
MENZIES, W.A., 220v. D.C.
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.
MERRIWA, N.S.W., 240v. 50c.
METUNG, Vic., 230v. 50c.
MIDDLE SWAN, W.A., 250v. 40c.
MIDDLETON, Tas., 240v. 50c.
MIDLAND JUNCTION, W.A., 250v. 40c.
MILDURA, Vic., 230v. 50c.
MILLENDON, W.A., 250v. 40c.
MILLER'S FOREST, N.S.W., 240v. 50c.
MILLICENT, S.A., 230v. D.C.
MILLTHORPE, N.S.W., 240v. 50c.
MILTON, N.S.W., 110v. D.C.
MINGENEW, W.A., 220v. D.C.
MINLATON, S.A., 230v. 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.
MITCHELL, Qld., 240v. 50c.
MITTAGONG, N.S.W., 240v. 50c.
MOAMA, N.S.W., 240v. 50c.
MOANA, S.A., 210v. 50c.
MOE, Vic., 230v. 50c.
MOLONG, N.S.W., 240v. 50c.
MONA VALE, N.S.W., 240v. 50c.
MONBULK, Vic., 230v. 50c.
MONEGEETA, Vic., 230v. 50c.
MONOMEITH, Vic., 230v. 50c.
MONTO, Qld., 240v. 50c.
MONTMORENCY, Vic., 230v. 50c.
MONT PARK, 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.
MOORINA, Tas., 240v. 50c.
MOOROOPNA, Vic., 230v. 50c.
MOOROOLBARK, Vic., 230v. 50c.

ELECTRIC SUPPLY VOLTAGES THROUGHOUT AUSTRALIA

MOOROODUC, Vic., 230v. 50c.
MORAWA, W.A., 220v. D.C.
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.
MORPETH, N.S.W., 240v. 50c.
MORPHETT VALE, S.A., 210v. 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 BOLD, S.A., 210v. 50c.
MOUNT BARKER, S.A., 210v. 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 ISA, Qld., 240v. 50c.
MOUNT KEIRA, N.S.W., 240v. 50c.
MOUNT KEMBLA, N.S.W., 240v. 50c.
MOUNT LOFTY, S.A., 210v. 50c.
MOUNT MAGNET, W.A., 220v. D.C.
MOUNT MARTHA, Vic., 230v. 50c.
MOUNT NICHOLAS, Tas., 240v. 50c.
MOUNT PLEASANT, S.A., 210v. 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.
MOYARRA, 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., 240v. 50c.
MURTOA, Vic., 230v. D.C.
MURWILLUMBAH, N.S.W., 240v. 50c.
MUSWELLBROOK, N.S.W., 240v. 50c.
MYLOR, S.A., 210v. 50c.
MYRTLEFORD, Vic., 230v. 50c.

N

NAGAMBIE, Vic., 230v. D.C.
NAIRNE, S.A., 210v. 50c.
NALANGIL, Vic., 230v. 50c.
NAMBOUR, Qld., 240v. 50c.
NAMBUCCA, N.S.W., 240v. 50c.
NANA GLEN, N.S.W., 240v. 50c.
NANANGO, Qld., 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.
NAROOMA, N.S.W., 240v. 50c.
NARRABEEN, N.S.W., 240v. 50c.
NARRABRI, N.S.W., 240v. D.C. (being changed to 240v. 50c.)
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.
NAURO, 110v. 50c., 500v. D.C.
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, N.S.W., 240v. 50c.
NEW GISBORNE, Vic., 230v. 50c.
NEW LAMBTON, N.S.W., 240v. 50c.
NEWPORT, N.S.W., 240v. 50c.
NEW NORCIA, W.A., 100v. D.C.
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.
NOARLUNGA, S.A., 210v. 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 ADELAIDE, S.A., 210v. 50c.
NORTH FREMANTLE, W.A., 250v. 40c.
NTH. PARRAMATTA, N.S.W., 240v. 50c.
NORTH SHORE, Vic., 230v. 50c.
NORTH SYDNEY, N.S.W., 240v. 50c.
NORTON SUMMIT, S.A., 210v. 50c.
NTH. WOLLONGONG, N.S.W., 240v. 50c.
NORWELL, Qld., 240v. 50c.
NORWOOD, S.A., 210v. 50c.
NOTTING HILL, Vic., 230v. 50c.
NOWRA, N.S.W., 240v. 50c.
NUMURKAH, Vic., 230v. 50c.
NURIOOTPA, S.A., 210v. 50c.
NYAH, Vic., 230v. 50c.
NYNGAN, N.S.W., 240v. D.C.
NYMBOIDA, N.S.W., 240v. 50c.
NYORA, Vic., 230v. 50c.

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., 240v. D.C.
OUYEN, Vic., 230v. D.C.
OWEN, S.A., 210v. 50c.
OXENFORD, Qld., 240v. 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, N.S.W., 240v. D.C.
PALMER'S FIND, W.A., 220v. D.C.
PARACOMBE, S.A., 210v. 50c.
PARKES, N.S.W., 240v. 50c.
PARRAMATTA, N.S.W., 240v. 50c.
PARRA WIRRA, S.A., 200v. 50c.
PARATTAH, Tas., 240v. 50c.
PATERSON, N.S.W., 240v. 50c.
PATONGA, N.S.W., 240v. 50c.
PATRICK'S PLAINS, N.S.W. 240v. 50c.
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.
PEMBERTON, W.A., 220v. D.C.
PENDLE HILL, N.S.W., 240v. 50c.
PENGUIN, Tas., 240v. 50c.
PENOLA, S.A., 230v. D.C.
PENNANT HILLS, N.S.W., 240v. 50c.
PENRICE, S.A., 210v. 50c.
PENRITH, N.S.W., 240v. 50c.
PENWORTHAM, S.A., 240v. 50c.
PEPPERMINT GROVE, W.A., 250v. 40c.
PERENJORI, W.A., 220v. D.C.
PERTH, Tas., 240v. 50c.
PERTH, W.A., 250v. 40c.
PETERBOROUGH, S.A., 230v. D.C.
PETERSHAM, N.S.W., 240v. 50c.
PETRIE, Qld., 240v. 50c.
PHEGAN'S BAY, N.S.W., 240v. 50c.
PHILLIP ISLAND, Vic., 230v. 50c.
PIALBA, Qld., 240v. 50c.
PICCADILLY, S.A., 210v. 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. and 240v. D.C.
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 ADELAIDE, 210v. 50c.
PORT AUGUSTA, S.A., 230v. D.C.
PORT AUGUSTA WEST, S.A., 230v. D.C.
PORT ARTHUR, Tas., 240v. D.C.
PORT BROUGHTON, S.A., 240v. D.C.
PORT CAMPBELL, Vic., 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., 240v. 50c.
PORT MACDONNEL, S.A., 230v. D.C.
PORT MELBOURNE, Vic., 230v. 50c.
PORT NOARLUNGA, S.A., 210v. 50c.
PORT PIRIE, S.A., 230v. 50c.
PORTSEA, Vic., 230v. 50c.
PORT STEPHENS, N.S.W., 240v. 50c.
PORT VICTORIA, S.A., 230v. 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.
PROSPECT, S.A., 210v. 50c.
PYRAMID, Vic., 230v. 50c.

Q

QUAIRADING, W.A., 220v. D.C.
QUAMBATOOK, Vic., 230v. D.C.
QUARRY HILL, Vic., 230v. 50c.
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., 220v. 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., 240v. 50c.
READ TOWN, N.S.W., 240v. 50c.
REDCLIFFE, Qld., 240v. 50c.
REDFERN, N.S.W., 240v. 50c.
RED HILL, S.A., 230v. D.C.
REDLAND BAY, Qld., 240v. 50c.
REDLYNCH, Qld., 240v. 50c.
REGENTS PARK, N.S.W., 240v. 50c.
RENMARK, S.A., 230v. D.C.
RENMARK IRRIGATION SETTLEMENT, 230v. 50c.
REYNELLA, S.A., 210v. 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., 220v. D.C.
ROBERTSON, N.S.W., 240v. 50c.
ROCHESTER, Vic., 230v. 50c.
ROCKDALE, N.S.W., 240v. 50c.
ROCKHAMPTON, Qld., 240v. 50c.
ROCKINGHAM, S.A., 250v. 40c.
ROMA, Qld., 220v. D.C.
ROMSEY, Vic., 230v. 50c.
ROOKWOOD, Tas., 240v. 50c.
ROSEBERY, Tas., 240v. 50c.
ROSEBUD, Vic., 230v. 50c.
ROSEDALE, Vic., 230v. 50c.
ROSEWORTHY, S.A., 210v. 50c.
ROSEWORTHY COLLEGE, S.A., 210v. 50c.
ROSS, Tas., 240v. 50c.
ROTTNEST, W.A., 220v. D.C.
ROZELLE, N.S.W., 240v. 50c.
ROWLANDS FLAT, S.A., 210v. 50c.
ROYSTON, Vic., 230v. 50c.
RUBICON, Vic., 230v. 50c.
RUBY, Vic., 230v. 50c.
RUPANYUP, Vic., 230v. D.C.
RUSHWORTH, Vic., 230v. D.C.
RUTHERFORD, N.S.W., 240v. 50c.
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., 210v. 50c.
SAMFORD, Qld., 240v. 50c.
SANDFLY, Tas., 240v. 50c.
SANDGATE, Qld., 240v. 50c.
SANDRINGHAM, Vic., 200v. 50c.
SARINA, Qld., 240v. 50c.
SASSAFRAS, Tas., 240v. 50c.
SASSAFRAS, Vic., 230v. 50c.
SCARBOROUGH, N.S.W., 240v. 50c.
SCONE, N.S.W., 240v. 50c.
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.
SEYMOUR, Vic., 230v. 50c.
SELMOUR, Vic., 230v. 50c.
SHEFFIELD, Tas., 240v. 50c.
SHELLHARBOUR, N.S.W., 240v. 50c.
SHEPPARTON, Vic., 230v. 50c.
SHERBROOKE, Vic., 230v. 50c.
SHERWOOD, Qld., 240v. 50c.

ELECTRIC SUPPLY VOLTAGES THROUGHOUT AUSTRALIA.

SILVAN, Vic., 230v. 50c.
SINGLETON, N.S.W., 240v. 50c.
SMITHFIELD, S.A., 210v. 50c.
SMITHFIELD, N.S.W., 240v. 50c.
SMITHTON, Tas., 240v. 50c.
SNOWTOWN, S.A., 220v. D.C.
SOMERSET, Tas., 240v. 50c.
SNUG, Tas., 240v. 50c.
SOMERS, Vic., 230v. 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.
STANHOPE, Vic., 230v. 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, N.S.W., 240v. 50c.
ST. GEORGE, Qld., 240v. 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.
ST. PETERS, S.A., 210v. 50c.
STEPHENS, Qld., 240v. 50c.
STIRLING, East and West, S.A., 210v. 50c.
STOCKINBINGAL, N.S.W., 240v. 50c.
STOCKTON, N.S.W., 240v. 50c.
STONY CREEK, Vic., 230v. 50c.
STRATFORD, Vic., 230v. 50c.
STRATFORD, Qld., 240v. 50c.
STRATHALBYN, S.A., 220v. D.C.
STRATHBLANE, Tas, 240v. 50c.
STRATHFIELD, N.S.W., 240v. 50c.
STRATHPINE, Qld., 240v. 50c.
STRATHFIELDSAYE, Vic., 230v. 50c.
STRATHMERTON, Vic., 230v. 50c.
STREAKY BAY, S.A., 230v. D.C.
SUBIACO, W.A., 250v. 40c.
SUMMER HILL, N.S.W., 240v. 50c.
SUMMERLEAS, Tas., 240v. 50c.
SUMMERTOWN, S.A., 210v. 50c.
SUNBURY, Vic., 230v. 50c.
SUNNYSIDE, Vic., 230v. 50c.
SUNSHINE, Vic., 230v. 50c.
SUTHERLAND, N.S.W., 240v. 50c.
SWANBOURNE, W.A., 250v. 40c.
SWAN HILL, Vic., 230v. 50c.
SWAN ISLAND, 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., 240v. 50c, 240v. D.C. (all being changed to 240v. 50c.)
SYDNEY, METROPOLITAN, N.S.W., 240v. 50c.
SYMMONS PLAINS, Tas., 240v. 50c.

T

TABLE CAPE, Tas., 240v. 50c.
TAILEM BEND, S.A., 230v. 50c.
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.
TAMBOURINE, Qld., 240v. 50c.
TAMWORTH, N.S.W., 240v. 50c.
TANUNDA, S.A., 220v. D.C.
TARADALE, Vic., 230v. 50c.
TAREE, N.S.W., 240v. 50c.
TARINGA, Qld., 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.
TEATREE GULLY, S.A., 210v. 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. 50.
TERANG, Vic., 230v. 50c.
TERANIA, N.S.W., 240v. 50c.
TERRIGAL, N.S.W., 240v. 50c.
THARGOMINDAH, Qld., 220v. D.C.
THE ENTRANCE, N.S.W., 240v. 50c.
THE ROCK, N.S.W., 240v. D.C.
THEODORE, Qld., 240v. D.C.
THEBARTON, S.A., 210 v. 50c.
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.
THORPDALE, Vic., 110v. D.C.
THREE SPRINGS, W.A., 220v. D.C.
THURSDAY ISLAND, Qld., 240v. 50c.
TINAMBA, Vic., 230v. 50c.
TINTENBAR, N.S.W., 240v. 50c.
TOCUMWAL, N.S.W., 240v. 50c.
TOLGA, Qld., 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., 240v. 50c.
TOOWONG, 240v. 50c.
TOOWOOMBA, Qld., 240v. D.C. and 240v. 50c.
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.
TRAYNING, W.A., 220v. D.C.
TREMONT, Vic., 230v. 50c.
TRENTHAM, Vic., 230v. 50c.
TULLY, Qld., 240v. 50c.
TUMBARUMBA, N.S.W., 240v. 50c.
TUMBY BAY, S.A., 240v. 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., 210v. 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.
UNGARIE, N.S.W., 240v. 50c.
UPPER COOMERA, Qld., 240v. 50c.
UPPER MACEDON, Vic., 230v. 50c.
UPPER SWAN, W.A., 250v. 40c.
UPPER BEACONSFIELD, Vic., 230v. 50.
UPWEY, Vic., 230v. 50c.
URAIDLA, S.A., 210v. 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.
VICTORIA POINT, Qld., 240v. 50c.
VIOLET TOWN, Vic., 230v. 50c.
VIRGINIA BLOCKS, S.A., 210v. 50c.

W

WAITARA, N.S.W., 240v. 50c.
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. 50c.
WALGETT, N.S.W., 240v. D.C.
WALLACIA, N.S.W., 240v. 50c.
WALLAROO, S.A., 240v. 50c.
WALLA WALLA, N.S.W., 230v. D.C.
WALLENDBEEN, N.S.W., 240v. 50c.
WALLERAWANG, N.S.W., 240v. 50c.
WALLISTON, W.A., 250v. 40c.
WALLSEND, N.S.W., 240v. 50c.
WALPA, Vic., 230v. 50c.
WANGARATTA, Vic., 230v. 50c.
WANTIRNA, Vic., 230v. 50c.
WARATAH, Tas., 240v. and 110v. A.C.
WARATAH, N.S.W., 240v. 50c.
WARBURTON, Vic., 230v. 50c.
WARIALDA, N.S.W., 240v. 50c.
WARNCOORT, Vic., 230v. 50c.
WAROONA, W.A., 220v. D.C.
WARRACKNABEAL, Vic., 230v. 50c.
WARRAGUL, Vic., 230v. 50c.
WARRANDYTE, 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. and 240v. A.C.
WASLEY'S, S.A., 210v. 50c.
WATERFORD, Qld., 240v. 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.
WEDDERBURN, Vic., 230v. 50c.
WEERITE, Vic., 230v. 50c.
WEE WAA, N.S.W., 240v. 50c.
WELLINGTON, N.S.W., 240v. 50c.
WELLINGTON POINT, Qld., 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. D.C.
WEST SWAN, W.A., 250v. 40c.
WEST WALLSEND, N.S.W., 240v. 50c.
WEST WYALONG, N.S.W., 240v. D.C.
WHEELERS HILL, Vic., 230v. 50c.
WHITE HILLS, Vic., 230v. 50c.
WHITTON, N.S.W., 240v. 50c.
WHYALLA, S.A., 220v. 50c.
WICKEPIN, W.A., 230v. D.C.
WICKHAM, N.S.W., 240v. 50c.
WILCANNIA, N.S.W., 240v. 50c.
WILLASTON, S.A., 210v. 50c.
WILLIAMSFORD, Tas., 230v. 50c.
WILLIAMSTOWN, Vic., 230v. 50c.
WILLOUGHBY, N.S.W., 240v. 50c.
WILLUNGA, S.A., 210v. 50c.
WILMINGTON, S.A., 230v. D.C.
WILUNA, W.A., 250v. 50c.
WINCHELSEA, Vic., 230v. 50c.
WINDSOR, N.S.W., 240v. 50c.
WINDSOR, Qld., 240v. 50c.
WINGHAM, N.S.W., 240v. 50c.
WINTON, Qld., 240v. D.C.
WISELEIGH, Vic., 230v. 50c.
WIVENHOE, Tas, 240v. 50c.
WODONGA, Vic., 230v. 50c.
WOLLONGONG, N.S.W., 240v. 50c.
WOMBARRA, N.S.W., 240v. 50c.
WONDAI, Qld., 240v. 50c.
WONGAN HILLS, W.A., 220v. D.C.
WONTHAGGI, Vic., 240v. 50c.
WOODBRIDGE, Tas., 240v. 50c.
WOODBURN, 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., 240v. 50c.
WOODVILLE, S.A., 210v. 50c.
WOOLLAHRA, N.S.W., 240v. 50c.
WOOLMERS, Tas., 240v. 50c.
WOOL WOOL, Vic., 230v. 50c.
WOOMELANG, Vic., 110v. D.C.
WOONGOOLBA, Qld., 240v. 50c.
WOONONA, N.S.W., 240v. 50c.
WOORALOO, W.A., 220v. D.C.
WOY WOY, N.S.W., 240v. 50c.
WUNGHNU, 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.
WYNNUM, Qld., 240v. 50c.
WYONG, N.S.W., 240v. 50c.
WYUNA, Vic., 230v. 50c.
WY YUNG, Vic., 230v. 50c.

Y

YACKA, S.A., 210v. 50c.
YALGOO, W.A., 220v. D.C.
YALINGUP, W.A., 220v. D.C.
YALLOURN, Vic., 230v. 50c.
YALUMBA, S.A., 210v. 50c.
YANCO, N.S.W., 240v. 50c.
YANKALILLA, S.A., 240v. 50c.
YANNATHAN, Vic., 230v. 50c.
YARLOOP, W.A., 220v. D.C.
YARRA GLEN, Vic., 230v. 50c.
YARRAGON, Vic., 230v. 50c.
YARRAM, Vic., 230v. 50c.
YARRAWONGA, Vic., 230v. 50c.
YASS, N.S.W., 240v. 50c.
YATALA, Qld., 240v. 50c.
YEA, Vic., 230v. 50c.
YENDA, N.S.W., 240v. 50c.
YERING, Vic., 230v. 50c.
YERINBERG, Vic., 230v. 50c.
YINNAR, Vic., 230v. 50c.
YOLLA, Tas., 240v. 50c.
YORK, W.A., 220v. D.C.
YORKETOWN, S.A., 230v. D.C.
YOUNG, N.S.W., 240v. 50c.

Z

ZEEHAN, Tas., 240v. 50c.

INSTALLATION RULES FOR RADIO

Electro-Acoustic and Combined Apparatus

Issued by Standards Association of Australia

Code No. C.C.3 of 1937

I. SCOPE.

1. EXTENT AND APPLICATION. The rules of this Code cover the installation of radio apparatus, electro-acoustic apparatus and combined radio and electro-acoustic apparatus, but do not cover the wiring of the building up to the point of power outlet, which is covered by the Wiring Rules of the Standards Association of Australia (S.A.A. Wiring Rules, Code No. CC.1.)

Radio apparatus, electro-acoustic apparatus and combined radio and electro-acoustic apparatus shall mean apparatus as defined in Clause 1, Application of Specification, A.S.S. No. C. 69, Radio Apparatus, Electro-Acoustic Apparatus and Combined Radio and Electro-Acoustic Apparatus—Safety Requirements.

II. MATERIALS AND APPARATUS.

2. QUALITY OF MATERIALS AND APPARATUS. Where radio and/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 A.S.S. No. C. 69, Radio Apparatus, Electro-Acoustic Apparatus and Combined Radio and Electro-Acoustic Apparatus.

III. INSTALLATION.

3. GENERAL. All radio apparatus, electro-acoustic apparatus and combined radio and electro-acoustic apparatus shall be installed in accordance with the requirements of this Code and the appropriate requirements of the S.A.A. Wiring Rules (Code No. CC. 1), where so specified in this Code.

4. POWER CONNECTION. Electricity from supply mains shall be conveyed to radio and/or electro-acoustic apparatus only through permanent wiring or an outlet installed in accordance with the provisions of the S.A.A. Wiring Rules (Code No. CC. 1.)

Flexible cord for connecting the apparatus to an approved outlet shall comply with the requirements of Rule 328, Flexible Cords, of the 1937 edition of the S.A.A. Wiring Rules (Code No. CC. 1.)

IV. EARTHING.

5. POWER EARTHING.

(a) **Earthed Situations.** Where apparatus is used in an "earth situation" as defined in Definition 26, Earthed Situation, of the S.A.A. Wiring Rules (Code No. CC. 1), exposed metal cases and/or frames shall be earthed to conform with the requirements of Section 5, Earthing, of that Code; in addition permanent earthing conductors (exclusive of flexible earthing leads attached to portable apparatus) shall be insulated cables of 250 volt grade.

(b) **Non-earthed Situations.** Where apparatus is used in a location other than an "earthed situation" exposed metal cases and/or frames shall not be earthed. Where two or more units are in close proximity in unearthed situations, exposed metal cases and/or frames shall be effectively bonded.

(c) **Line Filters.** 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 Clause (a) of this Rule, 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 any person 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 Clause (b) of this Rule, 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 13, Sub-clause (b), A.S.S. No. C. 69], a radio earthing conductor may be connected to that terminal for the purpose of improving reception. Radio earthing conductors shall comply with the conditions specified in Rule 14, Conductors for Indoor Aerials, etc., of this Code.

V. AERIALS.

Exterior to Buildings.

7. LOCATION. Aerials, counterpoises and stay wires exterior to buildings shall not pass over or under aerial electric light or power wires or cables, nor shall they be so located that failure of any aerial, counterpoise, stay wire, or of the abovementioned electric light or power wires or cables could result in a contact between the aerial, counterpoise and/or stay wires and such electric light or power wires, or any other wires or cables used for conveying electricity for energy or communication purposes.

8. CONSTRUCTION, ERECTION AND SUPPORTS. Aerials, counterpoises and their supports shall be so constructed and erected as to prevent accidental contact between aerial or counterpoise wires, and any of the wires or cables specified in Rule 7, Location, by breaking, sagging or swinging.

9. FORM AND SIZE OF AERIAL CABLES. For other than ultra-high frequencies, aerial and counterpoise conductors shall be stranded, and if of copper, hard drawn and of cross sectional area not less than that shown in Table I, Size of Aerial Cables, below. The stress in such conductors shall not exceed 25,000 lbs. per sq. in.

NOTE.—For ultra-high frequencies solid or tubular conductors may be required but the technique is not yet sufficiently developed to lay down any definite requirements in respect thereof.

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 Table I for the given spans.

TABLE I.
SIZE OF AERIAL CABLES.

Span (Minimum 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) **Material and Minimum Size of Wire.** Leading-in wires shall be copper, copper-clad steel, or other approved metal which does not corrode excessively, and shall in no case be smaller than 1/.044in.

(b) **Attachment of Leading-in Wires.** That portion of the leading-in wires, whether insulated or not, which is exterior to the building, may be fixed to the building, but only by approved insulators, and when exposed to the weather or dampness shall not be within normal reach of a person standing on the ground, or on the floor of a building.

(c) **Clearances.** Leading-in wires, whether within or outside buildings, shall not be 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. This non-conductor shall be in addition to any insulation on the wire.

(d) **Entry Bushing.** Leading-in wires shall enter a building through a non-ignitable, non-absorptive insulating bushing, so arranged as to prevent the entry of moisture.

(e) **Conductors Within Buildings.** Leading-in-conductors within buildings shall comply with the conditions specified in Rule 14, Conductors for Indoor Aerials, etc., of this Code.

S.A.A. Radio Rules *(Continued)*

11. PROTECTIVE DEVICE. Aerials exceeding 50 ft. in span and/or 30 ft. in height in any part above earth or above an earthed body (such as a building) shall have each leading-in wire not metallically connected to earth provided with an effective protective device (lightning arrester) fixed near the point where the wires enter the building. The protective device shall be mounted on a non-ignitable base, and shall include an air gap not exceeding 0.005 in. between aerial and earth connection.

12. AERIAL EARTHING SWITCH. If an aerial earthing switch is installed, its use shall not obviate the necessity for the protective device required by Rule 11, Protective Device, 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.

Aerials Within Buildings.

13. 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 electricity supply mains or communication circuits.

Aerial conductors (within buildings) shall comply with the conditions specified in Rule 14, Conductors for Indoor Aerials, etc., of this Code.

14. CONDUCTORS FOR INDOOR AERIALS, Etc. Conductors for indoor aerials, radio earthing and leading-in connections within buildings shall:

(i) Be made of stranded copper, of a total cross section of not less than 0.00066 sq. inch, and shall be covered with a layer of high-grade vulcanised rubber of thickness not less than $^1/_{64}$ inch, and an outer covering of durable braided cotton, or with a layer of high-grade vulcanised rubber of thickness not less than $^1/_{32}$ inch.

(ii) Withstand a voltage test of 1,000 volts R.M.S. after 24 hours' immersion in water.

The test shall be carried out with alternating current of approximately sine wave form at any frequency between 25 and 100 cycles per second, applied gradually and maintained continuously at the full voltage for fifteen minutes.

Special Aerials.

15. SPECIAL AERIALS. Special aerials, such as those 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 in this Code for aerials and for lead-in conductors within buildings, including the cross section and insulation specified in Rule 14, Conductors for Indoor Aerials, etc. 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 Rule 5, Power Earthing, Clause (a) Earthed Situations, of this Code; however, it may be connected to the radio earth terminal of the apparatus.

VI. GENERAL.

16. 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 this Code (No. CC. 3) and A.S.S. No. C. 69 shall apply to such alteration or addition.

Safety Requirements under S.A.A. Rules C.69-1937

I. SCOPE.

1. APPLICATION OF SPECIFICATION. This Specification applies to all "Radio Apparatus, Electro-Acoustic Apparatus and Combined Radio and Electro-Acoustic Apparatus" intended for operation from public or private electricity supply mains having a rated voltage not exceeding 300 volts. It applies to all associated devices including "power units" for supplying current and/or applying voltage to "Radio Apparatus, Electro-Acoustic Apparatus and Combined Radio and Electro-Acoustic Apparatus," power transformers for heating the cathodes of thermionic valves, devices connected to the supply mains such as "line filters" for the reduction of noise interference, power transformers and associated apparatus for furnishing energy to battery chargers, loud speakers, head telephones, control equipment, etc., whether incorporated in the "Radio Apparatus, Electro-Acoustic Apparatus and Combined Radio and Electro-Acoustic Apparatus" proper or whether used in conjunction with it as a separate unit or units.

This Specification does not cover the following apparatus:

(i) Special apparatus such as public address, theatre or hotel amplifying equipment.

(ii) Motor generators, or combinations of two or more rotating machines having separate windings.

(iii) Rotary converters or machines having A.C. and D.C. windings electrically connected.

II. DEFINITIONS.

2. TERMS AND DEFINITIONS. The following terms and definitions have been adopted for the purpose of this Specification:

(a) **Apparatus.** The terms "apparatus," when used without qualification, shall mean "radio apparatus, electro-acoustic apparatus and combined radio and/or electro-acoustic apparatus," as defined in Clause 1, Application of Specification, above.

(b) **Case.** The term "case" shall mean the housing of any apparatus.

Such apparatus may be housed in a single case, such as that commonly known as a "chassis," or may comprise one or more cases mounted independently or mounted within a larger case or cabinet. This outermost case, which may be the only container, is herein referred to as the external case when it is necessary to differentiate between it and an internal container.

(c) **Inner Structure.** The term "inner structure" shall mean the circuital wiring of the apparatus generally, including contacts, terminals, screens, windings and/or other metal work connected to such wiring, which operates at a potential above earth or frame.

(d) **Frame.** The term "frame" shall mean any exposed metallic part of a case, including "chassis," loudspeaker housing, power transformer or other component housing, valve shield, operating shaft, or escutcheon.

(e) **Isolated.** The term "isolated" shall mean that points so described are not connected together by any conductor, but may be connected by a suitable isolating device such as a condenser or a double wound transformer.

(f) **Live (Alive).** An object is said to be "live" when a difference of potential exists between it and

S.A.A. RADIO RULES—(Continued).

earth (or frame), but for the purpose of this Specification this shall apply only to a potential exceeding 32 volts. Earthing terminals for "line" devices for operation with A.C. apparatus, such as earthing terminals for "line filters" which are connected to the supply mains through condensers of capacity greater than 0.025 mfd., although connected to "earth" during normal operation, shall be deemed to be "live."

(g) **Metallically Connected.** The term "metallically connected" shall mean that points so described are connected together by a conductor of negligible resistance and having a current carrying capacity not less than twice the normal working current of the appropriate components.

(h) **Non-ignitable.** The term "non-ignitable" applied to a material shall mean one which under prescribed conditions neither burns itself nor gives off inflammable vapour.

For the purpose of this Specification a material shall be deemed to be non-ignitable if it neither softens, chars nor blisters when maintained at a temperature of 150° C. for six hours.

(i) **Power Unit (Eliminator).** The term "power unit" shall mean any device intended for supplying current and/or applying voltage to apparatus for radio and/or electro-acoustic reproduction wherein the energy is derived from electric power mains.

(j) **Power Operated Set.** The term "power operated set" shall mean a radio or valve amplifying apparatus housed in a common case with a power unit, or designed to be used permanently with a specific power unit.

(k) **Power Transformers.** The term "power transformer" shall apply to any transformer which has one winding (hereinafter referred to as the primary) effectually connected to the supply mains, and which is used as part of, or in conjunction with, the apparatus.

(l) **Rated Voltage.** The term "rated voltage" shall mean the voltage of the supply mains for which the apparatus is designed as marked on the rating plate.

(m) **Rating.** The term "rating" as applied to a power unit shall relate to the rated output together with associated conditions as marked on the rating plate.

(n) **Terminals.** The term "terminal" shall include sockets, plugs, jacks or like parts designed for the connection of wires, cables or flexible cords to the apparatus concerned.

III. ELECTRICAL CHARACTERISTICS.

3. **RATING.** A power unit when constructed and supplied in the form of a separate unit shall be rated in terms of the following electrical characteristics:

(i) Full-load current[1] in amperes or milliamperes for the maximum output tapping.

(ii) Voltage[2] at the maximum output tapping, when full-load current is passing.

IV. MARKING.

4. **NAME PLATE.**

(a) **Separate Power Units.** A power unit, when constructed as a separate unit, shall be marked by the manufacturer with the following information:

(i) Model No............
(ii) Rated supply voltage.
(iii) Rated supply frequency or frequencies.
(iv) Full-load input[3] expressed in watts.
(v) Rated output current[4] and voltage (in accordance with Clause 3, Rating).
(vi) S.A.A. Specification Number (A.S.S. No. C. 69).

(b) **Integral Power Units.** Power units constructed as an integral part of a power operated set shall be marked by the manufacturer with the following information:

(i) Model No..........
(ii) Rated supply voltage.
(iii) Rated supply frequency or frequencies.
(iv) Full-load input[6] expressed in watts.
(v) S.A.A. Specification Number (A.S.S. No. C. 69.)

5. **CAUTION NOTICE.** The case of the apparatus shall 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, that the apparatus should not be opened, and that no adjustments or alterations to the interior portions of the apparatus should be attempted without previously removing the connector (plug or adaptor) from the supply mains.

V. DESIGN AND CONSTRUCTION.

6. **CONSTRUCTION OF CASES.**

(a) **Material.** The live parts of the inner structure with the exception of the supply cord to the apparatus, and the cords connecting components mounted separately shall be enclosed in a case or cases of metal or non-ignitable material.

(b) **Mechanical Strength.** Cases shall be of substantial construction and of sufficient strength to protect their contents from mechanical injury. If the housing material be metal, it shall be of not less than 0.036 in. (20 S.W.G.) thick, except when the largest unsupported area is small, e.g. for a component case, such as for a tuning coil, transformer, etc.

(c) **Corrosion Protection.** All corrodible metal shall be adequately protected against corrosion by plating or other effective means.

(d) **Temperatures.** The cases shall be so proportioned and/or ventilated or installed that the highest temperature[6] of the interior surface of the case shall not attain a value higher than.

(i) For non-ignitable cases 82° C. (180° F.).
(ii) For ignitable external cases such as wooden cabinets 74° C. (165° F.).

(e) **Openings.** Openings in ventilated cases either shall have no dimensions larger than ¼ in. or shall be so designed, located or protected that the average small tool, or the operator's hand cannot be accidentally inserted so as to come into contact with a "live" part.

(f) **Bushings.** To avoid abrasion of the cables or cords all holes for the passage of cables or cords through the cases shall be furnished with insulating bushings having smooth, rounded edges.

7. **PROTECTION OF LIVE PARTS.**

(a) **Guarding and Access.** All parts, including metal cases, frames, terminals, knobs, dials, controls, metal parts and ends of wires, if any, attached to the apparatus, which are alive, shall be positively guarded to prevent accidental contact with them under normal conditions of use. Live parts other than recessed sockets shall not be accessible without the use of a tool, key or other suitable device, or alternatively without interrupting both poles of the supply mains. Notwithstanding the foregoing, properly protected valve sockets shall be accessible for the replacement of valves without the use of special tools.

(b) **Insulation of Live Parts.** All live parts shall be so mounted that they are effectively insulated[7] from the metal case or frame.

(c) **Clearances.** A spacing of not less than ⅛ in. over surfaces of approved insulating materials or through air shall be maintained between bare live parts effectually connected to the supply mains and the metal case or frame, except where the location and relative arrangement of the parts are such that permanent separation is assured. If bent lugs are employed, the spacing shall apply to any possible angle of bending.

[1] For test conditions, see Clause 14, Power Unit—Output Voltage.
[2] For test conditions, see Clause 14, Power Unit—Output Voltage.
[3] For test conditions, see Clause 15, Power Consumption.
[4] For test conditions, see Clause 14, Power Unit—Output Voltage.
[5] For test conditions, see Clause 15, Power Consumption,
[6] For test conditions, see Clause 16, Heating.

S.A.A. RADIO RULES—(Continued).

(d) **Main Switches and Connectors.** 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 shall be used, provided that access to live parts cannot be obtained while such connector is in place.

(e) **Removable Connections.** If the apparatus is fitted with a plug socket or similar device for a removable connection to the supply mains, such device shall be so constructed that the removable portion attached to, or intended to be attached to the flexible cord conveying the current, shall have its live parts so guarded or recessed as to prevent accidental contact therewith, both when withdrawn from and when connected to the apparatus.

(f) **Power Units and Sets of the Transformerless Type.** 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[8] 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[9] from the metal case or frame.

(g) **Head Telephone Terminals.** Head telephone terminals shall be isolated from the live parts of the inner structure by means of an efficiently insulated double wound transformer.[10] The secondary winding of such isolating transformer shall not be connected to the metal case or frame.

8. **CONNECTION TO SUPPLY MAINS.** The conductor of any cable or flexible cord forming part of the apparatus and intended for direct connection to the supply mains shall be of the high insulation type specified in the S.A.A. Wiring Rules (Code No. CC. 1). Unless other effective means are employed for the purpose, the ends of electric power supply cords shall be so wrapped or taped as to prevent fraying of the braid.

VI. COMPONENT APPARATUS AND WIRING.

9. **POWER TRANSFORMERS.**

(a) **General.** Power transformers[11] 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) **Insulation of Primary Windings.** The primary winding shall be effectively insulated from the core, the case and the secondary windings.

(c) **Secondary Winding—Midtap Connection.** Where practicable the midtap of the secondary winding of the transformer, which supplies power to the rectifying device, shall be 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, the plug should be held in place or the apparatus fitted with an attachment plug to prevent access to live parts [see Clause 7, Protection of Live Parts, Sub-clause (d), Main Switches and Connectors.]

10. **CONDENSERS.**

(a) **General.** Condensers[12] shall be constructed and made of such materials that they will not create an undue fire hazard or be themselves injuriously affected by the highest temperature likely to be attained in normal use.

(b) **Condensers in Power Circuit.** If a condenser be used in the power supply circuit of a power transformer, either it shall have a capacitance of not more than 0.025 mfd., or if it exceed that capacitance a double pole switch or suitable plug [Clause 7, Protection of Live Parts Sub-clause (d)], shall be provided and connected so that in its "off" position all transformers and condensers used in the primary circuit will be dead.

NOTE.—A tolerance of 20% will be allowed on the maximum condenser capacity specified in this Sub-clause.

11. **CUT-OUTS.** If the apparatus is fitted with cut-outs in the electricity supply circuit, they shall be of an approved enclosed type, but shall not be accessible until both poles of the supply mains are disconnected from the apparatus.

12. **WIRING.**

(a) **Conductors for Interior Wiring.** All conductors used for interior wiring shall be capable of withstanding the applied high voltage test specified.[13]

(b) **External Devices.** "Live" current-carrying devices external to the exterior case shall be suitably protected from mechanical injury during normal use. All flexible cords used for electrical connections between the apparatus and these external devices shall be of the type specified in Clause 8, Connection to Supply Mains, of this Specification.

(c) **Cord-Grips.** The terminal points of all wires and cables shall be relieved of strain by means of cord-grips or other approved means and the ends of the cords shall be so treated as to prevent fraying of the braid.

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 Rule 5, Power Earthing, of the S.A.A. Rules for the Installation of Radio Apparatus, Electro-Acoustic Apparatus and Combined Radio and Electro-Acoustic Apparatus (Code No. CC. 3). This 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" or "E."

(b) **Earth Terminal—for Radio Earthing.** A "radio earthing terminal" may be fitted for the purpose of earthing to improve reception conditions. Such terminals shall comply with the conditions specified in paragraphs (i), (ii) and (iii) of this Sub-clause. It shall be distinctly marked "RADIO EARTH" or "RE," and

(i) It shall have the exposed portion insulated in an approved manner;

(ii) it shall be positively insulated[14] from the frame in an approved manner by a suitable bush or other effective means, and

(iii) it shall be isolated[15] 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-clause (b), paragraphs (i), (ii) and (iii) of this Clause.

[7] For test conditions of general case, see Clauses 17 to 21, inclusive.
[8] For test conditions, see Clause 20, Condensers—High Voltage and Insulation Tests.
[9] For test conditions, see Clause 23, Operating Shaft Insulators—High Voltage Tests.
[10] For test conditions, see Clause 21, Sub-clause (c) Head Telephone Transformers.
[11] For test conditions, see Clause 18, Power Transformers—Tests.
[12] For test conditions, see Clause 20, Condensers—High Voltage and Insulation Tests.
[13] For test conditions, see Clause 22, Inner Structure—High Voltage Test.

S.A.A. Radio Rules *(Continued)*

VII. TESTS.

POWER UNIT.

14. OUTPUT VOLTAGE.

(a) **D.C. Terminal Voltage to be Measured.** A power unit, when constructed and supplied in the form of a separate unit, shall be tested to determine the D.C. terminal output voltage at the maximum tapping when the rated full-load current is passing.

(b) **Method of Measuring Voltage.** The voltage shall be determined by measurement with a D.C. voltmeter having a minimum resistance of 1,000 ohms per volt.

(c) **Output Voltage Tolerance.** The output voltage shall not vary from that specified on the nameplate by more than plus or minus 5%.

15 POWER CONSUMPTION.

(a) **Power Consumption Test Conditions.** Apparatus shall be tested to determine its power consumption under normal operating conditions at the voltage and frequency of its power supply circuit rating.

(b) **Power Consumption Tolerance.** The power consumption shall not exceed that specified on the nameplate by more than 10%.

16. HEATING.

(a) **Heating Test Conditions.** Heating tests shall be made at full load with the apparatus connected for a period of four hours to a source of supply, the voltage and frequency of which correspond to those of the supply circuit rating of the apparatus.

(b) **Permissible Temperature Rise.** The maximum permissible temperature rise for any component part of the apparatus, e.g. for the windings or core of a power transformer, when tested under the conditions specified in Sub-clause (a) of this Clause, shall not exceed 55° C. (131° F.). The temperature rise of windings shall be measured by increase of resistance method where practicable.

(c) **Maximum Temperature of Non-Ignitable Cases.** The interior surfaces of non-ignitable cases when tested under the conditions specified in sub-clause (a) of this clause, shall not attain a temperature higher than 82° C. (180° F. approximately).

(d) **Maximum Temperature of Ignitable Cases.** The interior surfaces of ignitable cases, e.g. cabinets of wood, when tested under the conditions specified in sub-clause (a) of this clause, shall not attain a temperature higher than 74° C. (165° F. approximately).

(e) **Ambient Temperature.** For the tests specified in sub-clauses (b), (c) and (d) of this clause, it shall be assumed that the air temperature may reach a value of 40° C. (104° F. approximately).

17. HIGH VOLTAGE TEST.

(a) **High Voltage Test Conditions.** The high voltage tests specified in Clauses 18 to 23, inclusive, shall be applied to the apparatus while it is still hot after the full-load temperature test of this Specification.

(b) **Test Voltage and Frequency.**

(i) A.C. High Voltage Test.—The A.C. high voltages specified for the tests shall be R.M.S. values, and the tests shall be made with alternating voltage of any convenient frequency between 25 cycles per second and twice the rated frequency of the apparatus being tested, but it is preferable to apply this test at the rated frequency of the apparatus being tested. The test voltage shall be of approximately sine wave form and during the application of the test the crest value, as would be determined by an approved method, shall not be more than 1.45 times the R.M.S. value.

The R.M.S. Value of the applied voltage shall be measured by a suitable voltmeter connected to the output side of the testing transformer or by other approved method.

(ii) D.C. High Voltage Test.—The D.C. high voltages specified for the tests shall be measured with a D.C. voltmeter having a minimum resistance of of 1,000 ohms per volt.

(c) **Application of Pressure.** The high voltage tests shall be commenced at a voltage of about one-third the test voltage and shall be increased to the full test voltage as rapidly as is consistent with its value being indicated by the measuring instrument. The test voltage shall then be maintained for one minute, after which the test voltage shall be diminished rapidly to one-third of its full value before switching off.

HIGH VOLTAGE AND INSULATION RESISTANCE TESTS.

18. POWER TRANSFORMERS—TESTS.

(a) **Primary Circuit High Voltage Test.** An A.C. potential of twice the highest primary open circuit voltage plus 1,000 volts shall be applied between the power transformer primary circuit and the secondary windings. This test shall be made:

(i) with the secondary windings, core, frame and electrostatic shield, if any, of the transformer connected together, and

(ii) without altering any permanent connections in the primary circuit (supply circuit) of the power transformer, that is, connecting wires, cut-outs and clips, line filters, condensers, supply flex, plugs, sockets and adaptors, etc., shall be subjected to the potential specified.

(b) **Primary Circuit Insulation Resistance Test.** The insulation resistance between the primary winding and all the secondary windings, when measured immediately after the above high voltage test [see Sub-clause (a) of this Clause] shall not be less than 20 megohms. The test shall be made at 500 volts D.C., and all the secondary windings, core and frame shall be connected together.

(c) **Secondary Circuit High Voltage Test.** An A.C. potential of twice the maximum open circuit voltage of the secondary winding giving the highest voltage, plus 1,000 volts, shall be applied between each secondary winding in turn and all other windings. If the highest voltage available is from a secondary winding having a mid-point effectually connected to frame, the test voltage shall be based on the open circuit voltage to frame. This test shall be made:

(i) with all windings—with the exception of the winding under test—connected to the core and frame and electrostatic shield, if any, of the transformer,

(ii) without altering any permanent connections between the power transformer and the rectifying device, but this device shall be removed and any connections to the load circuit, not open circuited by its removal, shall be broken, and

(iii) with the secondary windings not associated with the rectifying device, such as for heating amplifying valve filaments, open circuited at the power transformer terminals.

19. AERIAL AND RADIO EARTHING TERMINALS—HIGH VOLTAGE TESTS.

(a) **Test of Aerial Terminal.** An A.C. potential of 2,000 volts shall be applied between the "aerial terminal," together with its associated isolating device, and the inner structure, the inner structure being metallically connected to the frame.

(b) **Radio Earthing Terminal.** An A.C. potential of 2,000 volts shall be applied between the "earthing terminal" (for radio earthing), together with its associated isolating device and the inner structure, the inner structure being metallically connected to the frame.

[14] For test conditions, see Clause 19, Aerial and Radio Earthing Terminals—High Voltage Tests.
[15] For test conditions, see Clause 19, Aerial and Radio Earthing Terminals—High Voltage Tests.

S.A.A. Radio Rules *(Continued)*

20. CONDENSERS—HIGH VOLTAGE AND INSULATION TESTS.

(a) **High Voltage Test.** A.D.C. potential of three times the highest voltage to which it is possible to subject them during the normal operation of the apparatus shall be applied across the terminals of condensers other than those covered in Clause 18, Sub-clause (a), Clause 19, Sub-clause (a) and Sub-clause (b) and Clause 21, Sub-clause (b).

(b) **Insulation Resistance of Condensers.** The insulation resistance measured at 500 volts D.C. shall be as specified in paragraphs (i) and (ii) below.

(i) Insulation Between Terminals.—For condensers of capacity values not exceeding 0.25 microfarad, the insulation resistance shall be not less than 1,000 megohms.

For condensers of capacity values exceeding 0.25 microfarad, the product of the insulation resistance in megohms and the capacity in microfarads shall not be less than 300.

(ii) Insulation Between Terminals and Metal Case.—The insulation resistance between the terminals of a condenser and its metal containing case shall be not less than 100 megohms. The terminals shall be short circuited when carrying out the test.

NOTE.—The above tests will not be required for **self-sealing** condensers of the electrolytic type.

21. AUDIO OUTPUT DEVICES—HIGH VOLTAGE AND INSULATION TESTS.

(a) **Output Transformers.** An A.C. potential of at least four times the maximum D.C. plate voltage used on the output valve, but in no case less than 800 volts, shall be applied between the windings of output transformers used for loud speaker coupling. During the test the winding connected in the plate circuit of the valve shall be connected to frame.

(b) **Output Condensers.**

(i) High Voltage Test.—A D.C. potential of at least four times the maximum D.C. plate voltage used on the output valve, but in no case less than 800 volts, shall be applied across the terminals of output condensers used for loud-speaker coupling.

(ii) Insulation Resistance Test.—The insulation resistance of output condensers shall comply with the values specified in Clause 20, Sub-clause (b), paragraphs (i) and (ii).

(c) **Head Telephone Transformers.** An A.C. potential of 2,000 volts shall be applied between the windings of head telephone isolating transformers, the primary windings being connected to frame.

22. INNER STRUCTURE—HIGH VOLTAGE TESTS.

All live parts of the inner structure not covered in Clauses 18, 19, 20 and 21 shall be tested and the insulation and spacing shall be capable of withstanding a D.C. potential equal to three times the highest voltage to which it is possible to subject any of the circuits of parts in normal use. Apart from disconnecting resistors, condensers, etc., connected across the points under test, the test shall be made without altering any permanent connections in the circuits.

23. OPERATING SHAFT INSULATORS—HIGH VOLTAGE TESTS. An A.C. potential of 2,000 volts shall be applied between operating shafts and frame of apparatus of the transformerless type [Clause 7, Sub-clause (f)]. During the test the inner structure shall be connected to the frame.

24. LINE FILTERS AND SIMILAR APPARATUS—HIGH VOLTAGE TESTS.

(a) **Apparatus for Connection to A.C. Mains.** An A.C. potential of twice the supply voltage plus 1,000 volts shall be applied between:

(i) Each line terminal in turn and the metal enclosing case, if any.

(ii) Each line terminal in turn and the earth terminal of the filter.

(iii) The earth terminal of the filter and the metal enclosing case, if any.

(b) **Apparatus for Connection to D.C. Mains.** A D.C. potential of twice the supply voltage plus 1,000 volts shall be applied between the points specified in Sub-clause (a), paragraphs (i), (ii) and (iii), of this Clause.

SPECIAL NOTE.

In addition to the above Code, the attention of readers is drawn to the following Rule from the "S.A.A. Wiring Rules—Code CC1.":—

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.

Plastic Materials and Mouldings

This is well termed the day of creative chemistry. It has given us many new and better materials without which modern industry and our present-day standards of living would be impossible.

Among such new and better materials, all products of chemical research are vulcanised rubber, coal-tar dyes, celluloid, commercial aluminium and its alloys, carborundum, stainless steel, rayon, cellophane, and phenol resinoid plastics. The latter are the basic materials which have made possible the development of the modern plastic moulding industry.

Phenol resinoid plastics constitute an American achievement. They were invented in 1907 by Dr. L. H. Baekeland, after exhaustive research. Doctor Baekeland gave the world an entirely new substance, phenol resinoid, which has found extensive use in nearly every field of industry. It is a significant fact that those who were the first to take advantage of the distinctive qualities of the new plastic materials based on this new substance, are to-day among the largest users of these materials.

Plastic Materials in Industry.

Plastic moulded materials find application in such widely divergent uses as jewellery and dentures, dash pots and grinding wheels, pump valves and timing gears, refrigerator breaker strips, and condenser explosion chambers, door knobs, and wall panelling, low-loss radio insulation and radio cabinets, carbon brushes and switchboard insulation, gear shift knobs and distributor heads, lighting insulation and lamp-basing cements, chemically resistant lacquers and water resistant flexible coatings for fabrics.

Long before listeners had heard the term radio, plastic materials were aiding the commercial producers of radio broadcasting'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.

Following the first experimental 'phone transmissions, 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 requiring 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 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 few years.

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 maize 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, and 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.

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 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.

PLASTIC MATERIALS AND MOULDING—

(Continued).

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 executives, 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 re-designed his product and placed it in an attractive plastic-moulded case. His sales in 1933 were 43 per cent. above those of 1932, and 90 per cent. 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 withholding 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.

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 deg. C. (320 deg. F.) The tensile and impact strengths of certain of the mineral-filled products are unaffected for short periods by temperatures up to 235 deg. C. (455 deg. 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 plastic products as the solution to numerous insulation problems.

The automotive industry selected plastic moulded 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.

The Moulding Materials.

Plastic moulding materials are prepared from primary phenol resinoid and various so-called filling agents. The all important ingredient is the resinoid itself, which imparts to the moulding materials the property of quickly hardening in the heat which first renders them plastic, and which, as bonding and surfacing substance, imparts to the moulded products most of their distinctive properties.

The use of the filling materials, which include woodflour, asbestos, fabric, paper is for the added value given by the special properties of these materials—better moulding qualities, greater toughness and strength, and, in the case of mineral fillers, an increased degree of water and heat-resistance. In every case the hardened phenol resinoid remains unchanged in its many superior properties.

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.

PLASTIC MATERIALS AND MOULDINGS (Continued).

The Moulding Processes

Apart from the actual materials employed, there are two other factors which play an important part in plastic moulding processes. These are the moulds themselves and the presses used, and a few words concerning each should be of interest before describing the actual processes involved in the production of plastic mouldings.

Moulds.

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, are hardened, ground and polished, the higher the polish the better the lustre on the finished piece.

The Presses.

Presses are of two general classes, hydraulic and mechanical. Of each class there 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 powder; 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 the 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 presses, designated, respectively, 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.

The Process.

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 ("fluxes") at a temperature of approximately 375 deg. F. and the applied pressure forces the plastic material into the remotest corners of the mould. 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, a thin film of 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 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.

When this change has been completed, the moulding is finished, and the product cannot again be softened or fluxed by heat.

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.

Machining.

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 designed 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 moulded 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 0.001in. per inch and no surface effect. In boiling water for a year the increase is only about 0.003in. 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 condensers, coil 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.

PLASTIC MATERIALS AND MOULDINGS (Continued).

Standard Tests.

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 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.

Progress of Plastics in Australia.

The technique of moulding plastic materials has been developed in Australia in the comparatively short period of eleven years. The earliest mouldings, 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.

That Australian plastic moulders have profited by their experience, is amply demonstrated by the following outline list of products being moulded in Australia to-day:—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 holders; electrical switches, adaptors, and other electrical apparatus too numerous to mention.

This list is, to say the least impressive, and, when one further considers that the bulk of the equipment used is Autralian-designed and built, it is farily obvious that the plastic moulding industry is an important factor in Australia's industrial structure.

AUSTRALIAN WIRELESS COMMUNICATIONS

THE greater number of the wireless communication services now in operation and the many wireless achievements to-day regarded as commonplace, were, 25 years ago, either unthought of or were regarded as being outside the realm of practicability.

While geographical frontiers have shrunk with the annihilation of distance, the boundaries of wireless science are now wider than ever. Each discovery but opens the gateway to greater attainments. As each ideal set by A.W.A. is realised, another—larger and more expansive—takes its place. The outstanding progress of Amalgamated wireless and its leadership in Australia wireless communication services is due in a large measure to the foresight, ability, and research work of Sir Ernest Fisk, Chairman of A.W.A.

The principal wireless communication services of Australia which operated by A.W.A. may be classified as under:—

1. The Beam Wireless Service to Great Britain, the Continent of Europe, North and South America, and other parts of the world.
2. The Beam Wireless Picturegram Service to Great Britain and the Continent.
3. Wireless services to Papua, New Guinea, and Fiji.
4. Wireless services to ships.
5. Aircraft wireless services.

Beam Wireless.

The most important of Australia's overseas radio communications is the Beam Wireless Service, opened in 1927, between Australia and Great Britain, the Continent of Europe, and North and South America. It is the longest direct wireless telegraph service in the world.

Some indication of the magnitude of the Beam Wireless Service in relation to the business and social life of the community may be guaged from the fact that over 106,000,000 words have been handled by the Service since its opening. The establishment of the Beam made it possible to effect a decrease in the telegraphic rates between Australia and the outside world.

A great deal of experimental work in trans-ocean communications was carried out by Sir Ernest Fisk, Chairman of A.W.A., during the years preceding the opening of a commercial service. In September 22, 1918, Sir Ernest, in furthering his advocacy of a direct wireless service, received in Australia the first direct wireless message transmitted from England.

So successful was the Beam Wireless Service between Australia and Great Britain that a year later a similar service between Australia and Canada, serving North and South America, was opened.

The work of establishing the Beam was carried out under the supervision of Sir Ernest who, for more than a decade, had not only visualised direct trans-ocean wireless communication between Australia and Great Britain, and Australia and the other Dominions, but had consistently advocated and demonstrated the technical means and methods by which it could be carried out. To-day, Sir Ernest has the satisfaction of seeing his cherished idea of a direct wireless service operating with brilliant success.

Beam Wireless Stations.

The Beam 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 Canda. 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 Morse code perforations on paper tape. The tape is then fed through a small instrument which causes the world impulses to be conveyed by means of the special telegraph lines to the transmitters at Fiskville. The time of travel between Australia and England is a mere fraction (about 1/18th) 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.

Beam to Canada.

The service between Australia and Canada is practically identical with that between Australia and Great Britain.

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.

Amalgamated Wireless should be proud of the fact that the whole of the staff necessary to inaugurate and maintain the highly technical and intricate Beam wireless stations and high speed 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 Wireless Picturegram Service.

By the establishment of the Beam Wireless Picturegram Service, on October 16, 1934, A.W.A. pioneered still another modern wireless service. Pictures, photos, drawings, fashion plates, cheques, finger-prints, and documents of any character, can now be transmitted and received by wireless between Australia and Great Britain, and

AUSTRALIAN WIRELESS COMMUNICATIONS.

(Continued from Page 127.)

Australia and North America. The service has proved particularly useful to newspaper proprietors, enabling the pictorial reproduction of events on the other side of the world to be published in Australia almost simultaneously with their publication in London and New York. It is also being extensively utilised by commercial and financial houses and private individuals.

Trans-Ocean Wireless Telephone Service.

The A.W.A. Trans-Ocean Wireless Telephone Service between Australia and England is the world's longest telephone service. It was pioneered by A.W.A. on April 30, 1930, and represents the first wireless telephone between Great Britain and a Dominion.

To-day by means of this service it is possible for anyone in Australia within reach of a telephone to speak to anyone of the 33,000,000 telephone subscribers in other parts of the world, representing 93 per cent. of the world's total of telephones.

Australians can communicate by telephone with 52 nations. These include almost every European country, North and South America, India, South Africa, Egypt, Palestine, the Netherlands, East Indies 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. Telephonic communications can also be effected with the m.v. "Awatea" when crossing the Tasman Sea.

The transmitting and receiving equipment for the Australian end of these services is operated by Amalgamated Wireless, and is linked to the internal telephonic networks.

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 special 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 transmitters for small ships, and auto-alarm 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 auto alarm signal only, and immediately causes a bell to ring, thus summoning the operator to take up watch for further signals.

Pacific Islands Wireless Services.

An extensive wireless communication service is operated in the Pacific, affording direct communication services between Australia and 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.

There are many stations at smaller island centres, and these communicate with the nearest of the above-mentioned centres, which in turn, communicate with Sydney. Thus communication can be effected from any of the Pacific Island centres to Sydney for Australia and New Zealand, and any town in Great Britain, the Continent of Europe, and North and South America, by means of the Australian Beam Wireless Service.

The chief radio station in the Territory of New Guinea is at Rabaul, on the island of New Britain. Rabaul is in direct communication with Sydney, as well as with stations at Port Moresby and Samarai in Papua, and Wewak, Madang, Bulolo, Wau, Salamoa, Manus, Kavieng and Kieta in New Guinea, and Truk in the Caroline Islands. It also communicates with the Gilbert and Ellice Islands through the station on Ocean Island, with Tulagi in the Solomon Islands, with Vanikoro in the Santa Cruz Islands and with the island of Nauru.

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/sia) Ltd., on behalf of His Majesty's Colonial Government.

Sydney radio is in daily communication by wireless with Noumea and Suva. Suva station collects and distributes wireless traffic to and from almost all the Pacific Islands provided with radio. Among these are Tutuila and Apia in Samoa, Noumea in New Caledonia, Vila in New Hebrides, Nukualofa in the Friendly Islands, and Wallis Island (Fatuna Islands).

The radio station at Willis Island, about 300 miles east of Townsville, is maintained for the sole purpose of supplying information to the Weather Bureau at Brisbane, Sydney and Melbourne. Warnings of tropical disturbances sent from Willis Island have often been of great value to ships in the areas affected and to coastal residents, and in future will also be of value in forecasting the weather for aircraft.

Aircraft Wireless Service.

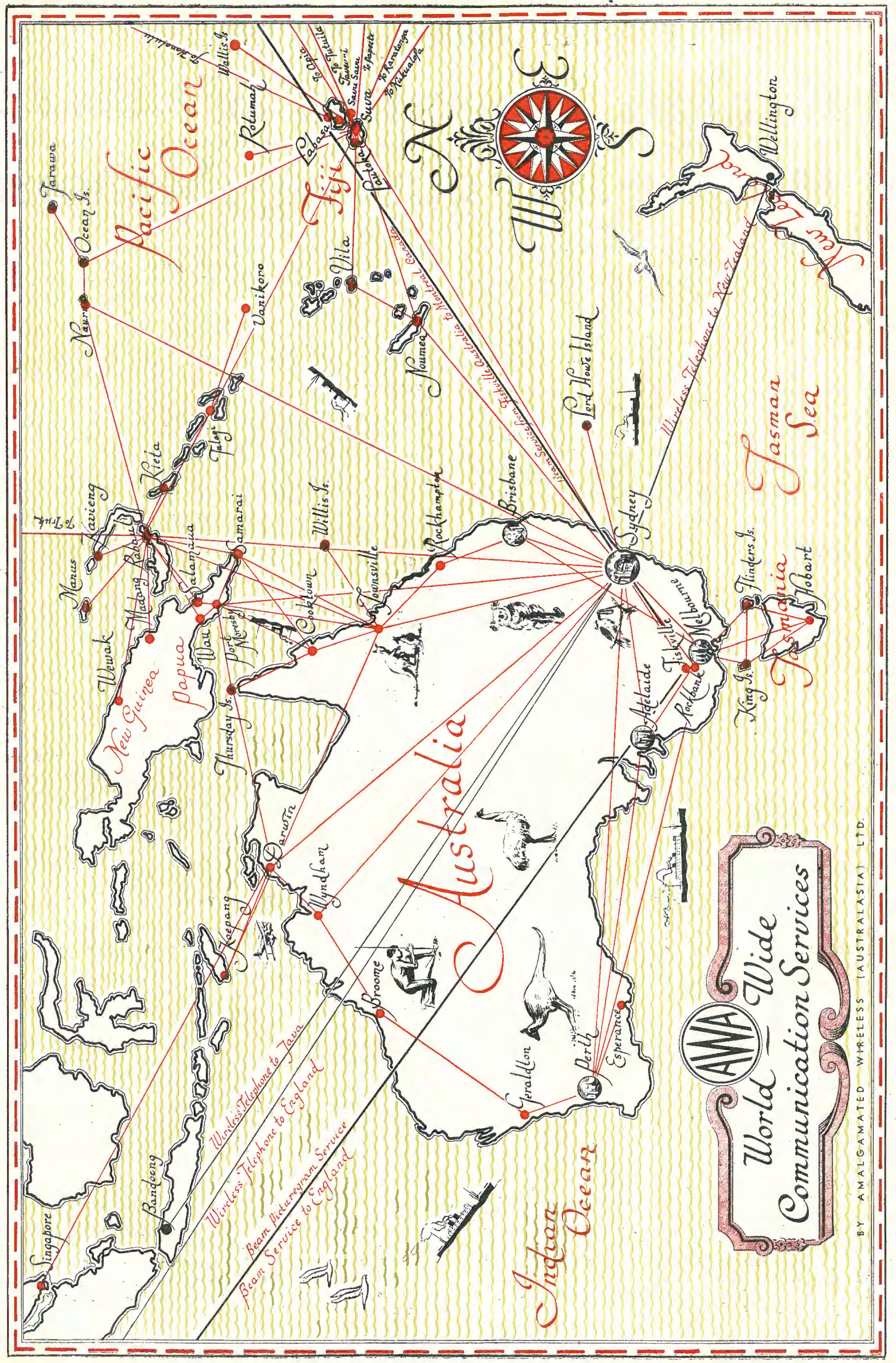
With the expansion of aviation a new and extensive field is being opened. Passenger and mail-carrying aircraft are now provided with wireless transmitting and receiving equipment, and ground stations are being established to assist the airmen in their flights. Two years have elapsed since A.W.A. provided to the order of the Civil Aviation Department a direction-finding station at Essendon Aerodrome, Melbourne, and an experimental radio beacon was installed by the same company at North Brighton, adjoining the Kingsford Smith aerodrome at Sydney. The Commonwealth Government has recently placed orders with A.W.A. for the provision of further aids to aircraft on the routes between Brisbane-Sydney-Melbourne-Adelaide-Perth. The equipment is now being constructed in the A.W.A. radio-electric works.

World-Wide Broadcasting Service.
THE "VOICE OF AUSTRALIA."

Australia was the first British Dominion to establish a regular overseas broadcasting service to the world on September 5, 1927. This service is operated by Amalgamated Wireless, and its purpose is to keep overseas countries informed of the resources and tourist attractions of the Commonwealth.

These world-wide short-wave broadcasting services are operated from station VK2ME Sydney, VK3ME Melbourne, and VK6ME Perth. During the past two years many thousands of letters of appreciation have been received from listeners in Great Britain, the Continent of Europe, U.S.A., and many other countries.

Australians are becoming more and more interested in international affairs, a fact accounted for partly by reason of Australia being a member of the League of Nations, and partly on account of the large number of movements in Europe having a reaction upon Australia's financial and economical position. Just as we can listen in Australia to transmissions in English from many foreign countries, A.W.A. has made it possible for people in non-English-speaking countries to follow the Australian stations by making some announcements over station VK2ME in English, French, German, Dutch, Italian, and Spanish,



Australian Federation of Broadcasting Stations

HEAD OFFICE: 371 Collins Street, Melbourne. Phone M5532.

SYDNEY OFFICE: Commonwealth Bank Building, Martin Place. Phone BW7310.

OFFICER BEARERS FOR 1936-37.

President: J. B. Chandler, Esq.

Vice-Presidents: D. W. Worrall, Esq. ((3DB), Senior; C. F. Marden, Esq. (C.B.N.); G. H. Anderson (2GZ), Country V.P.

Secretary General: M. B. Duffy, Esq.

Administrative Secretary: R. Dooley, Esq.

Federal Council comprises representatives of City Commercial Station; and two Country Commercial 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.

History.

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 in membership until now it has 70 Commercial Stations as members. Side by side with the expansion of the organisation so has the scope of its operations and interests increased also. To-day the Federation is a substantial stabilising influence upon almost every phase of broadcasting development in the Commercial sphere, and a close watch is maintained on all governmental matters affecting broadcasting. In 1935 important agreements were entered into with the Associated Record Manufacturers for the use of gramophone records, and with the Australian Performing Rights Association Ltd. for the use of copyright music. This latter agreement remains in force until 1938, but the former will be reviewed (and possibly renewed) during the present year.

Activities.

The following is an extract from the annual report of the Secretary-General, Mr. M. B. Duffy, delivered at the Sixth Annual Convention of the Federation in November, 1936:—

"Last Convention was very much concerned with the issue of regulations by the Government eliminating ownership of broadcasting stations, and in addition, placing restrictions upon co-operative efforts in regard to proprogramme and technical services. The Convention, in consequence, set up a Defence Fund to organise and protect the interests of a number of Federation members . . . A breaking down of the terms of the Regulations was accomplished. While complete repeal could not be obtained the efforts of the Federation have earned for it a greater respect for its power.

"The decision of last Convention was to aim at an independent board to control broadcasting and to have it separate from the P.M.G.'s Department, the main objects being—(a) To obtain some security of tenure for commercial broadcasting, and (b) Transfer issue and cancellation of Licenses to be placed upon a semi-judicial basis . . .

"In following this request for legislative security, a questionaire was issued to the various stations in order that stastics might be available to justify the maintenance of an industry that has reached fair proportions. From the replies received the following information was obtained:—

"(1) Capital invested in Commercial Broadcasting is approximately £500,000.

"(2) The direct employees of Commercial Broadcasting in Australia approximately 2,000.

"(3) The amount paid in talent fees, apart from regular members of the staffs amounted to £25,000 per annum.

"(4) Total salaries and wages paid £500,000 per annum.

All these facts, together with reasons why security of tenure was necessary, were set out and placed before the Government.

* * *

Since the last Convention the all-important question of accreditation of Service Agencies has been given close attention and sets of rules governing this phase of the business have been prepared.

Since the beginning of the year also, an agreement was entered into with the owners of mechanical copyright for the importation of recorded music for broadcast purposes. The Agreement was for a very short term only and evidence of its working has induced the broadcasting stations to seek a number of amendments particularly in relation to library items, short introductory and closing theme music and medley records.

The Federation views the year just past as a very successful one for Commercial Broadcasters. There has been quite a development of chain establishing, these chains hoping by their strength in combining to be able to produce much more expensive programmes, and it is considered quite possible during the coming year that outstanding artists from overseas will be heard over the Chain routes.

Code of Ethics.

1. RECOGNISING THAT THE RADIO AUDIENCE includes persons of all ages and all types of political, social and religious belief, each member station will endeavour to prevent the broadcasting of any matter which would commonly be regarded as offensive.

2. WHEN THE FACILITIES OF A MEMBER STATION are used by others than the owner, the member shall ascertain the financial responsibility and character of such client, that no dishonest, fraudulent or dangerous person, firm or corporation may gain access to the radio audience.

3. MATTER WHICH IS BARRED FROM THE MAILS as fraudulent, deceptive or obscence shall not be broadcast by a member station.

4. EACH MEMBER STATION SHOULD REFUSE TO accept any business on a cost per inquiry, contingent or percentage basis, or to accord free time for commercial use.

5. NO MEMBER STATION SHOULD PERMIT THE broadcasting of advertising statements or claims which he knows or believes to be false, deceptive or grossly exaggerated.

6. NO MEMBER STATION SHALL DEFAME OR DISparage a competitor, directly or indirectly, by word or acts which call in question such competitor's business integrity, ability to perform contracts, credit standing or quality of service.

7. NO MEMBER STATION SHOULD KNOWINGLY broadcast ambiguous statements which may be misleading to the listening audience.

8. MEMBER STATIONS SHOULD NOT BROADCAST anonymous advertising testimonials.

9. AS FAR AS POSSIBLE MEMBER STATIONS SHALL not allow more than 300 words of direct advertising in a 15 minute sponsored session or 450 words in a 30 minute session.

Radio Education in Australia

THE subject of radio education should be of paramount importance to radio employers and employees alike. That it has exercised the minds of employers for some considerable time is evidenced by the activity one sees amongst the more established manufacturers particularly. Several radio manufacturers have arranged for class instruction for their employees.

As mentioned in last year's Trade Annual, there was a dearth of trained and experienced personnel in the radio industry. That position still pertains to-day, and it is quite true to say that there are several positions waiting to be filled by good radio technicians and engineers. Of course, some people have their own ideas as to their degree of technical standing, and in some cases applicants for positions think they have been treated harshly because they did not get the job, whereas the position really is that they do not possess the technical qualifications necessary. Many of them have not received any training, quite a number do not do any study along organised lines, and in fact think it almost beneath their dignity to attend any radio instruction.

It was at one time thought that radio was almost a "dead end" occupation, but such is not the case to-day. There is ample scope for ambitious, skilled men. It is not sufficient that a man be home-educated to combat today's conditions. If he wants to rise to a high position in the radio technical world, he must be prepared to sacrifice his younger life in the cause of study. Competition is very keen to-day amongst the younger people. Many university graduates are finding good positions in the radio industry. Many graduates of the technical colleges likewise have received considerable encouragement and good positions in the radio industry.

There is no doubt that the day of the home-builder, the amateur constructor, etc., has gone for those who want to reach a position in the radio profession.

With that end in view, the following information is supplied for those who want to seek out the places where they can obtain radio education in Australia.

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 world-wide 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.

Marconi School of Wireless.

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 24 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 five 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 Station 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 and at Pennant Hills and La Perouse radio centres.

Course C: Radio Operator.—Enables the student to qualify for P.M.G. 1st or 2nd Class Commercial Operator's Certificate of Proficiency which is required by Marine and Coast Station operators. First fifteen months is conducted by home study papers and telegraphy is practised at home. The student then attends the school for further practice and instruction.

Course D: Talking Picture Operator.—Period of course, 12 months. The theoretical portion conducted by correspondence deals with electricity as applied to Talking Picture apparatus, after which the student attends the school for practical tuition on standard theatre equipment.

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.

Radio Serviceman's Course. A five months' correspondence course dealing with broadcast receivers.

During the last two years there has been a keen demand for trained Technicians, Operators, and Mechanics, and at times, the School has been unable to supply the number of men required.

The engineering section of the Marconi School of Wireless is supervised by Dr. W. G. Baker, B.Sc., D.Sc. Eng., while the marine section in Australia is conducted by Mr. H. E. Buik, who was one of the first to adopt radio as a profession 26 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 7 years. The College originating from the New South Wales Division of the Wireless Institute of Australia taking over the classes formed by that Institute.

Individual personal instruction is the keynote of all A.R.C. training. Day classes, night classes and correspondence training are conducted by the College which is directed by Mr. L. B. Graham as Principal. In order to cater for the training needs of all students a staff of 10 is maintained, 5 of whom are instructors, in addition to Mr. Graham.

Radio Education in . . .
. . . Australia *(Continued)*

AUSTRALIAN RADIO COLLEGE.

Night classes are held on Monday and Thursday nights between the hours of 7 and 9 p.m., instruction being entirely individual, and the student is able to commence at any time. Monday nights are devoted to lectures, whilst practical work is performed on modern apparatus by the students on Thursday nights. In addition to the student's work on the College premises, he is supplied with complete printed lessons which are studied at home. Examination questions are set on these lessons by the College which the student is required to answer. For those who cannot attend in Sydney, a direct correspondence course is available.

The courses of training the Australian Radio College has to offer are: The Radio Engineer's and Serviceman's course, the Radio and Television Engineer's Advanced Course, and the A.O.P.C. Course. In addition to these, students are coached for membership of the I.R.E.

Every requirement of the modern radio industry is catered for in A.R.C. training, for example, the inclusion in the Radio Engineer's and Serviceman's Course of lessons are lessons on "Salesmanship and Approaching the Customer in the Home when engaged in service work."

In addition to the actual training, the student's welfare is attended to by means of various services which are maintained free of cost to the student. They include the Buying Service which advises upon buying problems; the Employment Service which assists in the matter of employment, the Consultation Service which gives advice to students upon any technical problems, and the Radio Service Engineering Department to which students may send highly complicated jobs for consultation.

Persons interested in radio have an open invitation to attend a lecture in the College lecture hall upon any Monday or Thursday night.

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.

The classes are conducted by Mr. W. W. Honnor, B.Sc., B.E., F.S.A.S.M., M.Inst. R.E. (Aust.), assisted by Mr. S. F. Ackland, M.Inst. R.E. (Aust.), and Mr. J. M. Honnor, A.S.A.S.M.

About 45 students can be enrolled for the first year classes and 15 for the second year. The first year course is usually filled to capacity, making early application necessary to secure a place in the class. The fee is 30/- per term for both first and second year classes. The syllabus is very comprehensive and thoroughly covers the fundamental principles of wireless.

The School of Mines has also commenced a course in Electronics which deals with the theory and industrial applications of all types of electronic devices. The course is designed to give the electrical engineer sufficient knowledge of these devices to enable him to apply them successfully in modern industrial engineering problems.

Both lectures and practical work are included in the course, which occupies two hours per week throughout the school year.

Before commencing this course, students must have passed in Electrical Engineering II (Associateship) or have attained an equivalent standard. The fee for the course is £1/1/- per term and the lecturer is Mr. W. W. Honnor.

Full particulars in regard to the syllabus of both Wireless and Electronics courses can be obtained from the Principal of the South Australian School of Mines, North Terrace, Adelaide.

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 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. Dr. Martyn will, during this year, give a course of lectures on Atmospheric Physics.

Full particulars in regard to these courses can be had from the Registrar, University of Sydney.

THE SYDNEY TECHNICAL COLLEGE.

THERE are two courses at the Sydney Technical College in radio work, both being evening courses of five years duration. Only those persons whose regular employment is suitable are admitted to these courses which are designed to be definitely supplementary and complementary to the daily work of the students. These courses are the Radio Mechanics' Trade Course, leading to the Certificate of Trade Competency, and the Radio Engineering Diploma Course, at the conclusion of which the Diploma of Associateship of the College is awarded.

Neither the Certificate of Trade Competency nor the Diploma is issued until the student has submitted proof of adequate experience at his daily work.

The Radio Mechanics' Course is designed to start at approximately the standard of the Intermediate Certificate of the State Education Department, and a preparatory course of one year is provided for the benefit of those who are not up to this standard.

During the first three years the student passes through a theoretical and practical course in elementary science and applied electricity, including alternating current work, together with workshop work, drawing and calculations. These years form the Lower Trades Course, and require attendance on three evenings a week for two hours each.

In the Higher Trades Course the students spend four hours per week in the evenings on radio work which they are now well able to understand after completing the work of the Lower Trades Course. To a large extent the instruction deals with radio receivers, as this course is primarily intended to turn out expert service men, but other parts of the subject are not neglected.

The Radio Engineering Diploma Course can only be entered by those who are up to the Leaving Certificate standard in English, methematics, and either physics, chemistry or mechanics, and who are so employed that they can be considered to be Cadet Engineers. (Continued on Page 135.)

TECHNICAL PROGRESS IN AUSTRALIAN BROADCASTING

An Account of the Activities of the Postmaster-General's Department in the Radio Broadcasting Field in Australia

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, insofar as the National Service is concerned, including 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.

Stations of the National Broadcasting Service now number 21, including the short-wave transmitter 3LR Lyndhurst, Victoria. Eight stations have been erected since the commencement of the second stage of the National construction programme in 1935.

The new stations and the dates on which they were put into service are as under:—

7NT Kelso, Tasmania, 3/8/1935.
3GI Longford, near Sale, Victoria, 31/10/1935.
2NR Lawrence, near Grafton, N.S.W., 17/7/1936.
4QN Clevedon, near Townsville, Q'land, 26/11/1936.
6WA Minding, near Wagin, W.A., 7/12/1936.
6GF Kalgoorlie, W.A., 10/12/1936.
3WV Dooen, near Horsham, Victoria, 25/2/1937.
2CR Cumnock, N.S.W., 29/4/1937.

A complete list of the stations of the National Broadcasting Service is given in page 72.

Further extensions and improvements are in hand. Tenders for the replacement of plant in Sydney and Melbourne have already been let. Equipment is on order for stations to provide an alternative service in Brisbane and Adelaide, and plans are well advanced for the provision of additional Regional Stations at Dalby (Qld.) and Canberra (F.C.T.).

Because of the proved importance of short-wave broadcasting to the outback portions of Australia, where medium-wave stations cannot be expected to be reliably heard, further extensions of the department's activities in the short-wave field are contemplated. The existing short-wave station 3LR is to be doubled in power, and a more suitable type of radiating system is to be erected. Plans are well advanced for the installation of a short-wave broadcaster to be run in conjunction with Station 6WF Perth, the intention being that the short-wave plant will provide a West Australian service to the north-west of that State.

The main developments in transmitter design have been in the direction of installing the so-called cabinet type transmitters completely operated from A.C., with practically no rotating machinery. More recent types of transmitters to this design are assembled in such a manner that installation work on the site is reduced to a minimum.

Four stations are now equipped with the type of vertical radiator developed in the Department's Research Laboratories. The heights of these structures vary from 500 to 650 feet. Extensive electrical tests, including measurements made from an aeroplane flying at heights up to 10,000 feet over the radiators have shown that the structures considerably reduce near fading and result in a much greater overall efficiency from the viewpoint of ground field strengths.

To meet the demands of modern broadcast programme production requirements, an extensive overhaul of the existing technical equipment of the National studios is in hand. The first studios to be re-equipped are those in Perth, where advantage has been taken of a removal to provide more up-to-date equipment. Under the new scheme each studio or group of studios will be provided with individual control equipment, thus permitting programme production, rehearsal or audition to be carried out independent of activities existing in other studios within the building. Plans are well advanced for the introduction of this scheme in conjunction with extensive additions that are being made to the studios of the Australian Broadcasting Commission in all capital cities.

The direct recording of programmes within the studios is becoming a more important feature of the Australian Broadcasting Commission's activities. To meet this need, recording equipment is being provided in all capital cities. In Melbourne the steel tape machine, which was installed some time ago, is still giving good service, but experience has shown that its use is limited, particularly from the viewpoint of producing recordings that require transportation around the Commonwealth for reproduction from more than one studio. Extensions to equipment are, therefore, being made on the basis of installation of disc recording equipments, the recordings being made on acetate coated discs. These machines will be capable of producing records at either 78 or 33 1-3 r.p.m.

Constant investigation is in progress to ensure that the latest and most suitable types of microphones and gramophone pick-ups are made available for programme production purposes.

The introduction of high quality microphones, by virtue of their low level output, has necessitated the development of pick-up amplifiers having an overall gain considerably in excess of that previously required. The Department's modern type of amplifiers have a gain of 100 decibels with an output of 100 milliwatts into a 600 ohms line. The amplifiers are arranged for operation either from an A.C. commercial supply or direct from profitable batteries.

The use of ultra high frequency transmitting and receiving units is being gradually extended in connection with outside pick-up work, many pick-ups from remote points to which it is impracticable to provide physical programme lines being made possible by the use of this type of apparatus.

To connect the various stations of the National Broadcasting Service to their respective studios, permanent programme lines totalling some 3,000 circuit miles are now in use. These circuits are made up in the main of physical channels, but the necessity of obtaining the greatest use out of every mile of copper wire erected is tending to force the introduction of a greater number of programme carrier channels, the operating carrier frequency of which is 42.5 kC. The channels connecting Stations 2NR and 2CR with the main studios in Sydney are of this type. The interstate circuits from Brisbane to Adelaide, including Hobart, also operate on this principle, and orders have recently been placed for what amounts to a duplicate channel of this type for operation between Sydney and Brisbane, via the Northern Tablelands. The total inter-capital circuit mileage amounts to 3,900 miles.

The rapid development of commercial broadcasting in Australia, combined with the increase in the number of National transmitters, has necessitated a considerable amount of work being done in the allocation of operating frequencies for the various transmitters. The frequency band that is set aside by the International Telecommunication Convention for local broadcasting is, of course, particularly limited so that, with the large increase in the number of transmitting stations, a certain amount of frequency sharing has been found necessary.

The Department's obligations under the International Telecommunication Convention necessitates a constant check being kept on the frequency of transmitting stations throughout the Commonwealth. The Department's fundamental standard of frequency is operated in conjunction with the Research Laboratories and the Mont Park receiving station. Subsidiary units are now, however, installed at various points throughout the Commonwealth, and by this means adequate steps are taken to ensure that all transmitters comply with International requirements.

The Department's activities in this field are as follows:

(i) The operation of the National short-wave transmitter 3LR, and

(ii) The reception of overseas programmes for subsequent rebroadcast over the Australian network.

Earlier reference has been made to the National short-wave transmitter. Numerous reports received, not only from within Australia, but also from surrounding territories and other more distant countries, show that this transmitter is performing a very useful function.

The reception of overseas programmes is carried out at the departmental short-wave receiving station at Mont Park. This station is staffed constantly, and by the use of specially designed receivers and efficient directional aerials, many programmes of international note are received, not only from the British Broadcasting Corporation's Daventry transmitter, but also from other international stations. As it is frequently inconvenient to transmit these programmes direct into the National network, the practice of recording programmes for subsequent rebroadcast is, if anything, increasing. Notable services given by this station during the past twelve months were those in relation to the death of King George V and the abdication of his successor.

RADIO EDUCATION IN AUSTRALIA— (Continued from Page 132).

For those who are not up to the required standard of education, a preparatory course in English, mathematics and physics is available. Students who are doing the Higher Trades Course may be admitted to this preparatory course.

The Radio Engineering Diploma Course is nearly the same as the Electrical Engineering Diploma Course for the first three years, the subjects including three years of mathematics, two of chemistry and part of the work in electrical engineering, with some drawing and design.

In the last two years, these students concentrate on radio engineering, including all the various branches of the subject, with design work. They also do some work on applied mechanics and heat engines.

Fundamental Electrical Formulae

Direct Currents

Ohm's Law and Its Application

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.

$$E = IR \quad \ldots \quad (1)$$

$$I = \frac{E}{R} \quad \ldots \quad (2)$$

$$R = \frac{E}{I} \quad \ldots \quad (3)$$

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:—

We wish to supply 200 volts to a valve electrode which draws 4 mA. at that voltage. The supply voltage available is 250 volts, so that it is necessary to drop 50 volts in a series resistor in order to obtain the required supply voltage. The current flowing through this resistor will be that drawn by the valve electrode, so, by applying equation (3) 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

$$\text{or } W = EI \quad \ldots \quad (4)$$

But from equation (1), $E = IR$.

$$\text{Therefore } W = IR \times I = I^2R \quad \ldots \quad (5)$$

$$\text{Similarly, from equation (2), } I = \frac{E}{R}$$

$$\text{Hence } W = E \times \frac{E}{R} = \frac{E^2}{R} \quad \ldots \quad (6)$$

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 in series, each rated according to the wattage calculated for the total 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.

The value of the resistors necessary to make up a parallel combination of the desired value will depend, of course, on the number used and the resistance value of each. The relationships are expressed in equations (7), (8) and (9), below.

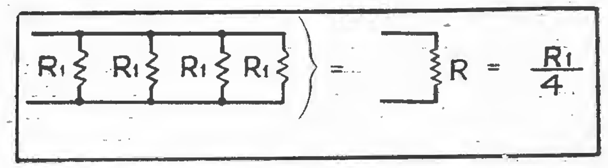


Fig. 1.
Resistors in Parallel.

In general, if there are "n" resistors, each of resistance "R_1"

$$\text{Effective Resistance} = \frac{R_1}{n} \quad \ldots \quad (7)$$

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

$$R = \frac{R_1 R_2}{R_1 + R_2} \quad \ldots \quad (8)$$

If we have more than two resistors, "R" is given by

$$R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots} \quad \ldots \quad (9)$$

Current Distribution.

In a simple case, where two resistors of like value are paralleled, the current divides equally between the two, but where a parallel combination is made up of unlike resistors the current divides unequally.

In the case of two resistors, the current in each is directly proportional to the value of the other resistor. Referring to Fig. 2,

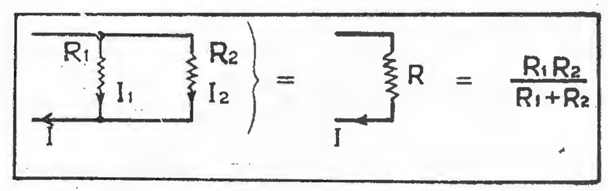


Fig. 2.

$$I_1 = I \frac{R_2}{R_1 + R_2} \quad \ldots \quad (10)$$

I_2 will be, of course, the difference between I and I_1.

Where there are more than two resistors in parallel, it is first necessary to determine the effective resistance of the combination. Having done this, the current flowing in any one resistor of the combination will be

CURRENT DISTRIBUTION—(Continued).

$$I_1 = I \frac{R}{R_1} \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \quad (11)$$

Where I_1 = Required current,
I = Total current,
R = Effective resistance,
and R_1 = Resistance in which I_1 is flowing.

This last equation (11) can be used as an alternative to equation (10) in cases where the effective resistance of the combination is known.

If two resistors of known current rating are available, it is possible to make use of equation (10) to determine the maximum total current which it is permissible to pass through a parallel combination of these without damage to either.

For example: We have a 5,000 ohms 10 mA (R_1, I_1) resistor and a 3,000 ohms 15 mA (R_2, I_2) resistor in parallel to give 1,875 ohms. What total current will this combination then pass without damage? Reversing formula (10) we have

$$I = I_1 \times \frac{R_1 + R_2}{R_2} \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \quad (10a)$$

and we find that the total current, which flows when the maximum rated current, 10 mA, is flowing in the 5,000 ohms resistor, is

$$I = 10 \times \frac{8000}{3000} = 26.6 \text{ mA.}$$

Under these circumstances a current of 16.6 mA. would be flowing in the 3000 ohms resistor. As this resistor is only rated at 15 mA. it will be overloaded, so another calculation based on this is necessary. Substituting values in equation (10a) we have—

$$I = I_2 \frac{R_1 + R_2}{R_1} \quad \ldots \ldots \ldots \ldots \ldots \ldots \quad (10b)$$

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.

A practical application of the above would be found in a case where it was necessary to parallel a resistor of known current rating in order to carry a given total current.

Voltage Dividers.

One of the commonest applications of the principles of Ohm's Law is found in the determination of voltage divider constants. In spite of this, "cut and try" methods still seem to be in general use, and some examples of the application of Ohm's Law to such problems will be in order.

The simplest of such problems 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. It is first necessary to 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 required screen voltage. This is usually 100 volts, so that the current flowing through R_1 is 5 mA.

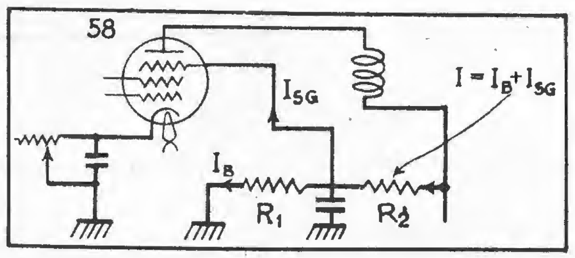


Fig. 3.

The screen current of a typical R.F. pentode 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 high-tension supply voltage is 300 volts (on load) this necessitates a drop of 200 volts across R_2. Substituting these values in equation (3), R_2 is found to be approximately 30,000 ohms. If it is necessary to supply several tubes the calculations are similar.

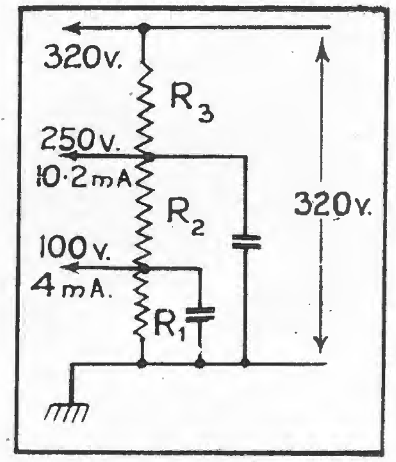


Fig. 4.

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

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 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.

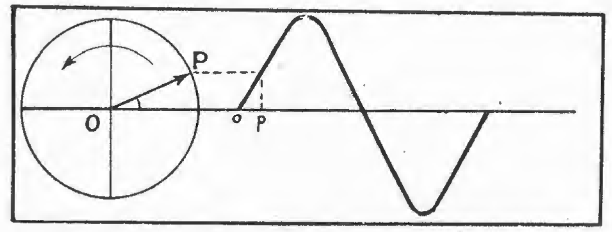


Fig. 5.

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.

All the equations and examples given above on D.C. flowing through resistors apply equally well to the passage

(Turn to Page 140.)

ALTERNATING CURRENT.

(Continued from Page 138.)

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 analogus quantity known as the **impedance** and denoted by "Z."

Ohm's Law for A.C. states that

$E = ZI$ . . . . (12)

$I = E/Z$ . . . . (13)

$Z = E/I$ . . . . (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

$X_L = 2\pi fL$ . . . . (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

$Z = \sqrt{R^2 + X_L^2}$ . . . . (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

$$X_c = \frac{10^6}{2\pi FC} \quad \text{. . . . . (17)}$$

"C" is in microfarads and "10^6" represents 1,000,000. "π" and "f" are as previously enumerated for equation (15).

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 a A.C. circuit, or in other words, their effects are in "phase opposition."

Fig 6 shows several combinations of resistance, inductance and capacity which might be encountered in practice. As pointed out before, the effects of inductance 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 the diagram. (Refer to (15) and (17) for values of X_L and X_c).

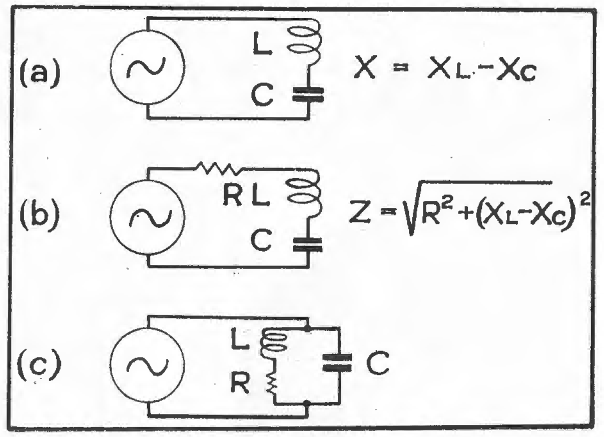


Fig. 6

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. When determining the impedance of the network, these two resistances may be lumped together with any other series resistance in the circuit and shown as "R" in fig. 6 (b).

The impedance of the combination is then given by 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 by the following equation:—

$$Z = X_c \sqrt{\frac{R^2 + X_L^2}{R^2 + (X_L - X_c)^2}} \quad \text{. . . . . (18)}$$

Where "Z" is the overall impedance in ohms; "X_c" is the reactance of the condenser (equation 17); "X" is the reactance of the inductor (equation 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 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 equation then becomes:—

$$Z = \frac{L}{RC} \quad \text{. . . . . (19)}$$

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 equations 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; equation (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 Ohms'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 equations (15) and (16), it will be seen that the reactance and impedance of an inductor are **directly** proportional to both the frequency of the 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. (12) to equation (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.

Ohm's Law Applied to Inductance.

For these determinations the combined equations (12) and (15) become:—

$E = 2\pi fLI$ . . . . (20)

Transposing for the purpose of inductance determination this becomes—

$$L = \frac{E}{2\pi fI} \quad \text{. . . . . (21)}$$

and for frequency determination it becomes—

$$f = \frac{E}{2\pi LI} \quad \text{. . . . . (22)}$$

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**.

Inductance Determination.

If any fixed supply of A.C. is available, such as from normal A.C. mains, equation (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 equation then becomes—

$$L = \frac{0.764}{I} \quad \text{. . . . . (23)}$$

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 equation (21), or its derivative (23), 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 of the limiting choke. The inductance value calibrated on the meter should be that of the inductance, under test, 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 connnected 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.

Frequency Determination.

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 kept constant at a predetermined level. If this is so, and a value of inductance for the purposes is decided upon, equation (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 equation becomes—

$$f = \frac{2.44}{I} \quad \text{. . . . . (24)}$$

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 equation (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

INDUCTANCE AND CAPACITY—(Cont.)

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.

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, it 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 "ripple voltage" 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 200 ohms and 31,000 ohms at 100 cycles, which is the predominant frequency in the "ripple" output of a full-wave rectifier operating on 50 cycles. 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 over 99% of any A.C. present will flow through the condenser and less than 1% 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.

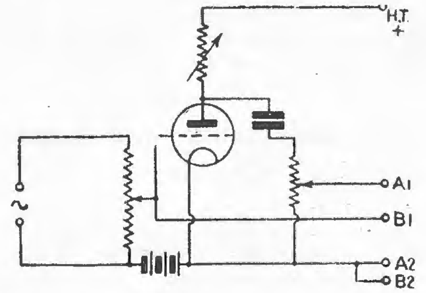


Fig. 7.

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 potentimeter 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.

Ohm's Law Applied to Capacity.

Getting back to the inverse relationship of reactance to capacity and frequency, once again we find that equation (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)—

$$E = \frac{10^6}{2\pi f C} \times I \quad \text{.......................} \quad (25)$$

Transposing for the purpose of capacity determination, this becomes—

$$C = \frac{10^6 \times I}{2\pi f E} \quad \text{.......................} \quad (26)$$

and if the capacity is known, but the frequency is required, it becomes—

$$f = \frac{10^6 \times I}{2\pi C E} \quad \text{.......................} \quad (27)$$

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.**

OHM'S LAW APPLIED TO CAPACITY.

(Continued from Page 142.)

These equations 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.

Capacity Determination.

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:—

$$C = 13.26\ I \quad \text{.......................} \quad (28)$$

where "I" is the current flowing in **amperes** when the condenser is connected across 240 volt 50 cycle A.C. mains. (Equation (26) may, of course, be similarly simplifed to suit any other mains voltage supply condition.)

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 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.

Condensers in Series.

To recapitulate, in terms of capacity:—

$$C_s = \frac{C_1 \times C_2}{C_1 + C_2} \quad \text{.......................} \quad (29)$$

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 condenser under test and current limiting condenser in series have been determined by means of the current flow and equation (26), or it derivative (28), it will be necessary to effect a transposition of (29) in order to obtain the actual capacity of the condenser under test.

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 "unknown" condenser) may be found by the following:—

$$C_2 = \frac{C_1 \times C_s}{C_1 - C_s} \quad \text{.......................} \quad (30)$$

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 micofarads.

Of course, it is possible to connect the unknown condenser 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 (under 240v. 50c. conditions) will prevent any possibility of damage being done due to a fautly "unknown" condenser. 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. ("Measuring Instruments.")

Frequency Determination.

Equation (27) may be applied to the determination of frequency in exactly the same manner as was done with the inductance equations.

Quite considerable error may be introduced if the waveform 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:—

$$f = 666\ I \quad \text{.......................} \quad (31)$$

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 foregoing details should provide an excellent indication of the principles governing the independent application of inductance and capacity to alternating current circuits. Their combined application will be dealt with under the heading "Resonant Circuits."

RESONANT CIRCUITS

"Tuned" Combinations of Inductance and Capacity

ALTHOUGH an example of the combined effect of inductance and capacity in one circuit has been given, this example merely served to emphasise the particular properties of each with relation to an alternating current. The actions of each in the example cited (a filter circuit), although complementary, were distinct and separate in that neither depended entirely on the other for its effectiveness.

RESONANT CIRCUITS (Continued.)

The most effective applications of inductive and capacitive reactance are found in **resonant** circuits where the two are combined in such a manner that the final value of reactance is either considerably smaller or considerably greater, at a given frequency of operation, than the reactance component.

"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."

Circuit combinations of this 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.

"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 was 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 alternating 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 effect 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 main 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 either component alone if a well-designed inductor is used. Another property of a series resonant circuit is that the counter-voltage (back E.M.F.) developed across either component is always greater than the impressed voltage, providing that no other resistance than that of the components themselves 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.

Phase Relationships.

Before detailing a few of the applications where series resonant circuits can be used advantageously, it will be of interest to investigate the phase relationships of such a circuit. These are of great importance in certain resonant circuit applications, and although such applications will not be dealt with here, it is well to bear them in mind.

It has already been shown that the current leads the voltage applied to a condenser by nearly 90 degress, and that the converse applies to an inductance. Furthermore, it has been shown that the reactance of a condenser is inversely proportional to frequency, and that the reactance of an inductance is directly proportional to frequency.

From this it follows that in a series resonant circuit the reactance will be capacitive at frequencies below resonance and inductive at frequencies above resonance, and that, as a result, the current will lead the voltage at frequencies below resonance and lag behind the voltage at frequencies above resonance. The voltage distribution across the network varies accordingly, i.e., the majority of the voltage drop will be across the condenser at frequencies below resonance and across the inductance at frequencies above resonance.

Applications of "Series" Resonance.

Even as a pure resonant circuit, a series combination of inductance and capacity has many applications. Voltage amplification may be obtained by using the counter-voltage developed across either component, or attenuation of any particular frequency may be effected by shunting the entire network across a circuit which contains an 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—

$$E_L = X_L \frac{E}{R} = E \frac{X_L}{R} \qquad \ldots\ldots\ldots (32)$$

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.

It is of interest to note that the operation of the "Q" Meter depends on the fundamental principle that a voltage amplification dependent on the series resistance present is obtained across either of the components in a series resonant circuit. In the "Q" Meter, the voltage developed across the capacitive component is measured. This instrument is dealt with in a later section ("Measuring Instruments"). In the meantime, we shall merely give a definition of the term "Q" in relation to the matter at present under discussion.

RESONANT CIRCUITS (Continued.)

Determination of "Q" Factor.

The ratio X/R may be regarded as an indication 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 $X_L = 2\pi fL$ 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.

$$Q = \frac{2\pi fL}{R} \qquad \ldots\ldots\ldots (33)$$

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 inductances/capacity combination—

$$Fr = \frac{1}{2\pi \sqrt{L\,C}} \qquad \ldots\ldots\ldots (34)$$

where "Fr" 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:

$$Fr = \frac{159}{\sqrt{L\,C}} \qquad \ldots\ldots\ldots (35)$$

where "Fr" 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 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 situated 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

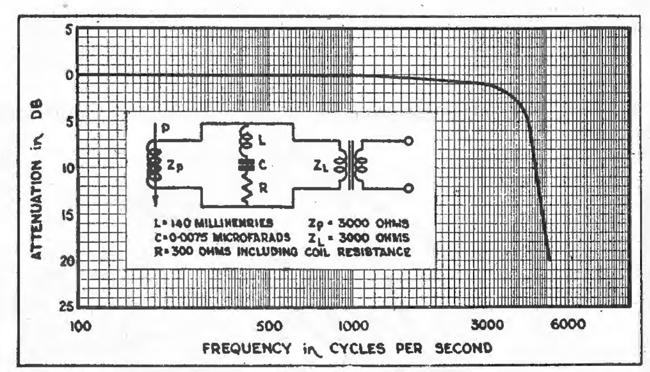


Fig. 8.

"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 200 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 100 cycles. The resultant reactance in this case would only be the D.C. resistance of the choke (probably no more than 100 ohms).

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 am-

TUNED POWER FILTERS—(Continued).

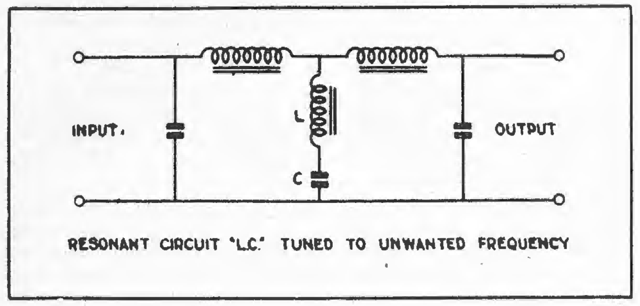


Fig. 9.

plifiers. 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 cycles 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 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. To clarify matters still further, the use of the charts in connection with the problem in hand is as follows:—

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). (See explanatory notes accompanying charts for further details of their use.)

REACTANCE CHARTS.

(Continued from Page 146.)

Following the 100 cycles line vertically it is quite evident that there are 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 frequnecy. 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 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 of fig. 9. The values used in the first pair are readily obtainable and as a 5 henry choke can be easily 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 100 ohms at 100 cycles. 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 4mfd. 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 counter-voltage 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 equation (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.

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 "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 equation (fig. 6b) for a series network. In addition, the phase relationships for a parallel resonant circuit under "off-resonance" conditions are the reverse of those for a series resonant circuit.

(Turn to Page 150.)

Instructions for the Use of Reactance Charts

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 the chart, and that the upper values on the scales correspond to the upper set of values at the bottom of the complete chart 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 chart 1, corresponds to a frequency of about 700 k.c. and an inductance of 0.5 henry, or a capacitance of 0.1 mmfd., 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 CHART 2: Chart 2 is used to obtain additional precision of reading but does not place the decimal point, point, which must be located from a preliminary entry on chart 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. By using this chart it will be found that, following on the previous example, the reactance corresponding to 0.5 henry or 0.1 mmfd. is 2,230,000 ohms at 712 k.c., their resonant frequency.

For further information on the used 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."

Always use corresponding scales

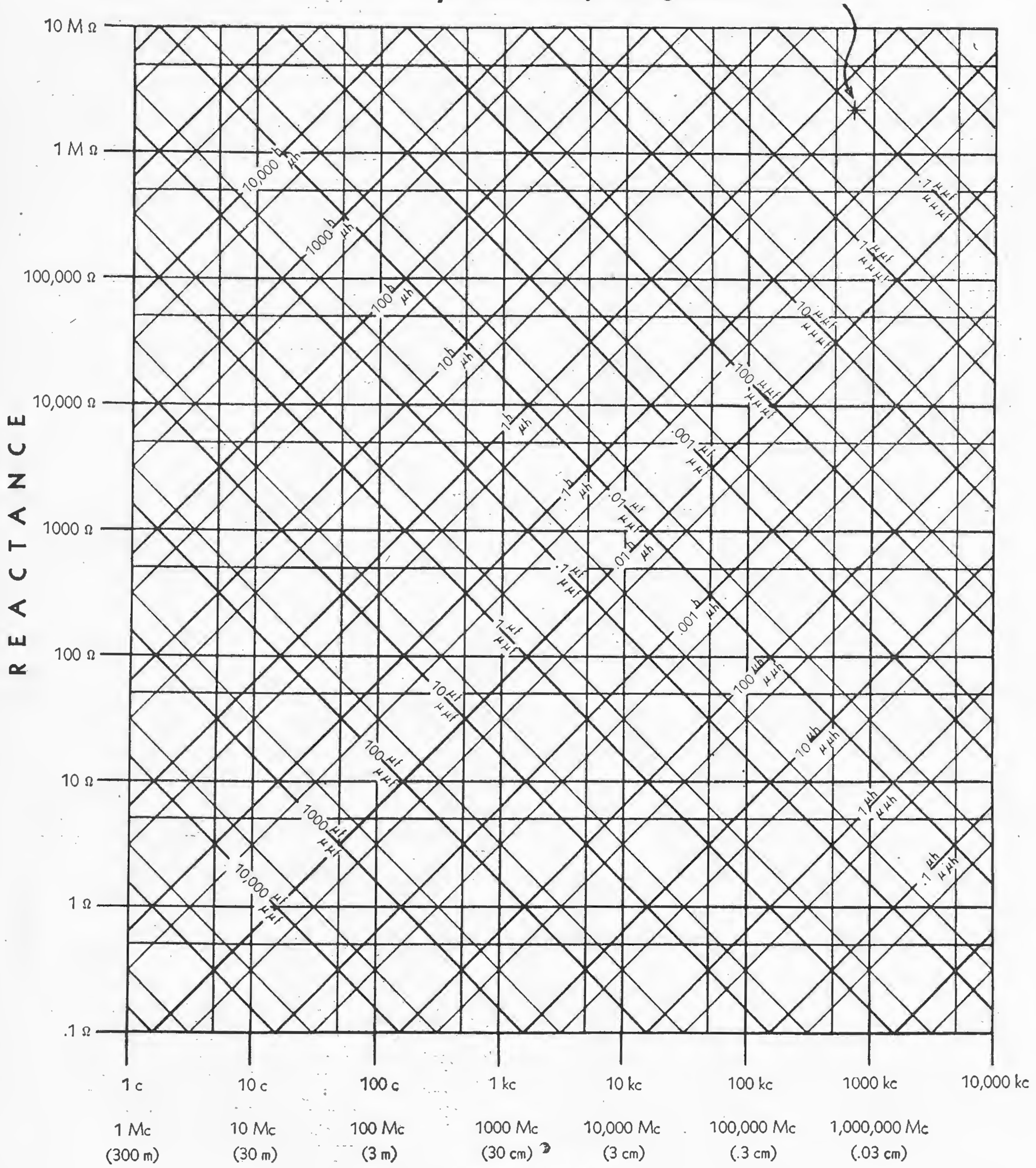
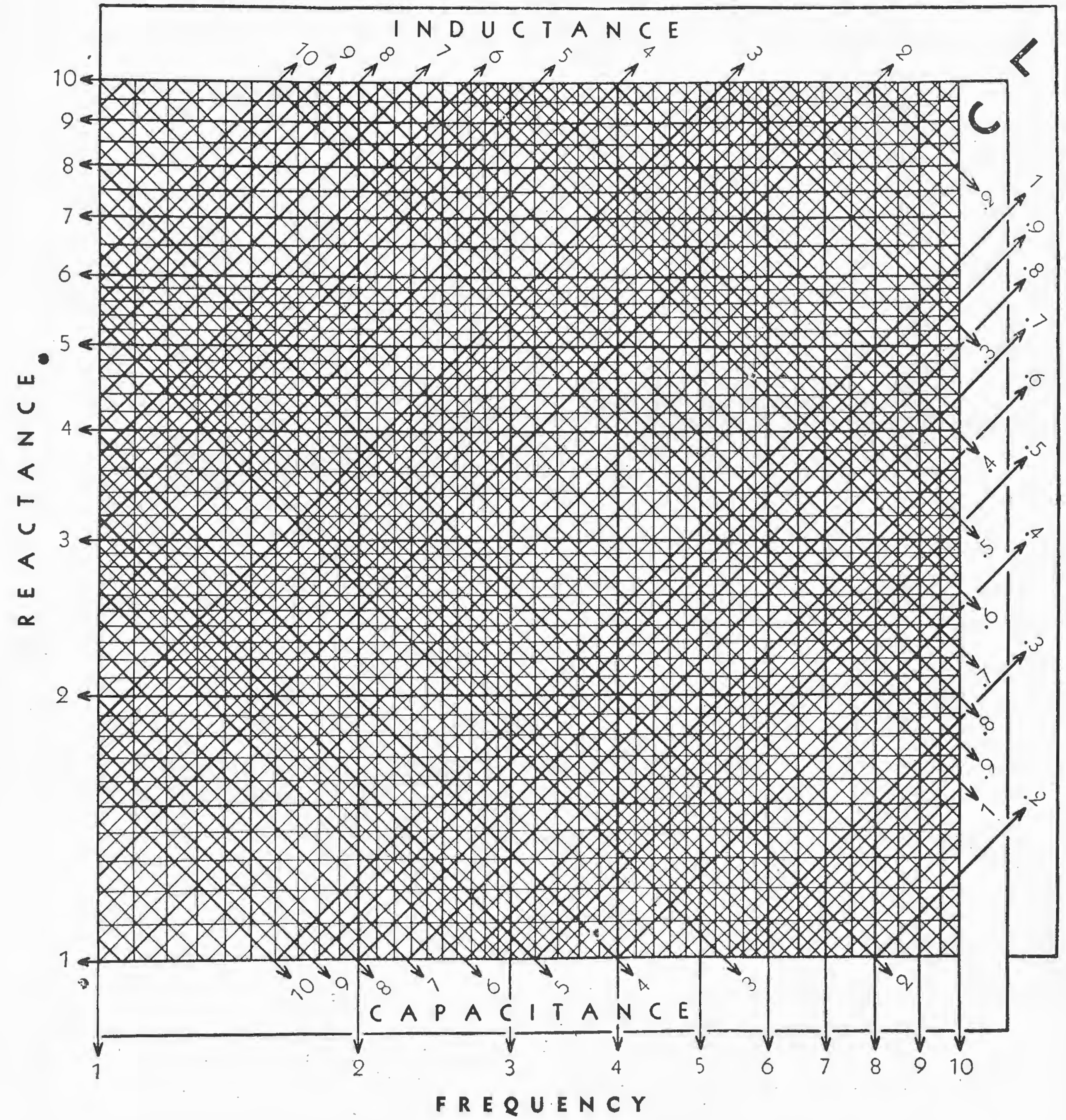


FIGURE 10 (Chart 1), above, for approximate resonanceand reactance determination.

FIGURE 11 (Chart 2), facing, for accurate determination of same,

Always obtain approximate value from Figure 1 before using Figure 2



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. Chart 1, is a complete chart (containing 100 sections) to be used for rough calculations, while chart 2 (one of the sections of chart 1 enlarged approximately 7 times) is to be used where the significant two or three figures are to be determined.

(Instructions and examples of the use of these charts will be found on pages 146 and 147.)

PARALLEL RESONANT CIRCUITS.

(Continued from Page 147.)

"Parallel" Resonant Impedance.

The "high impedance" property of a parallel resonant circuit is explained by the fact that two paths are offered 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 under ideal conditions 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 alternating 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 impedance 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 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.

"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 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

$$Z = \frac{50,000,000}{200 \times 0.05} = 5,000,000 \text{ ohms}$$

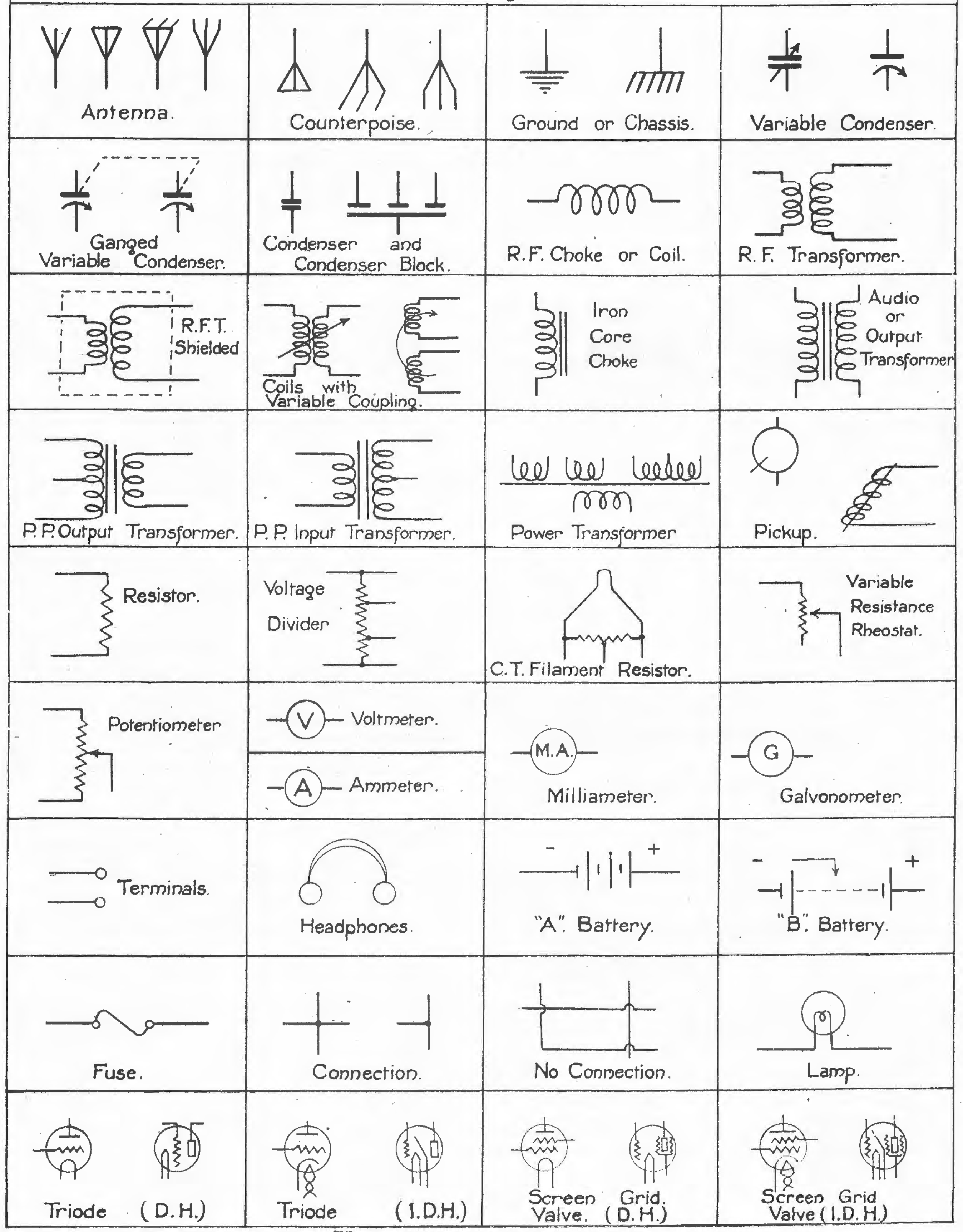
which is the impedance of the network to 100 cycles.

This is rather a phenomenal increase, and may seem to be rather ridiculous. However, the figures are correct, and serve to demonstrate the propertes of parallel resonant circuits in no uncertain manner.

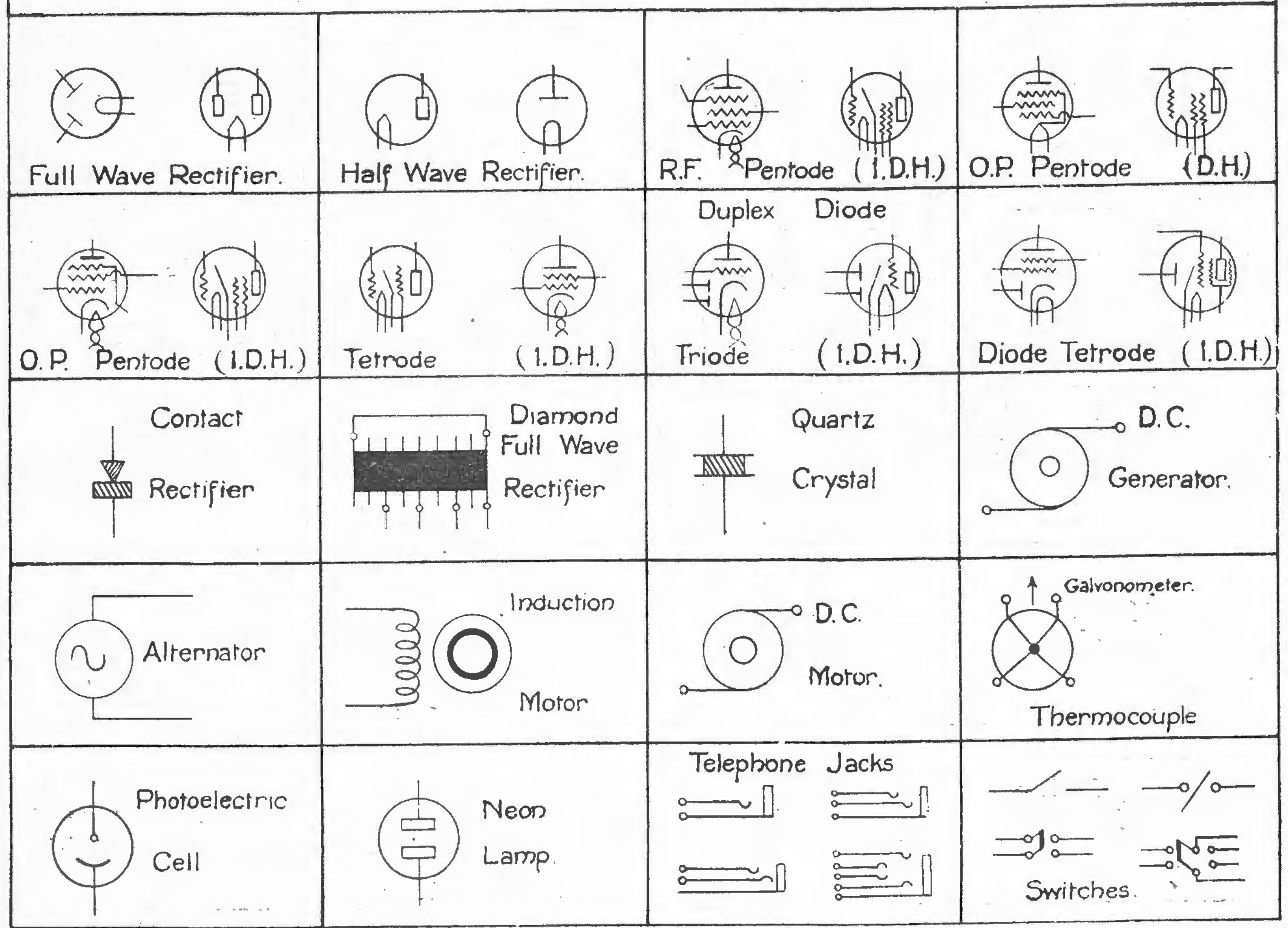
A point that must be remembered, however, is the fact that a filter similar to the one just described is very sharply tuned, and maximum attenuation will only be exercised at the resonant frequency. Frequencies more than a few cycles above or below 100 cycles would hardly be affected at all, other than 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 by-pass the choke at high frequencies, with the result that the higher harmonics of te 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

RADIO SYMBOLS—(Continued from Page 152.)

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

RADIO SYMBOLS

(Continued from Page 153.)

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	13/64	17/64
1	11/64	7/32
2	5/32	13/64
3	9/64	3/16
4	1/8	5/32
5	3/32	1/8
6	5/64	5/64
8	3/64	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	.10	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.

Current 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	7.15
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	.0136	.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.)

INDUCTANCE CALCULATION

IT is often necessary when engaged in radio design work, to ascertain the approximate inductance of a solenoid or a multi-layer air-core coil. Conversely, it may be necessary to determine the winding details for a coil of given inductance. Several inductance calculation formulae are given below which will prove useful for work of this nature. The use of any particular formula will be dependent upon the constants available.

An approximate value for the inductance of a single-layer air-core solenoid, in microhenries, is given by the formula:—

$$L \doteq 0.0251\, d^2 n^2 b K \quad \ldots \ldots \ldots \ldots (1)$$

where "n" is the number of turns per inch of winding; "d" is the mean diameter of the coil in inches; "b" is the length of the winding in inches, and "K" is a "form factor" which depends for its value on the ratio obtained by dividing the mean diameter of the coil by the length of the winding. This is known as Nagaoka's correction factor, and a chart showing the values of "K" for the more usual diameter/length ratios is presented in Fig. 1.

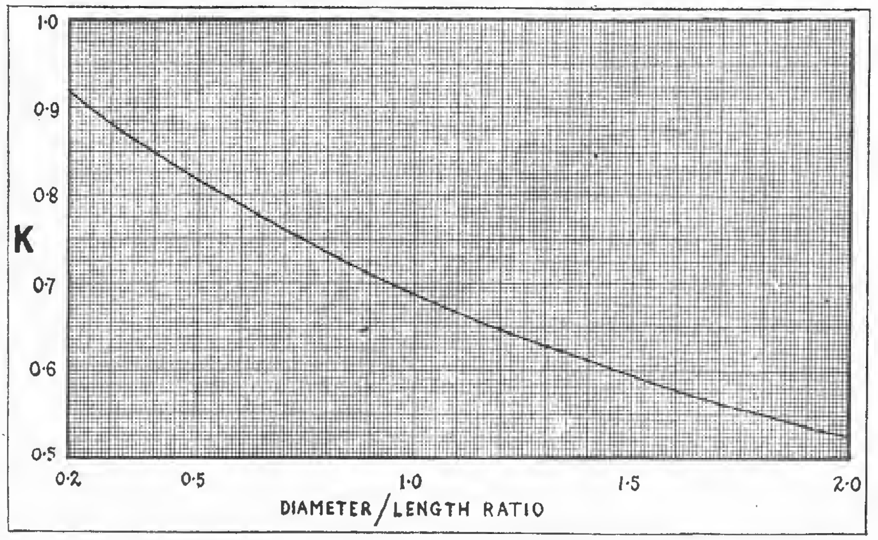


Figure 1.

Several formulae have been developed which do not make use of a correction factor, but most of these are unduly complicated in application. One in particular, however, which is due to J. H. Reyner, is of interest as it not only gives accuracy well on a par with formula (1), but is extremely simple in calculation and does not use a "form factor." In addition, a corrective term is provided which enables the inductance of multi-layer coils to be calculated with reasonable accuracy. The first section is as follows:—

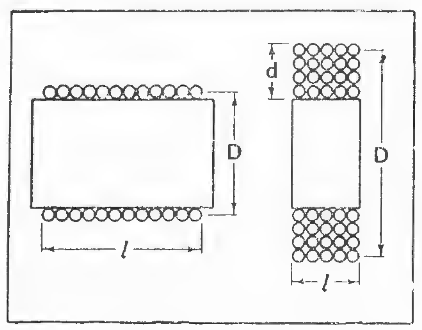


Figure 2.

$$L = 0.2 \left(\frac{n^2 D^2}{3.5D + 8\,l} \right) \quad \ldots \ldots \ldots (2)$$

and this gives the inductance in microhenries of a single layer aircore solenoid when "n" is the total number of turns in the coil; "D" is the mean diameter of the coil in inches and "l" is the winding length of the coil in inches.

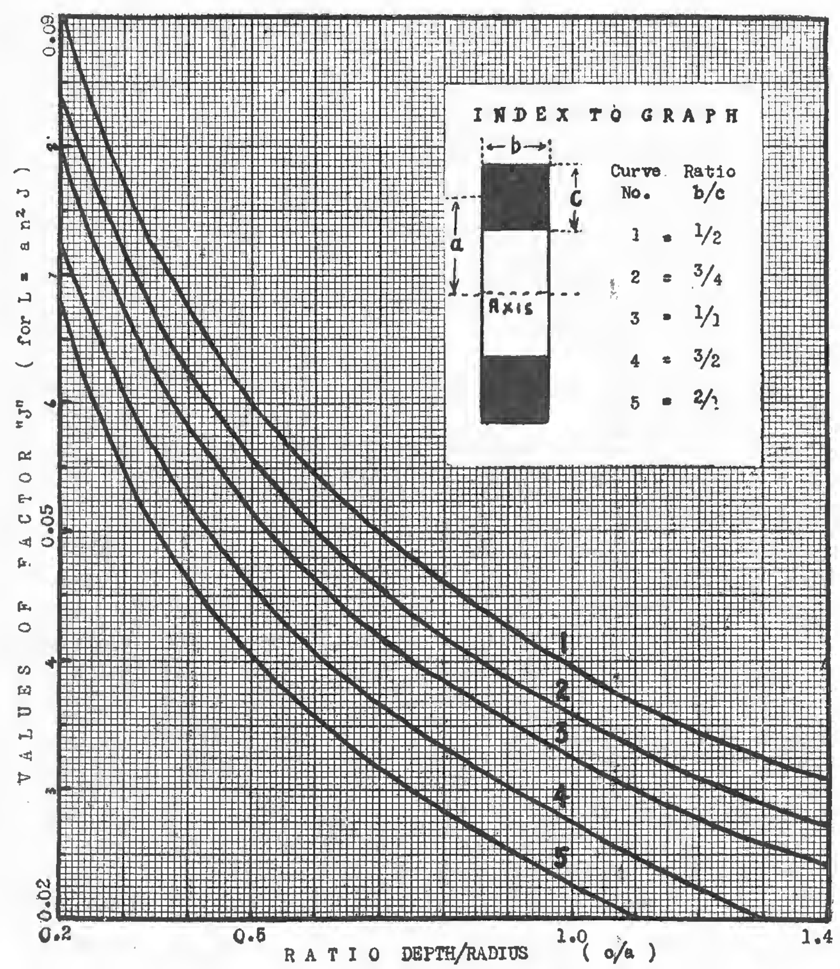


Figure 3. Form factor determination for inductance formula (4). Dimensions are required in inches.

INDUCTANCE CALCULATIONS—(Continued).

The expression gives a very close approximation which is within 1 per cent. of the true value of inductance. For multi-layer coils, the expression becomes:—

$$L = (2) \times \left(\frac{D - 2.25d}{D} \right) \quad \ldots\ldots (3)$$

(2) represents the formula (2) given above, with the value of "D" changed as noted below.

The second half of the formula is the corrective term mentioned above. The constants are similar to those employed in formula (2), the only difference being that "D" is now the **external** diameter of the coil in inches. The additional constant "d" is the winding depth of the coil in inches. For purposes of clarity, a diagram is presented in Fig. 2 which illustrates the dimensions of the coils for purposes of formulae (2) and (3).

An alternative means of calculating the inductance of a multi-layer coil is given by the following expression:

$$L = an^2J \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where "L" is the inductance in microhenries; "a" is the mean coil radius in inches (see Fig. 3); "n" is the number of turns; and "J" is a form factor determined from Fig. 3. The "b/c" ratios given in Fig. 3 will cover most standard multi-layer coil shapes, but in the event of any ratio falling between those plotted, interpolation should not be difficult.

For any "b/c" ratio falling **outside** of those plotted, or for coils having "c/a" (radial depth of winding/mean radius) ratios outside of the scope of the graph, it will be advisable to make use of the multi-layer inductance formula (3).

Finding Turns Required.

The above formulae can be transposed quite easily if the inductance required is known, together with the dimensions of the coil former or shape to be used. A suitable procedure for designing a solenoid coil is to first determine the maximum acceptable length and diameter (bearing shielding requirements in mind). Having done this, the number of turns necessary to give the required inductance on a former of the size chosen may be determined by means of a transposition of formula (1). For this purpose, formula (1) becomes:—

$$n = \sqrt{0.0251\ d^2bLK} \quad \ldots\ldots\ldots (5)$$

where all constants are the same as in the parent equation (1).

The number of turns required having been determined, it is a simple matter to find the wire size required for either close or spaced winding. (Simple division of the turns into the coil length and a wire table are the essentials of this procedure. The thickness of the insulation on the wire to be used should also be borne in mind, especially when dealing with spaced coils, as the insulation forms part of the spacing.)

For multi-layer coils, the procedure is a little more difficult if formula (3) is to be used, as it is necessary to reduce one side of the equation to a simpler form before transposition can be effected. However, this is only a matter of substituting values for the indices used and resolving the sum to a simple multiple or fraction of "n^2." This will, of course, be equal to "L," the value of which is already known. "n^2" can then be transposed and the square root of the product on the other side of the equation gives the turns required.

Transposition of formula (4) is quite simple, as the equation is a plain multiplication problem. The transposed and simplified formula is:

$$n = \sqrt{aLJ} \quad \ldots\ldots\ldots\ldots\ldots (6)$$

in which all constants are the same as in the parent equation (4).

In order to determine the turns required to provide a given value of inductance it is obvious, from the above details, that it is first necessary to decide on a size and shape for the finished coil. This means that a wire gauge must be used which will make up a coil of that size and shape, otherwise the final value of inductance obtained will be somewhat different from that desired and used as a basis of calculation.

The problem of wire gauge determination would be fairly simple if multi-layer coils for tuning purposes were wound like cotton on a reel, as, in this case, almost any wire table would provide the required information.

The use of "honeycomb" windings introduces several difficulties, but they are not insuperable. The following example will show one way of overcoming them:—

Assume that 250 turns of wire wound in a former half an inch in diameter to make a coil ¼in. wide and ¼in. deep will give an inductance of 1000 microhenries. The gauge of wire to use and the number of turns per layer necessary to make a coil of the size required is yet to be determined.

To begin with, it is necessary to assume a definite number of turns per layer to be used. For the sake of an example, this can be 25, so that it can be seen that 10 layers will be required to make a coil of 250 turns. At first glance it would appear that the thickness of each layer will be the thickness of wire to be used, but it must be remembered that honeycomb winding, due to the cross-overs, takes up about half as much space again as the thickness of the wire used. Therefore, if we divide ¼in. (the depth of the winding) by 15, we will obtain a fair approximation of the wire thickness, with insulation, which must be used. Simple division shows us that this will be about 0.0166in., and reference to a wire table will show that 30g. S.W.G. single silk and enamel covered wire (the usual insulation) is about the nearest. However, the very fact that this wire is 0.016 (or thereabouts) in diameter indicates that it cannot be wound 25 turns per layer. But if we reduce the number of turns per layer the number of layers to make 250 turns goes up, so that 30g. is obviously useless.

At this point, it is necessary to resort to "cut and try" methods, but, as we have some guide as to the requirements, the procedure is simplified. If a finer gauge of wire is used more layers will be required to make up the depth of winding, therefore there must be fewer turns per layer, and as a thicker gauge is out of the question, the procedure is obvious. Finally, after a little thought, it will be seen that 34g. S.W.G., S.S.E., wound 20 turns per layer, will come very close to doing the job. A trial coil may be wound to these specifications and measurement of the dimensions will soon show how correct they are. Having done this, the exact gauge to use can soon be arrived at.

READING THE FREQENCY/ 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 time 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

Capacity Calculations

ALTHOUGH condensers are normally purchased to requirements nowadays, it is useful for the technician to have a general knowledge of the principles underling the design of a condenser and the determination of its capacity.

Broadly speaking, condensers are divided into two classes; fixed and variable. While each of these classes is divisible into a number of sub-classifications, the laws governing the design of each are basically the same, and depend on the class of service for which a condenser is to be used.

The voltage at which a condenser is operated is fundamentally a minor consideration, and is purely a matter for the dielectric used between its plates. The **nature** of the voltage is a different matter, however, and it is upon this that the design of a condenser rests. The voltage applied to a condenser can be any one or all of three types:—D.C.; low-frequency A.C.; or high-frequency A.C.

The design of a condenser for operation on D.C. presents no problems other than those of providing the required capacity and the necessary insulation to ensure freedom from dielectric rupture. The dielectric may be any insulating material or even a film of gas as in an electrolytic condenser.

The design of a condenser for use on low-frequency A.C. is a little more stringent as the alternating fields set up by the reversal of potential applied to the plates impose a greater strain on the dielectric. This condition automatically rules out any dielectric of an unstable nature (such as the polarised gas film in an electrolytic). In addition, greater care must be used in the arrangement of the plates to ensure that resistance is kept down to a minimum. This is so that an approximately equal potential will be applied to all portions of the assembly. If this is not done, losses will occur and the power factor of the unit will be seriously disturbed.

The same remarks, with greater emphasis, apply to the design of condensers for use on high-frequency A.C. (or radio-frequency, as it is usually known). Even a small amount of series resistance will have a marked effect on the voltage distribution in a condenser for this class of service and large losses will result. In addition, it is essential that the conducting paths to the plates be kept extremely small on account of the danger that inductance will be introduced. Even a small amount of inductance in a condenser for R.F. use will result in its acting as a tuned circuit at some frequency, and thus nullifying its action as a blocking or bypassing unit.

Space does not permit of a detailed description of the means to be adopted to ensure that a condenser conforms to the requirements for any particular class of service, but sufficient has been said to indicate that any condenser will not do any job. It will be evident that a condenser designed for R.F. work (for instance) will be suitable for use on D.C., but it is equally evident that it will be needlessly elaborate for the job. The point to bear in mind is that when condensers are being ordered **always** give full particulars of the application in which they are to be used.

Apart from the question of the operation of a condenser in a given circuit, the question of its capacity must be considered. This is regulated mainly by three factors: The area of the plates; the nature of the dielectric used between them; and the thickness of the dieletric.

A simple expression which shows the relationship of these three, and also gives the capacity of any condenser in microfarads:—

$$C = \frac{K \times a \times (n-1)}{4.45 \times 10^{6} \times d}$$

where "C" is capacity in microfarads; "A" is active area of **one** side of **one** plate in square inches; "d" is the dielectric thickness in inches; "K" is the "specific inductive capacity" or dielectric constant of the dielectric; and "10^{6}" is the abbreviation for one million. To make this brief discussion complete, a tabulation of "K" values for usual dielectric materials, followed by a tabulation of their breakdown strength in volts per mil. (a "mil" is one-thousandth of an inch) is presented below:—

Material.	"K"
Air (normal presure)	1.00
Bakelite (moulded)	5—7
Bakelite (paper base)	5—6
Beeswax	3.00
Castor Oil	4.7
Celluloid	4—16
Ebonite	2—4
Frequentite	6.00
Fibre	3—5
Glass	6—9
Isolantite	6.00
Mica	3—7
Mica (clear India)	6—7
Paraffin Wax	2.5
Paraffin Waxed Paper	3.5
Quartz (fused)	4.5
Shellac	3—3.5

The following table gives breakdown strengths in volts per mil for some of the materials listed above. These breakdown voltages do not always increase in proportion to the increase in thickness of the material:—

Material.	Volts per mil
Air (normal pressure)	30 —70
Bakelite (moulded)	200—500
Bakelite (paper base)	250—700
Castor Oil	300—400
Bakelite (paper base)	250—700
Celluloid	100—150
Ebonite	100—500
Frequentite	150—250
Fibre	100—200
Glass	150—200
Isolantite	150—250
Mica	1000—2000
Paraffin Wax	100—150
Paraffin Waxed Paper	120—200
Quartz (fused)	200—400

VARIABLE CONDENSERS

U.S.A. Design Standard

ON November 18, 1936, the Radio Manufacturers' Association of U.S.A. adopted a new standard for the capacity variation law and accuracy of variable condensers for use in broadcast receivers. This standard is of interest in that it provides Australian technicians with an indication of the American trend in gang condenser design.

The complete standard specification is as follows:—

ITEM 1.

The following capacitance-displacement characteristics shall be a standard for the oscillator section of a variable tuning capacitor:—

% of Total Rotation.	Capacity Change of Osc. Section. (MMF.)	Production Test Points % Rotation.
0	0	
10	7.3	
20	25.2	
25	36.7	25
30	50.1	
40	84.5	
50	130.3	50
60	187.2	
70	251.4	
75	284.1	75
80	316.3	
90	381.5	
100	442.2	100

ITEM 2.

It shall be standard to locate "zero per cent. of total rotation" at 180 degrees removed from position of mechanical stop in the region of maximum capacity.

ITEM 3.

It shall be standard in variable capacitors to provide a displacement-capacity characteristic as in Item 1 above, but in three calibration classifications known as grade 1, grade 2, and grade 3. In grade 1, the oscillator section shall depart from the capacity values given in Item 1 at the production test points there in-

(Continued on Page 164, Col. 2.)

RADIO COLOUR CODES

APART from resistors and a few makes of fixed condensers, the R.M.A. (U.S.A.) standard methods of colour coding have not been generally adopted in Australia. However, it is quite possible that they will be, and, in any case, numerous items of American equipment are encountered from time to time, so that the list of colour codings presented below should be of general reference value. The standard resistor coding is repeated for ease of reference.

Resistors

The resistor is coloured at three points:—

(1) All over, as the base or "body" colour.
(2) At one end, on top of the "body" colour, as the "tip" colour.
(3) A band or dot, on top of the "body" colour, around the centre of the resistor as the "dot" colour.

The "body" colour designates the first figure of the resistance value (in ohms): the "tip" colour designates the second figure; while the "dot" colour designates the number of ciphers following the first two figures. The colours used are as follows:—

Figure	Colour
0	Black
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Violet
8	Grey
9	White

From the above it can be seen that a 250,000 ohms resistor, for example, would be coloured with a red body, a green end, and a yellow dot.

Speaker Windings

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.

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.

I.F. or R.F. Coils

Standard Windings.

Blue .. .. plate lead.
Red .. .. B + lead.
Green .. grid (or diode) lead.
Black .. grid return.

Full-wave Diode Transformer.

Green .. diode lead.
Green-Black diode lead.
Black .. .. centre tap (diode return).

Fixed Condensers

Fixed condensers are marked with a series of three coloured dots. The significance of each colour is basically the same as that for the resistor code given above, but as there are one or two variations, the colours and their equivalent values are repeated below for easy reference.

In order to ensure that the dots are read in the right order they are always arranged so that they are on the same side of the condenser as some other markings, such as the brand, which must be turned up the right way in order to be intelligible.

The first colour (left) in the series of three indicates the number of ciphers following the decimal point; the second colour, the first figure, and the third colour, the second figure.

The colours used, and their significance, are as follows:—Black—nought or one cipher; Brown—one; Red—two or two ciphers; Orange—three or three ciphers; Yellow—four; Green..five; Blue—six; Purple—seven: Grey—eight; White—nine. White is also used by some manufacturers in the first position to indicate a decimal point. This usage is normally only restorted to in the case of condensers having a capacity of from 0.1 to 0.9 mfd. (A condenser having a capacity of 0.1 mfd. would be marked with a white dot, a brown dot and a black dot, or a blank space in order from left to right).

It will be noted that three colours only are provided for use in the first position, thus allowing for a maximum indication of three ciphers by the first colour. Black, however, can be used in the second position, and as this colour indicates zero or one cipher, four ciphers can be indicated without any difficulty. For example, a 0.00005 mfd. condenser would be branded with orange (three ciphers after decimal point), black (one cipher) and green (five).

RADIO POWER TRANSFORMERS.

R.M.A. (U.S.A.) Colour Code for Leads.

1. Primary Leads..............................Black
   If tapped—Common ....Black
   —Tap ....Black & Yellow 50/50 Striped Design
   —Finish ....Black & Red 50/50 Striped Design
2. Rectifier—Plate Winding...................Red
   Centre Tap ....Red & Yellow 50/50 Striped Design
3. Rectifier—Filament Winding................Yellow
   Centre Tap ....Yellow & Blue 50/50 Striped Design
4. Amplifier—Fil. Winding No. 1. ....Green
   Centre Tap ....Green & Yellow 50/50 Striped Design
5. Amplifier—Fil. Winding No. 2................Brown
   Centre Tap ....Brown & Yellow 50/50 Striped Design
6. Amplifier—Fil. Winding No. 3................Slate
   Centre Tap ....Slate and Yellow 50/50 Striped Design

VARIABLE CONDENSERS.

(Continued from Page 162.)

dicated by not more than one per cent., of 1 mmf, whichever is the larger value.

In grade 2 the oscillator section shall depart from the capacity values given in Item 1 at the production test points there indicated by not more than one per cent. plus 1 mmf.

In grade 3 the oscillator section production test point shall be 100% of rotation, departure from the capacity value given in Item 1 to be not more than one per cent., plus one mmf.

ITEM 4.

It shall be standard in variable capacitors of grade 1, as defined in Item 3, to provide sections which depart in capacitance from that of the oscillator section by not more than one-half per cent., or one mmf., whichever is the larger value.

ITEM 5.

It shall be standard in variable capacitors of grades 2 and 3, as defined in Item 3, to provide sections which, depart in capacitance from that of the oscillator section by not more than one-half per cent. plus one mmf.

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 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 ($R = E/I$) 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 (Figue 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 cast 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 caluculation 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 Formulae," but a few further details should serve to clarify the position somewhat. It is quite obvious that the chart will be of assistance 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 valves in a radio receiver require a screen volt

(Continued on Page 168.)

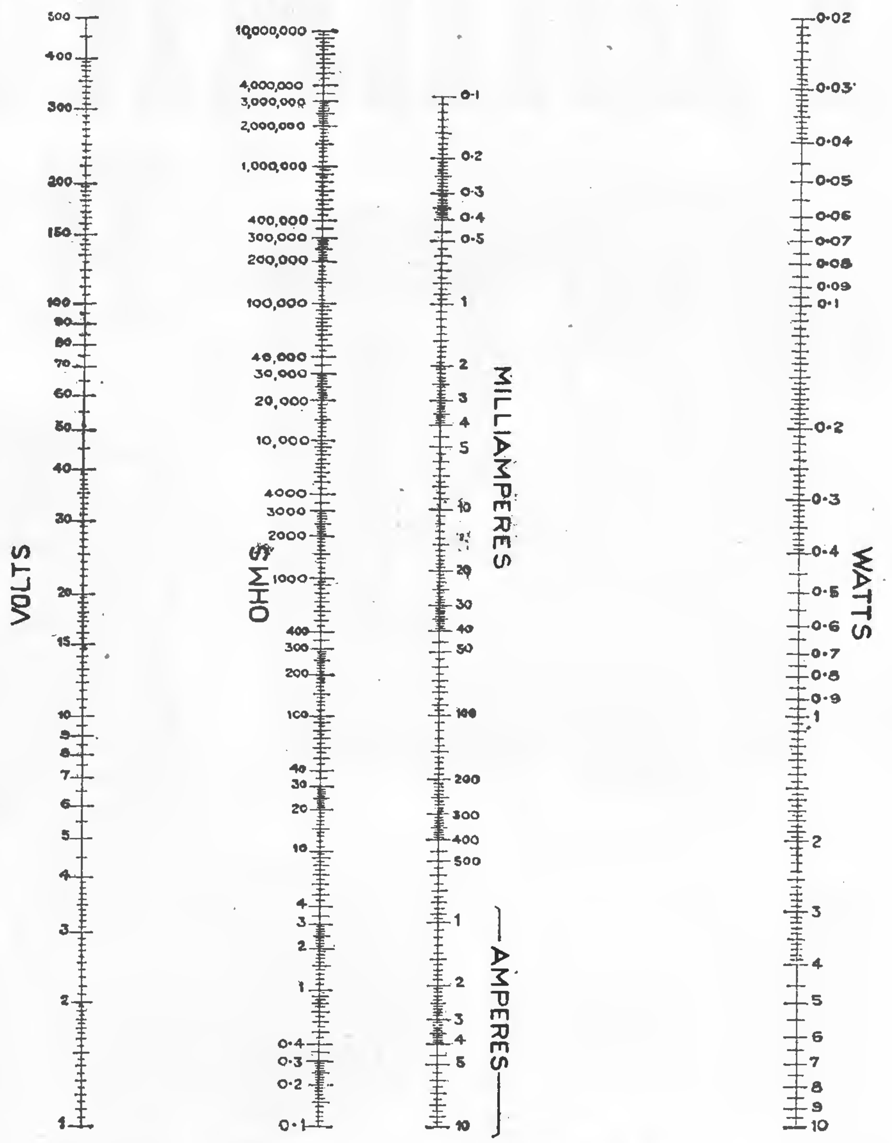
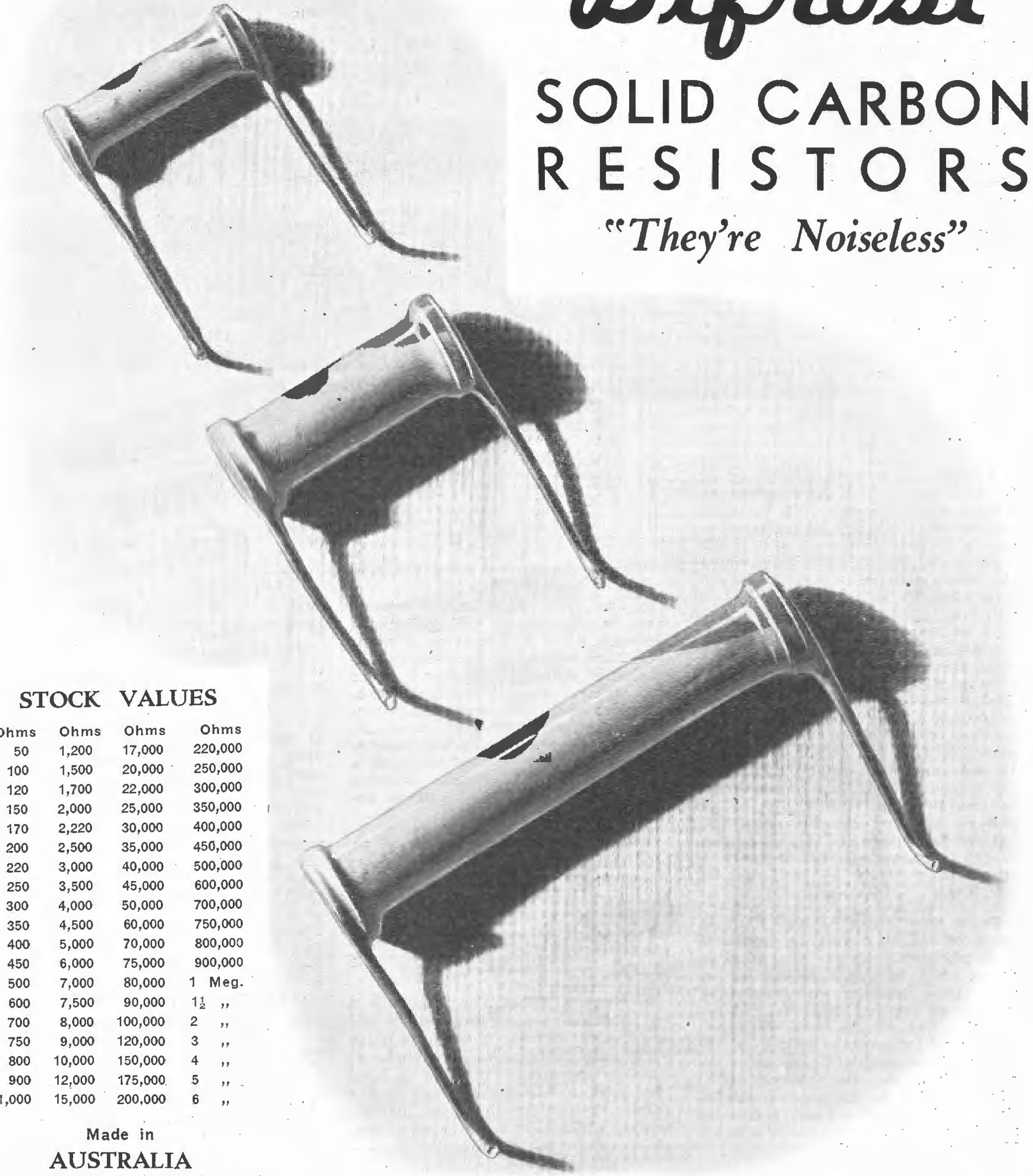


Fig. 1.—Chart for Calculating Resistors, etc.



RESISTANCE CALCULATION.

(Continued from Page 166.)

age 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 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 ohms 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 5 mA, 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 somewhere 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 act only as filters.

GREEK SYMBOLS USED IN RADIO FORMULAE

Letter.		Name.	English Equivalent.
Small.	Capital.		
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 ")

The first type, which carry current, 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 valves which are all fed from one voltage divider tapping and those which are used to decouple the plate circuits of two or more valves which are all fed from one main supply.

When the functions of voltage dropping and decoupling (or filtering) are intentionally combined, 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 resistance to capacitative impedance 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 valve, as in this case there is a definite limit to the amount of resistance which can be inserted in the grid circuit of the valve.

In this particular instance the procedure is usually to employ the maximum size of resistor possible (bearing the characteristics of the valve in

(Continued on Page 170.)

RESISTANCE CALCULATIONS

(Continued from Page 168.)

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 3,000 ohms at 100 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 ripple filtration. (Reference to earlier notes in the "Fundamental Electrical Formulae" section will serve to clarify this point).

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 variation 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 is merely 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 twofold one, the first phase of which is to flatten out any peaks in the transformer response 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 valve 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 optimum plate load 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 rated to operate with a load resistance of 10,000 ohms the secondary of the transformer should be shunted with a resistance of 40,000 ohms. This procedure will result in a big drop in overall level, but is well worth while if bass response is at all lacking.

(Continued on facing Page.)

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.

RESISTANCE CALCULATIONS (Continued.)

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 valve 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 valves. Some people are apt to forget that the screen current of a valve passes through the 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 valve 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 valves used in the receiver. In the case of R.F. and other valves controlled by A.V.C. or other means which causes the plate current of the valves 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 valves 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 valves 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 valves 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 manufacturers' valve 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 detector diode, the resistance value to be used is controlled by the same factors, but is to some extent modified by the coupling condensor 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 of the valve—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 valve, thus causing loss of voltage, is in direct opposition to the requirements for maximum gain from a valve operating as a resistance capacity coupled amplifier.

An expression which gives the theoretical stage gain which may be expected from a valve 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 valve 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.1, 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.

Theoretically, the amplification of the stage will increase with the ratio RL/RP until a figure very close to that of the valve 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 valve 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 valves 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 valve will be incapable of handling any signal at all. To explain:—a type 75 valve requires two volts negative grid bias at 250 volts on the plate. As this valve 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 1 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 satis-

(Continued on Over-leaf.)

RESISTANCE CALCULATIONS (Continued.)

factory operation of this valve, 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 valve. 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 used for the following valve.

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 valve in question. Somewhere near the lower value is usually employed for indirectly heated valves, where contact potential is on the negative side of zero bias, unless unlimited plate voltage is available. Directly heated valves 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.

The preceding remarks apply mainly to triode type valves. When pentodes are used, a number of other factors enter into the discussion and it is normal practice to use a load resistor which has a value considerably lower than the plate resistance of the valve. The value of the load in this case affects the fidelity as well as the gain. Detailed information should be obtained from valve manufacturers' data.

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.

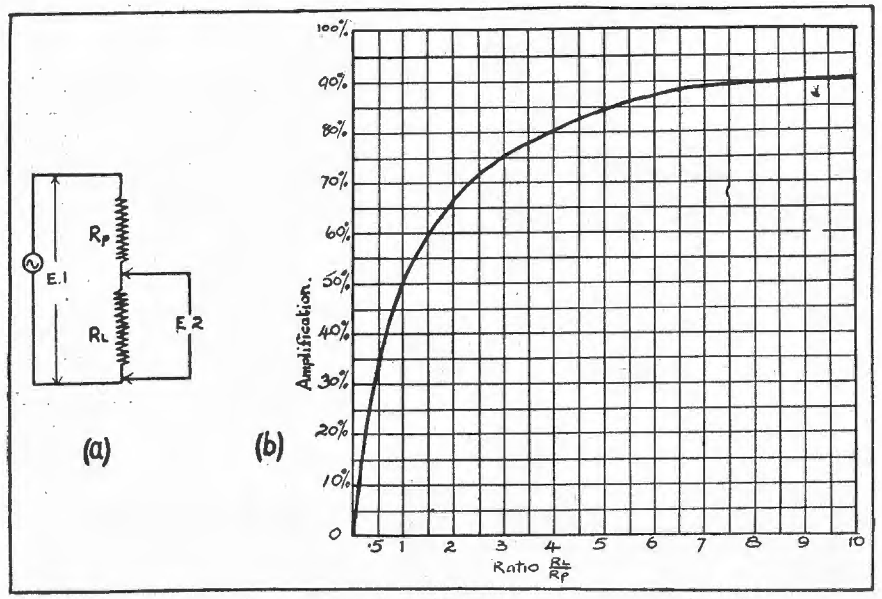


Fig. 2—Load Resistance/Amplification Graph for Resistance Coupled Triode Amplifiers.

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 valve 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 valves, with strong signals, there is a definite limit to the amount of resistance which can be used in the grid circuit of an amplifier valve. This grid current flow causes loss of bias, the amount of loss being dependent on the value of resistance in circuit. Consequently, valve manufacturers usually specify a maximum value of grid resistor for various valves; this value being also dependent on the manner in which the valve is biassed. Self-biassed valves 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. Valves operating with semi-fixed bias (such as bleed arrangements where most of the current is supplied by the power 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 operation limits the resistance to only 10,000 ohms, so that transformer coupling is the only system which is normally practicable under the latter conditions.

Intermediate stage valves, 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. These factors remain the same whether the preceding valve is a triode or pentode.

The first thing that must be remembered is that the stage coupling condenser and the grid-leak are in series between the preceding valve 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 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 valve, the grid resistance 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

RESISTANCE CALCULATIONS (Continued.)

make this clearer. We will assume that the output valve 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 (at 100 cycles and less at higher frequencies) of 330,000 ohms which is presented to the plate load resistor of the preceding valve. If this valve 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, howexer (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 place load being reduced to 125,000 ohms, but will also result in a higher effective plate voltage being applied to the valve. This in turn means that more bias can be applied to the valve, 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 surprising improvements in performance these lines will often result in quite ance 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 valves 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 favorable. 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	,, ,,

All of these combinations of leak and condenser values will give approximately 95% of optimum 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 the increase in resistance due to 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 in 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 nearly 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.

(Continued at bottom of Page 177.)

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.

Acoustical 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 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," or a small Greek "rho". (See "Radio Symbols" section, also table of Greek symbols in "Resistance Calculation" section.)

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."

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, antinoise." A muting system arranged to suppress noise during breaks in carrier. Specially developed for communications services.

RADIO DICTIONARY

(Continued.)

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. (See section "The Decibel System" for further details.)

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.

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.

Electron Multiplier. A special valve-like device which utilises secondary emission principles.

Facsimile Transmission. The electrical transmission of a graphic record having a limited number of shade values.

Farad. The unit of capacity. The normal unit used in radio is the "microfarad" (one millionth of a farad).

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 at 10,000 Gauss.

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.

Henry. The unit of inductance.

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.

(Continued overleaf.)

RADIO DICTIONARY

(Continued.)

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 Feed-Back. Also termed "negative" or "reversed" feed-back. A system whereby portion of the output from a valve amplifier is fed back to the input in reverse phase, thus setting up degeneration. Useful for the reduction of distortion and resonance effects.

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.

Kilocycle 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 wavelength 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. Symbal is "H."

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 change in plate current of a valve to the 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.

Neper. A transmission unit somewhat similar to the decibel, but is calculated on the Napierian or base "e" scale of logarithms.

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 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 definition of all terms used in cathode-ray oscillograph operation.)

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 value.

Piezo-electric Effect. A phenomenon exhibited by certain natural crystals (such as Rochelle Salt, quartz or tourmaline) as a result of which physical stresses in the crystal are set up by the application of an electrical potential. The reverse also applies.

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 interference between 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 an 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.

RADIO DICTIONARY

(Continued.)

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. The feed-back in such a system is "in-phase," as distinct from "negative feed-back."

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. Abberviated, S.I.C. The usual symbol is "K."

Static. See atmospherics.

Strays. Electric-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.

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.

Thyratron. A special form of gas-filled rectifier in which the plate current is controllable by a grid. The term "Thyratron" is a registered trade name and the term "grid-controlled rectifier" is usually used.

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.

Video. Vision. A term used to distinguish between the sound and vision channels in television transmission and reception.

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.

RESISTANCE CALCULATIONS

(Continued from Page 173.)

(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.

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 number of decibels Ndb corresponding to the ratio between two amounts of power P_1 and P_2 is

$$N\,db = 10 \log_{10} \frac{P_1}{P_2}$$

When two voltages E_1 and E_2 or two currents I_1 and I_2 operate in the same or equal impedances.

$$N\,db = 20 \log_{10} \frac{E_1}{E_2}$$

and

$$N\,db = 20 \log_{10} \frac{I_1}{I_2}$$

If E_1 and E_2 or I_1 and I_2 operate in unequal impedances,

$$N\,db = 20 \log_{10} \frac{E_1}{E_2} + 10 \log_{10} \frac{Z_2}{Z_1} + 10 \log_{10} \frac{k_2}{k_1}$$

and

$$N\,db = 20 \log_{10} \frac{I_1}{I_2} + 10 \log_{10} \frac{Z_1}{Z_2} + 10 \log_{10} \frac{k_1}{k_2}$$

where Z_1 and Z_2 are the absolute magnitudes of the corresponding impedances and k_1 and k_2 are the values of power factor for the impedances.

The accompanying table will enable the number of decibels corresponding to various energy and voltage ratios to be ascertained without calculation. Current ratios may be substituted for the voltage ratios given if desired.

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 factor 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.

(Continued Overleaf.)

It should be noted that the decibel equivalents on left for voltage ratios "up" or "down" are only correct when the input and output impedances are the same. For dissimilar impedances, a calculation along the lines indicated in the text will be necessary.

Decibel System (Continued.)

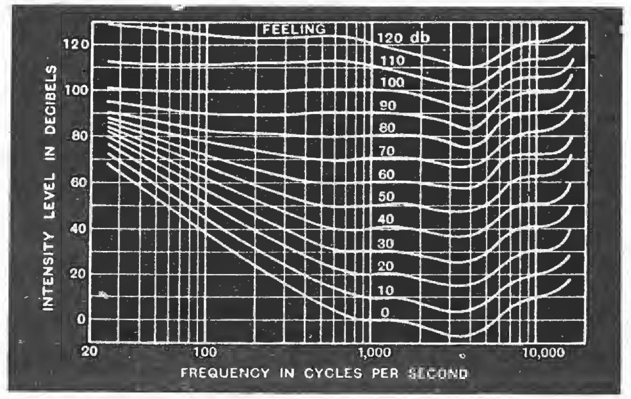
This is a much simpler and less unwieldly procedure than the older method of multiplying the gain factors together.

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 power index. In the examples above, $10 = 10^1$, $100 = 10^2$, and $1{,}000 = 10^3$, hence the levels are (10×1), $10 \times 2)$, and (10×3) decibels respectively. This should be of assistance to those unfamiliar with the use of logarithms.

SENSITIVITY OF THE EAR

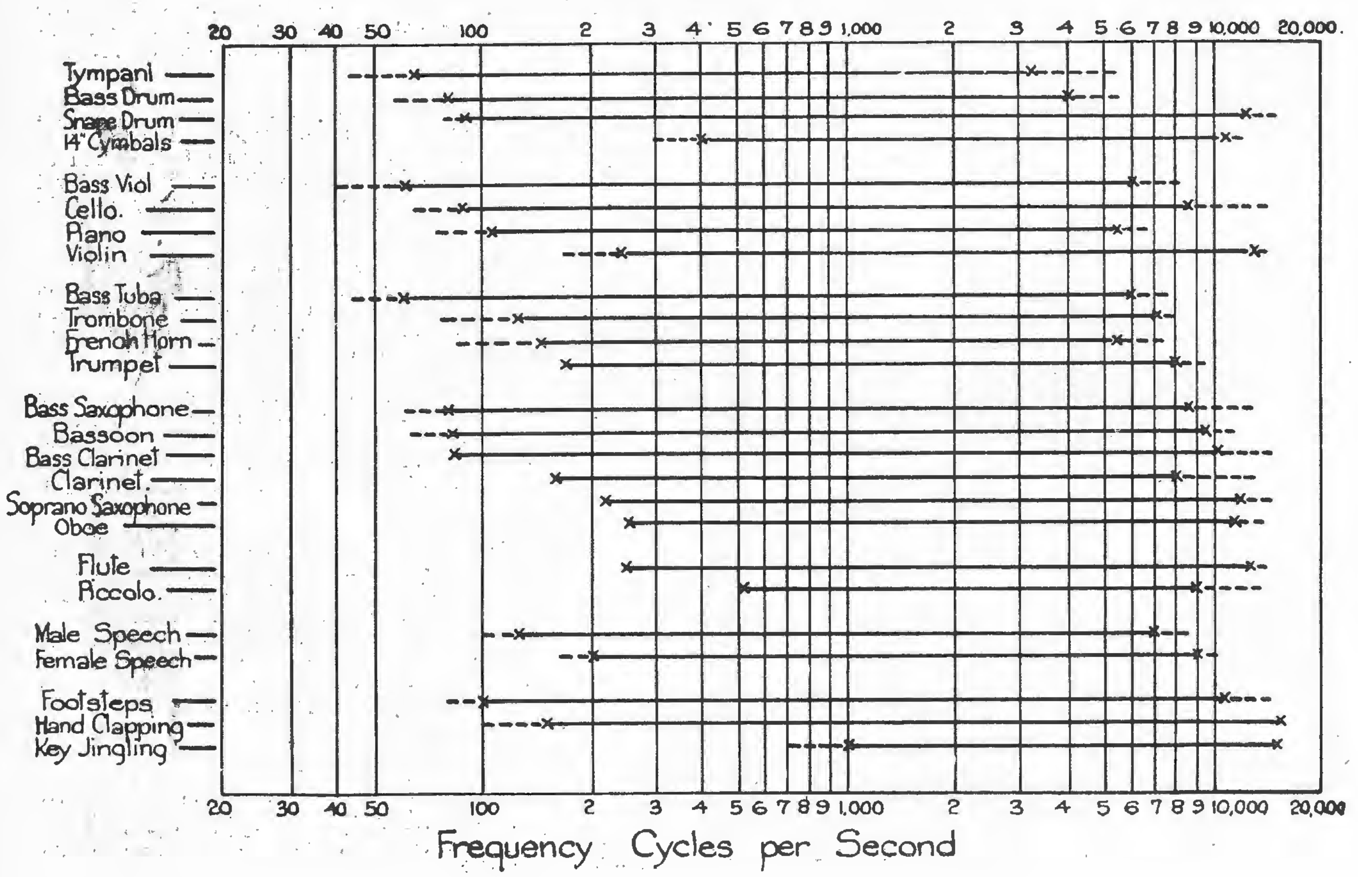
While the human ear is an extremely sensitive acoustic device it is also an extremely erratic one. No two ears are exactly the same when judged by "sensitivity" or frequency response curves. Each one is full of small peaks at differing frequencies. In addition the sensitivity of the ear will vary from 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.

A further factor to be considered is that the sensitivity of the ear varies considerably with the intensity of the sound being heard. The accompanying illustration gives an excellent indication of the manner in which the sensitivity of the "average" human ear varies over the audio frequency spectrum and also over a range of levels from "threshold" up to the point where a sound is "felt" instead of being "heard." This illustration, together with that showing the frequency spectra of various musical instruments, should be of value to all acoustic engineers.



The relationship between sound intensity (to the ear) and level at various frequencies.

Frequency Spectra of Musical Instruments



Electrical Interference with Radio Reception —and Its Suppression

A Paper delivered before the Victorian Division of the Institution of Radio Engineers, Australia, at the Technical College, Melbourne, on August 11, 1936.*

by
W. H. CONRY†
M. Inst. R. E. (Aust.)

THIS paper refers to the annoyance to broadcast reception caused by interfering disturbances having their origin in electrical plant or appliances. The necessity for low levels of such disturbance or noise energy in relation to the received signal is emphasised. The principal types of interference met with by investigators of the Postmaster-General's Department are referred to, and the procedure adopted in tracing the causes as well as the methods employed in suppressing or eliminating the interference are described.

The paper is divided into nine sections, under the following headings:—

1. Introduction.
2. Origin of disturbance.
3. Signal to noise ratio.
4. Causes of interference classified.
5. Types of interference and methods of suppression.
6. Causes not responsive to normal suppression methods.
7. Aerial treatment.
8. Tracing causes of interference.
9. Co-ordination of interests.

1. Introduction.

The successful development of a broadcasting service depends largely upon the ability of the programme transmitted to be received as free from interference as is possible. One of the principal contributing factors that mitigate against a successful service is the disturbing noise which frequently accompanies the received programme.

In some instances these disturbances are heard only when the radio set is tuned to a radio transmitting station, and this may lead the listener to suppose that the noise is caused by some defect in the transmitting station equipment. However, assuming the radio receiving set itself is in good order, it will be found that the noises are produced by electrical disturbances due to natural or artificial causes. The noises do not come from the radio transmitting station.

Interference or disturbance may be due to two causes, namely, natural static or artificial static. Artificial static, popularly referred to as "man-made," is the subject around which these notes have been written and referred to as electrical, or radio-inductive, interference.

Natural disturbances are those which occur during redistributions of the electrical state of the atmosphere or the magnetic state of the earth. They are known to radio listeners under the names of "atmospherics," "statics," "strays" or "X's."

Artificial disturbances may be experienced in practically all places where electrical power is used. Certain types of electrical machinery, apparatus and appliances in their normal or abnormal operation generate energy which is audible in radio receiving sets as noise. The generation of this energy is of no value in the normal use of the apparatus, and often is produced when the apparatus is in some way defective in its operation. Under these circumstances the removal of the defect benefits both the radio listener and the interfering apparatus.

As distinct from natural disturbance, artificial disturbance can be regarded as preventable, either by preventing the generation of the noise energy, or by absorbing the energy at its source, thus preventing it from causing interference.

2. Origin of Disturbance.

Disturbances in radio receivers have different characteristics which enable the experienced investigator to determine fairly accurately what the probable cause may be. The disturbance itself can reach the receiver via the aerial (by direct radiation) or via the mains into the power pack of the set itself. The cause in practically every instance is due to the current in an electrical circuit being suddenly interrupted or varied in a manner consistent with the normal operation of an appliance. This interruption or variation will maintain a change of potential of one portion of the circuit in relation to another or to earth. The result of these changes introduces into the electric system a new current—a parasite of high frequency—the effect of which, on being normally rectified by the detecting valve in a receiver, produces in the loud speaker an objectionable noise which interferes with satisfactory reception.

In some cases the noise may affect the whole wave band of a receiver. In other cases it would appear to peak at some particular part of the broadcast spectrum. Popular opinion would indicate that interference is more pronounced on the higher frequencies from, say, 1000 to 1500 KC/s. than below 1000 KC/s. It must not be overlooked, however, that some receivers have a sensitivity much greater on the higher frequencies than on the lower ones, which would tend to aggravate such a condition on the higher frequencies. To this must be added the listeners' preference, which apparently exists, for stations of relatively lower power on these higher frequencies. The reception of these stations, of course, requires more amplification of the received signals.

The characteristic sound of noise varies with different types of electrical appliances, and it is often possible for the experienced investigator to determine the cause of a given noise interference merely by listening to it. Appendix "B" is based on this characteristic.

3. Signal to Noise Ratio.

Since the inception of wireless, the most important feature in establishing a receiving station has been the necessity for erecting an efficient aerial.

As sensitive multi-valve receivers were developed, the need for efficient aerials became less important. By using smaller aerials, selectivity was improved and adequate signal strength was obtained by the amplification available in the sets. Short indoor aerials become popular and are still extensively used. In many instances they are quite satisfactory.

†Radio Inspector, Postmaster-General Department, Melbourne.
*This paper is reprinted from "Radio Review of Australia," Vol. IV, No. 9, September, 1936.

ELECTRICAL INTERFERENCE
(Continued.)

The last few years has seen an enormous increase in the use of electrical apparatus for both domestic and industrial purposes, and each piece of apparatus is a potential source of trouble to reception over a wide range of frequencies. Electrical appliances may therefore be regarded as miniature radio transmitters capable of seriously interfering with services which may be operating in the vicinity.

These transmitters of unwanted signals may put down a field strength far in excess of the signal from a desired broadcasting station, and, by increasing the amplification of the receiver, both unwanted and desired signals are magnified in equal ratio so that the "noise" will completely override the signal. In the case of receivers using high fidelity reproduction, the ratio of disturbance is exaggerated. The necessity for endeavouring to increase the ratio of the strength of wanted signal to that of unwanted noise is the problem involved in the question of interference suppression. If the ratio is high, no additional amplification will make the interfering noise louder than the wanted signal in the loud speaker; conversely, if the ratio is low, no matter how weak the amplification be, the noise will predominate in the loud speaker. By employing small indoor aerials the most favourable conditions for receiving radio noise, compared to radio entertainment, are produced. The aerial in such a position, is situated well within the electrical interference field and is therefore ideal for the reception of noise.

If the aerial is erected higher and outside the dwelling, the wanted signal will be stronger and the signal to noise ratio improved. Signals from a strong or local station will result in a high ratio and very little amplification will be needed. Signals from the weakest station may be received without excessive noise, or at least to a point where the noise can be tolerated. The whole problem of interference depends, therefore, on increasing this ratio of signal to noise. Weakening or suppressing the noise is an obvious remedy.

4. Causes of Interference.

Reception of broadcast programmes may be affected either by the normal operation of some particular device or by some defective apparatus. For the purpose of comparison, potential causes of interference have been arranged into two classes, major and minor. "Major causes" are intended to apply to those instances where the trouble affects a large number of listeners or the "wiping out" of whole towns, while "minor causes" are those which affect individual listeners or a few in a particular locality. Appendix "A" sets out this classification. Causes of interference are frequently recognisable by the characteristic noise which is heard at the loud speaker. These characteristic sounds have been classified into five groups and appear as Appendix "B."

5. Types of Interference and Methods of Suppression.

With few exceptions, cases of interfering plant can be successfully treated at the source by the application of suppressive measures. The suppressor may be embodied as part of the appliance itself during manufacture (making the device a non-interfering unit) or, as is the case in the majority of instances, by adding subsequently to the installation.

The most common appliances which investigators are called upon to prescribe treatment for are commutator type motors. By virtue of the rotating armature speed the sudden rapid change of current produces a magnetic

(Continued overleaf.)

APPENDIX "A"

CAUSES OF INTERFERENCE CLASSIFIED.

MAJOR CAUSES.

(a) **High Tension Transmission Lines.**
Transformer primaries; transformer bushings; defective insulation; loose tie wires.

(b) **Generating Stations.**
Alternators; D.C. generators; exciters.

(c) **Traction Services.**
Driving motors; compressors; contactors.

(d) **Rectifiers.**
Precipitators.

MINOR CAUSES.

(f) **Communication Services.**
Telegraph equipment; telephone ringers; auto. telephone dials; ringing keys.

(g) **Motors—D. C. and A.C. Commutator Types.**
Industrial motors; lifts; dough mixers; battery chargers; refrigerators; electric fans; rotary converters; motor generators; electric drills; blacksmith blowers; dental appliances; cinema apparatus.

(h) **Domestic Appliances.**
Vacuum cleaners; sewing machines; dish washers; floor polishers; hair driers, electric ovens; food mixers; beaters; electric washing machines.

(j) **Vibrating Apparatus.**
Hair clippers; vibrating battery chargers; electric bells.

(k) **Private Lighting Plants.**
Delco plants; hydro-driven generators.

(l) **Thermostat-Controlled Apparatus.**
Incubators; flashing signs; advertising displays; contactors; heating pads.

(m) **Medical Apparatus.**
Diathermy; "X" Ray; Violet Ray.

(n) **High Voltage Systems.**
Flour bleachers; pilot arc welders; neon signs; oil burners; ignition systems.

(o) **Defective House Wiring, etc.**
Loose fuses; dry joints, defective fittings.

APPENDIX "B"

CHARACTERISTIC SOUNDS OF CAUSES CLASSIFIED.

Whirring or Whining Noises.

Alternators; D.C. generators; exciters; driving motors; compressors; industrial motors; lifts; dough mixers; battery chargers; refrigerators; electric fans; rotary converters; motor-generators; electric drills; blacksmith blowers; dental appliances; cinema apparatus; vacuum cleaners; sewing machines; dish washers; floor polishers; hair driers; electric ovens; food mixers; beaters; electric washing machines; hair clippers; delco plants; hydro-driven generators.

Rattles, Buzzes and Rapid Clicking Noises.

Telephone ringers; auto telephone dials; vibrating battery chargers; ignition systems; loose fuses; dry joints; defective fittings.

Heavy Buzzing or Rushing Noises.

Precipitators; electric bells; diathermy; "X" ray; violet ray; flour bleachers; pilot arc welders; neon signs; oil burners.

Crackling or Spluttering Noises.

Broken filaments; time switches; transformer primaries; transformer bushings; defective insulation; loose tie wires; contactors.

Intermittent or Regular Clicking.

Telegraph equipment; ringing keys; incubators; flashing signs; advertising displays; contactors; heating pads.

ELECTRICAL INTERFERENCE

(Continued.)

field which, in association with the stray capacities in the machine, sets up a train of electro-magnetic waves. The operation of the motor is not affected except in cases of serious bad adjustment, where sparking at the commutator takes place. Even in perfectly adjusted machines, where no sparking whatever is apparent, high frequency current can be, and is, generated by a motor. This high frequency current reaches the receiver either by direct radiation, mains radiation or re-radiation, and may, according to the location of the appliance in respect to the receiver, have a field strength several times as high as that of the wanted signal. Figure 1 illustrates an oscillographic reproduction of the wave form of an A.C. supply voltage with "whiskers" of interference caused by a motor.‡

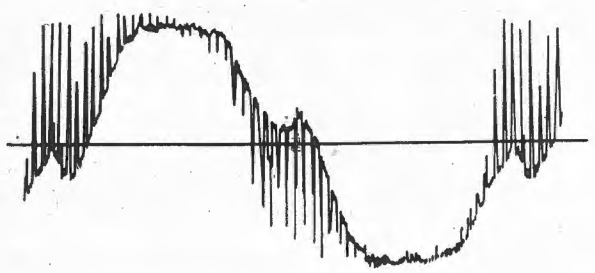


Figure 1.

The most effective and economical method of supressing high frequency current from appliances of the type under consideration is to by-pass the current by connecting condensers from the brushes of the machine to the frame. (See diagram, Fig. 2.)

In cases where,for some reason, it is impracticable to attach the condensers to the brushes of the machine, the suppressing unit may be fitted across the power point from which the appliance is being supplied with current. In these instances, however, it is important that a third wire be included in the power supply lead to the machine, which must be connected to the frame of the machine. The centre point of the suppressor is then connected to the frame connection on the power plug. Provision for three conductor leads, power plugs and sockets is now standard practice, and is specified by electrical authorities and fire underwriters as essential. Figure 3 indicates the method.

The foregoing arrangement applies equally to A.C. and D.C. commutator machines. Induction type motors, if in good mechanical and electrical condition, do not give trouble. As there are no connections to moving armature or rotor, little or no interference is generated.

Suppression of A.C. repulsion motors, however, differs slightly from the types described above. Connections to the commutator do not serve to lead in the current to the machine, but are actually short-circuited. Circulating currents are set up in the armature of the machine and the magnetic field produced interacts with that in the stator to produce motion. A suppressor connected across the brushes in these cases will have very little effect and a remedy therefore is to connect the suppressor across the input lead to the motor, but as near as possible to the machine.

The foregoing remedies may be safely accepted as suitable to all those types listed under columns "G" and "H" of minor causes (Appendix "A.") Appliances of the vibratory type, the circuit of which is alternatively made and broken, call for treatment of a slightly different nature to that already described. The make and break may be rapid or relatively slow, depending on the form of appliance. The remedy is simple and consists of a condenser of low capacity (say, 0.01 mF.) in series with a resistance of about 150 ohms connected across the contact.

Figure 4 shows the arrangement. The sudden change in potential, when the contact operates, causes an instantaneous flow of current in the circuit; generating a train of high frequency current which travels along the mains. Each occasion the contact is made or broken an objectionable click in the receiver is heard. The object of a condenser, therefore, is to absorb the current surge

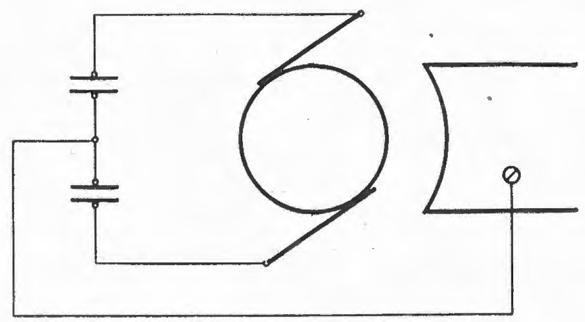


Figure 2.

or "backlash," enabling the potential to fall less sharply to zero. The resistance in series with the condenser prevents the discharge becoming oscillatory in character by rapid dissipation, otherwise the effectiveness of the remedy would be lost. The necessity for employing a small capacity will be apparent when it is remembered that a condenser can pass quite an appreciable amount of current, and in A.C. circuits sufficient current may flow across the contacts to maintain the device in permanent operation. A condenser of 0.01 mF. has usually been found sufficient.

At this juncture it is of interest to note that investigators have found that suppressors have been removed from electrical devices causing disturbance on the grounds that the current consumed is too great. The conclusion is unsound, and unfortunately is frequently arrived at by people who are in charge of electrical plant. The error is, however, appreciated when reference is made to standard formulae.

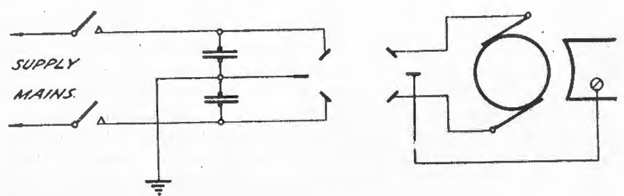


Figure 3.

Suppressors recommended by the Department vary in capacity from 0.01 to 2 mF. The value selected for a particular case depends upon the nature and extent of the trouble experienced and the smallest capacity found suitable is always recommended.

The standard formula for computing current flow through a known capacity which is connected across an alternating current supply is:—

$$I = \frac{E \times 2\pi F \times C \times 1{,}000}{1{,}000{,}000}$$

when I = current in milliamperes
E = supply voltage
2π = 2 × 3.14
F = frequency of supply in cycles per second
C = capacity in microfads.

‡Reproduced from paper by Col. A. S. Angwin, British Post Office, London.

ELECTRICAL INTERFERENCE

(Continued.)

With this formula in mind, it will be of particular interest to compute the current passed by 0.2 and 2 mFds., connected across a 200 volt 50 cycles supply. In these cases the formula shows that the current values are 12.55 mA. and 125.5 mA. respectively. The current therefore, is directly proportional to capacity and voltage.

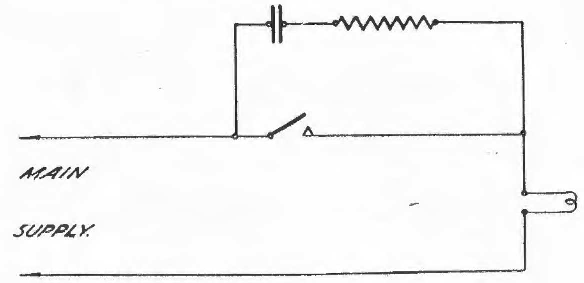


Figure 4.

As suppressor devices are generally connected across inductive loads, their inclusion in the circuit improves the power factor, with the result that in many cases they are advantageous, quite apart from the suppression accomplished.

It should also be remembered that suppressors connected directly to the offending appliance only take power, if any, when the device is in operation, for when the switch is "off" the suppressor is out of circuit.

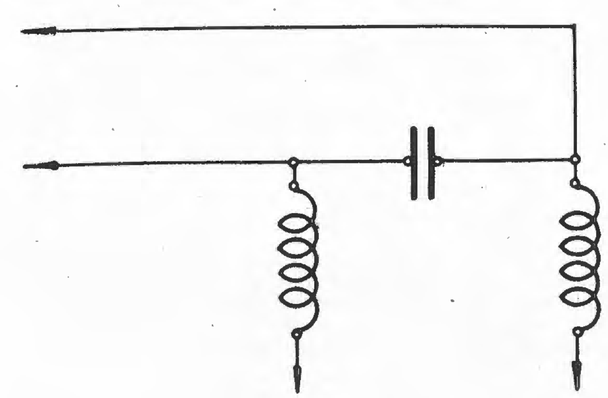


Figure 5.

Obstinate cases of interference from causes of the kind referred to prior to the digression on the current-drawing properties of suppressors may demand more drastic treatment, and though instances are fortunately rare, the remedy shown in figures 5 and 6 may be found necessary. In both of these revised arrangements it will be noted that an air-core R.F. choke or chokes have been inserted in the supply lines to the device in order to filter out the parasitic interference ripple which would otherwise tend to travel along (or be radiated by) the mains.

The foregoing comments apply equally to devices classified in Column "L" of minor causes. In Column "N" each of the devices mentioned depends upon high voltage ranging from 3,000 to 50,000 volts for their normal operation, and special treatment is required according to circumstances. These are dealt with separately in the following paragraphs.

Neon signs of the high tension gas discharge type may cause interference under certain conditions. Trouble from these sources is comparatively rare in this country, but reference is made in literature from overseas to serious causes being experienced. Instances met by investigators here have disclosed some obvious defect in the installation which, when remedied, overcame the trouble. The rather rugged character of the sudden changes of current brought about by its discharging momentarily and re-striking each half cycle, produces a high frequency oscillation which will be radiated by the H.T. wiring and the sign itself, but usually at a frequency well outside the broadcast band. It has been found that 11 mm. tubing signs produce serious

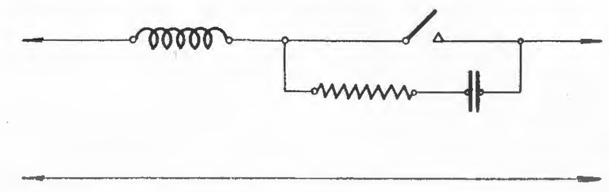


Figure 6.

interference and the use of a low frequency choke of about 50 H. connected in the centre of the H.T. circuit has been found necessary. In addition, a suppressor unit across the primary leads is required.

An important feature regarding the installation of neon signs is the necessity for running low tension and high tension wiring in screened cable and effectively earthing it.

Bleachers or ozonators used for bleaching flour or purifying air are, without exception, unless suitably treated, a serious cause of disturbance. Although classified as a minor cause, occasions have been met where the circumstances would undoubtedly place the case in a very major position. Bleachers depend upon a high voltage spark discharge in an airtight metal chamber for their operation. A current of air is passed through the chamber, which is electrically broken up into its constituent gases. The metal spark chamber fortunately offers natural assistance for simple suppression methods to be applied. The high frequency currents set up by the spark discharge are fed back into the low tension wires and re-radiated over the supply system. The suppressor necessary is a combination of chokes and condensers inserted in the supply mains to the primary of the bleacher, with the centre point of the condensers to the metal spark chamber and earth. (See Fig. 7).

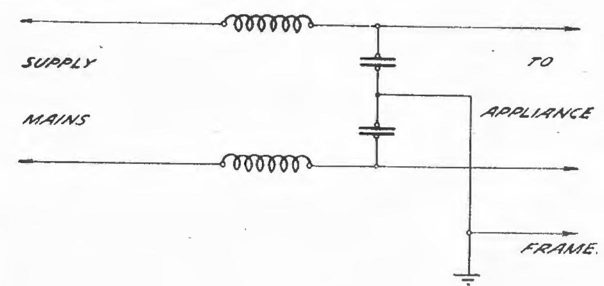


Figure 7.

Pilot arc welders are comparatively new welding devices employing A.C. for their normal heating function. They have incorporated a small H.F. spark to start the arc on the welding electrode.

Wireless men whose memory can go back 20 years will recognise a very familiar circuit as that enclosed in the dotted line of Fig. 8, which is the circuit arrangement of a typical pilot arc welder. Little imagination is needed to appreciate and realise the serious effects that appliances of this type can have on reception, particularly when the supply mains offer such an effective radiator. Experiments are still being carried out to ascertain an economical method of suppressing the effects caused.

(Continued overleaf.)

ELECTRICAL INTERFERENCE

(Continued.)

Only partial elimination has been accomplished, by altering the frequency of the oscillatory circuit incorporated in the appliance.

Oil Burners, which are now becoming popular installations in central heating systems, contain a type of thermo-controlled device which enables the boil of the plant to be maintained at a uniform heat by occasional periods of heating. The fuel for the jet is obtained from a reservoir by means of an electrically-driven pump. The oil itself is ignited by a spark from an ignition system. This ignition is usually a discharge across the air gap of a H.T. transformer of anything up to 10,000 volts.

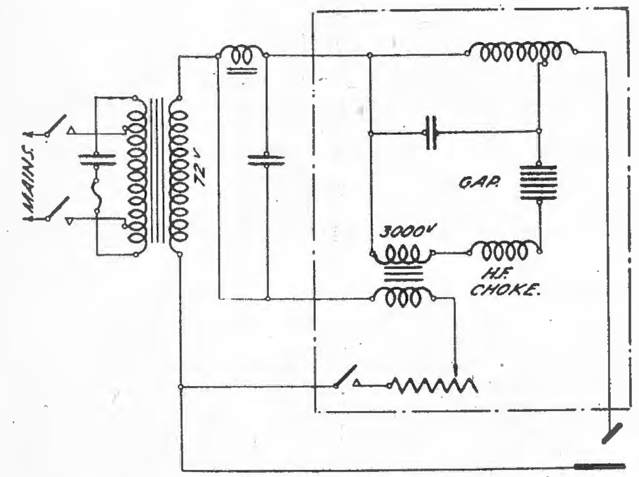


Figure 8.

Suppression of the motor is, as already described, accomplished as in Fig. 2, but the effects of the ignition disturbance can only be remedied either by the insertion of a resistance between the electrode of the gap (a motor car spark plug suppressor, for instance) or by treating the primary of the supply to the H.T. transformer by a suppressor combination of chokes and condensers similar to that prescribed for flour bleachers, or by both.

Electro-Medical apparatus is one of the real worries of an investigator. Not that the effects of disturbance cannot be remedied, but that the co-operation needed is a very deterring factor. The most important piece of medical apparatus that investigators meet is diathermy equipment.

Diathermy equipment is without doubt the nearest approach to a small spark transmitter that is made. The circuit is fundamentally similar to that portion of Fig. 8 contained in the dotted lines, while the more recently developed diathermy apparata, designed to operate on short waves, are virtual short-wave wireless transmitters rated with approximately 200 watts output.

Experiments have been carried out in many countries, including Australia, in an effort to find a simple, effective and economical method of treatment, and it is interesting to note that all opinions are unanimous that total screening of the appliance and patient is necessary.

To prove the efficiency or otherwise of this screening method, a series of tests were carried out by officers of the Wireless Branch, and a leading firm of diathermy manufacturers in Melbourne. It was found that screening of the appliance only was effective, but the patient on being placed under treatment, became a very efficient radiator, nullifying any advantage gained by enclosing the appliance only. On constructing a cage large enough to contain both patient and appliance, the effects sought were obtained.

The British Post Office officials experimentally produced equipment employing a closed circuit which proved non-interfering, but the expense involved discounted any desire on the part of manufacturers to adopt the method found practical.

The screening while important, does not present very great difficulties. It is essential that walls, ceiling, floor, doors and windows be effectively covered, and electrically connected. Care must be taken to protect the patient from coming in contact with the screen, and with this object in view, it is recommended that the wire gauze should, if possible, be concealed beneath the surface of the wall (i.e., behind the plaster) under the floor, etc. What is known as fly wire has been recommended, and, in each instance of its adoption, complete success has been attained.

It is noteworthy that the recommendations abovementioned were adopted by the Warburton Sanatorium Authority when their recent extensions to that institution were carried out. At present they have a chamber containing two diathermy machines screened in such a way that only the screens over the windows are seen, and even they may be mistaken for ordinary fly screens. Total elimination of radio disturbing noise has been accomplished.

Medical practitioners in Sydney and Melbourne, too, have adopted the suggestions and their clinics are immune from causing interference to nearby listeners.

There is now available a form of metallised paper which it is considered will materially assist in lowering the cost of treatment to diathermy chamber screening. Rolls of this material may be obtained in standard lengths and widths similar to ordinary wall paper and at comparable costs. In addition to the screening suggested above, chokes and condensers must be used. These are connected in the power supply to the diathermy apparatus.

X-Ray apparatus is popularly regarded as a severe source of disturbance, but no cases yet met by me have confirmed that impression. In D.C. areas where a rotary converter was the source of supply to the X-ray transformer and tube, the converter was the cause rather than the high voltage produced in the equipment.

Violet Ray equipment of the small or portable type which depends upon a local buzzer for interrupting the primary of the high voltage transformer, may cause interference over a considerable distance, but the effects caused can be reduced considerably by the inclusion of a choke and filter arrangement similar to that for diathermy. Total screening of the appliance and patient is the most effective means for overcoming the trouble.

Defective house wiring is a source of worry to many investigators. Some seem to have developed an additional sense and can trace the cause while others are still thinking about it. "Fresh air" connections or "dry joints" do still exist in some installations, despite the rigid requirements of the fire underwriters' regulations, and have been found in the most peculiar and inaccessible places. Fuses are perhaps the most common faults, and this can perhaps be understood when it is realised that most people have some idea how to renew a fuse, but most people do not know how to renew a fuse properly. Perhaps it is nervousness that makes them gently handle the device for fear of shocks. Perhaps it is a good thing that this fear does exist.

The hopeful of the family is usually the responsible party, and this information is learned from the proud parent very early in the investigations. Defective fittings such as switches, power points, lamp holders, etc., too, are frequent causes. Constant use of power points for electric irons, vacuum cleaners and other portable equipment tends to loosen the connections on switches and sockets. Lamps with dirty contact pins are also a contributing factor. All these causes can only be overcome by repair or renewal.

ELECTRICAL INTERFERENCE

(Continued.)

Communication services account for a small proportion of trouble, particularly in country centres or where the signal to noise ratio is low. Morse equipment at both post office and railway establishments is responsible for this cause. No difficulty is encountered in having matters remedied as a working arrangement exists whereby immediate attention is given after the most effective treatment is found.

High Tension Services. One of the major causes of interference to radio reception is that due to the proximity of listeners to high tension lines, or to some defect developing in the service to these lines. When a defect develops, it is not surprising that investigators are early on the scene because so many complaints reach headquarters in so short a time that an indication of extensive trouble is soon apparent.

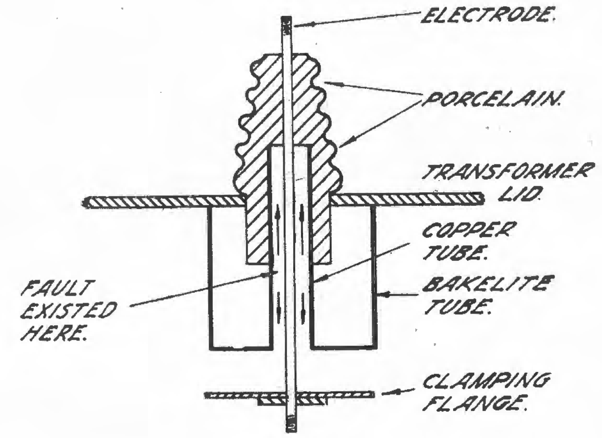


Figure 9.

The causes usually are one of three defects, developing in transformers, insulators, or tie wires, which would not show up in a normal way in the generating station meters. Interference investigators have been regarded as the best friends of power supply authorities, as, in very many cases, the trouble found was the forerunner of more serious trouble, and consequent dislocation and expense.

The reason for classifying H.T. trouble as a major cause is because the area served by these lines is many miles in length, frequently passes through the main thoroughfare of a town, and consequently affects a relatively large number of listeners, even to the extent of wiping out all reception of broadcast programmes.

A classical example of this condition existed some six years ago on the Mornington peninsula. Complaints were received from listeners north of Mornington to some districts near Sorrento, that reception of all stations was practically wiped out. The supply in question was from the State Electricity Commission standard 22,000 volt line. The majority of listeners, who lived in the towns through which this line passed, resided on the Pt. Nepean Road. A spur single-phase line off the main 3-phase one at Dromana served a 10 KVA transformer about two miles south. This transformer was the cause of the Mornington peninsula disturbance, and was overcome by changing the transformer.

I was privileged to be present at the examination of this transformer at the S.E.C. Laboratory at Spotswood where the actual cause was sought, and it proved to be a most interesting one. All the local conditions were reproduced on the test bench, and voltage in gradual steps from 5000 to maximum 22,000 were applied. It was ultimately found to be due to an electrostatic discharge between the electrode and a metal housing which formed a part of the complete insulator bushing, leading through the transformer's metal casing to the primary winding. Fig. 9 illustrates the location of the fault.

The remedy was to place a metal spring clip between the electrode and metal tube. The outcome of this test was that all similar transformers were opened up and the same treatment applied.

Insulators have been suspected as potential causes of H.T. trouble for many years, but owing to the fact that normal tests applied would not show up any defects, authorities were hard to convince. It is, however, gratifying to learn that this aspect alone has engaged the scientific attention of engineers, and it is with pleasure that I refer to the work of three of our own Victorian State Electricity Commission Engineers, the result of whose investigations are recorded in a paper delivered about this time last year before the Institution of Engineers, Melbourne Division.§ Their investigations showed that discharges causing interference occurred at three places—at the conductor and tie, at the pin, and at the edges of the joints between multi-part insulators. The conductor and tie were the most important parts found to require treatment, as the greatest severity is reached when the conductor and tie are held clear of the insulator, or touch the insulator at points only. The remedy for the discharges thus permitted, is to provide a conducting surface in intimate contact with the porcelain on all the areas which may be occupied by the conductors or other electrodes.

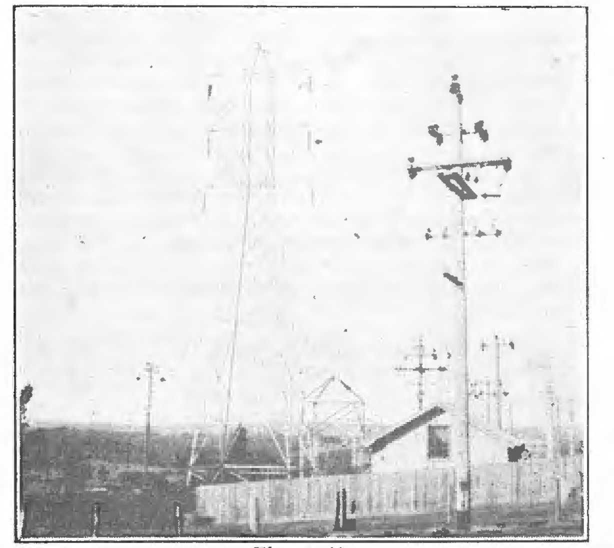


Figure 10.

Although metal spraying was applied to two experimental insulators, it was found that some discharge occurred at the edges of the metal coating.

Their investigations, however, pointed to the necessity for any conducting coat being tapered off to avoid sharp transition from high conductance to high resistance. Leading manufacturers are now concentrating on the design of interference-free insulators.

Extensive observations have shown that interference from H.T. lines supported by suspension insulators is much less frequent than from the pin type. The illustration in Fig. 10 shows both types.

Fig. 11 shows an investigator using a sensitive detecting instrument immediately beneath the main 132,000 volt

(Continued overleaf.)

§"Radio Interference from High Tension Lines," by S. A. Prentice, B.E.E., J. R. Callow, B.E.E., and W. W. Miller, B.E.E.—Paper No. 531.

ELECTRICAL INTERFERENCE

(Continued.)

Yallourn-Melbourne line, and almost adjacent to one of the main 22,000 volt breaking-down stations at Ringwood.

Fig. 12 illustrates a structure where it would be excusable if trouble did occur. It shows a standard aerial substation carrying 22,000 volt H.T. line, 400/230 V. service supplies, and junction feed of H.T. single phase 22,000 volts, and 1500 volt D.C. feeders of the suburban trains in the background. Further references to High Tension effects are made in Section 6.

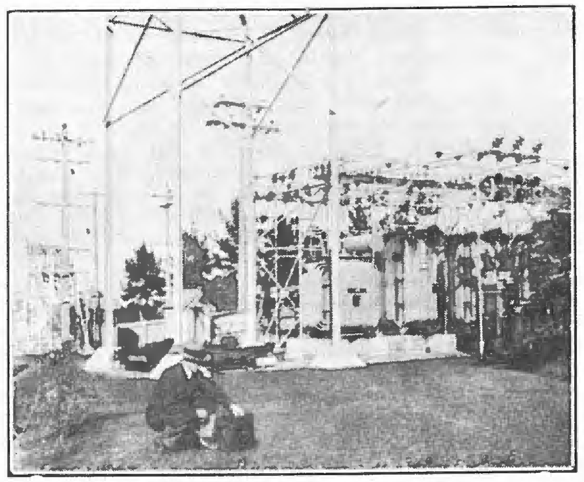


Figure 11.

Generating stations are a serious cause of disturbance to radio reception unless adequate precautions are taken to guard against trouble. Some power supply engineers anxious to make their plant free from interference have hung condensers of various sizes and capacities all over the equipment, but usually managed to omit the correct place. The use of a special detecting set is essential, and by its use the investigator can "see" what he is doing. (Further reference will be made to this set under the heading "Tracing Causes of Interference.") The natural noise of the moving machinery will not permit him to hear the result, but the intensity meter gives him visual results.

In D.C. generating stations commutation is usually the direct cause. The first move in power station treatment, therefore, is to arrange for commutators to be free from sparking. This might even necessitate turning the commutator "true." Brush seating on the commutator must be snug and free from any vibration. Where sparking exists it indicates that the brushes are not in the correct electrical relationship to the pole pieces. A mark is usually placed by the makers on the brush rocker and frame supporting it, which indicates the correct position for the rocker. This position, which may be the correct electrical position, does not necessarily mean the correct "radio" position. The rocker may require to be advanced or retarded a fraction of an inch. The position found where least noise is received is the correct radio position, and must be the correct electrical position also. The application of a suppressor unit to the brushes, and centre point to the frame of the generator, should, under these conditions, eliminate all disturbance from the generator.

The foregoing comments apply, of course, to generators in good condition. Faulty armature coils, for example, will cause an electrical ripple that cannot be removed without repair to the machine.

Alternators, generally speaking, do not cause trouble, but disturbance is usually attributable to the exciter associated with the alternator. Treatment of the exciter is exactly the same as in the case of the generator just described. Occasions have been met, however, where an A.C. roar affects the reception of nearby listeners. In these instances, suppressor units were attached between the brushes of each phase and the neutral (if not earthed) and the frame of the machine. This had te effect of removing te disturbance.

Interference from traction services is caused by the driving motors, compressor motors and in some instances contactors. In some countries elaborate precautions have been taken to prevent disturbances from street cars being radiated. Conditions for this form of disturbance are rendered ideal because the feeder line being in favourable inductive relation to the supply mains, for long distances, propagates the noise right into the listener's home. Large choke coils have been constructed to carry the total current of the car, and erected at the base of the trolley pole on the car roof. Information from other countries shows that by re-arranging the field coils of the motor, i.e., the driving motor, in such a way that the current passes first through the field coil, then the armature windings to earth, is the best condition for least interference. The field coils then act as a choke.

This arrangement was tried on the cars on one of Victoria's provincial towns' service, but it was found that, in addition, suppressor units were necessary across the brushes. In another town, it was found that suppressors alone accomplished all that was necessary. Compressor motors responded to the same treatment, namely, suppressors only.

Figure 12.

The surge of current when the contactor of the Melbourne trams is broken was a cause for considerable concern to the Tramway Board for some time. Likewise, equal concern was caused to listeners along any tram route.

The contactors on the big city cars are such that, as the motor is started, resistance is gradually reduced as the speed of the car is increased, but, on cutting off the current, it is not gradually increased over the starter contact, but operates the contactor in the form of a circuit breaker, suddenly interrupting the full load taken by the car. A sudden "plonk" would be heard in neighbouring receivers, and at peak periods the succession of "plonks" was anything but pleasant.

ELECTRICAL INTERFERENCE

(Continued.)

All attempts to squelch the spark caused by this device failed. Choke coils were useless, condensers superfluous, and the listeners affected were forced to try remedial measures themselves. It was ultimately demonstrated that a simple form of receiving aerial re-arrangement (referred to later) completely overcame the trouble, and the tramway authorities were saved what promised to be anything up to £60 per car for special treatment to their 700-odd cars.

One serious form of interference from tramway equipment occurred some considerable time ago, when the reception by listeners in East Malvern was literally wiped out. The cause was due to a "chattering relay" in an equaliser box, which is installed for the purpose of sectionalising the track in the event of an excessive overload as would result in the case of an overload trolley wire contacting with earth. The chattering was actually the result of a partly burnt-out relay, and the trolley wire in this instance acted as a most efficient radiator over the whole of the East Malvern area served by the tramway system.

Rectifiers, particularly those utilising high voltage, though not in very general use, are serious offenders of radio reception.

Dust precipitators, such as the Lodge-Cotterill type as used by power stations and large industrial concerns, employ this form of rectifier. The equipment comprises an electrode suspended in the centre of large chimneys or smoke stacks to which a high D.C. potential is applied. The function of these electrodes is to attract the small particles of carbon dust (smoke) and retain it (it ultimately falls to a receptacle) rather than permit it to issue forth through the stack to the discomfort of all neighbouring establishments and dwellings. Yallourn Briquette Works are equipped with two of these precipitators.

The rectifier comprises a rotating disc revolving at a synchronised speed which permits only each positive half-cycle of alternating current to be passed to the positive electrode in the stack. The intense spark caused by the 60,000 to 100,000 volt potential, apart from causing the electrode to act as a direct radiator, feeds back a high frequency current into the service mains and is radiated over a considerable distance. In the case of Yallourn, the whole town was affected.

A high frequency choke consisting of 100 turns of ¼in. copper tube wound on an 18in. former connected in the lead to the electrode, and the whole device enclosed in a close meshed cage, removed the trouble.

Another major cause of interference is due to **broken filaments of street lighting globes.** Unfortunately, this trouble has been a serious matter of late and concerns a particular type of globe recently placed on the market. In marked contrast to other globes of similar voltage, the filaments of which, when broken, droped to the bottom of the glass container, the filaments of these lamps (being too good, we will say) merely broke, but retained their incandescence by the current bridging the small gap in the broken filament wiring. The condition would remain unchecked until the lamp was extinguished. The globe causing the trouble would then be found the following evening, when no light would appear owing to the open circuit in the filament.

The serious nature of this trouble is brought about by the number of these particular globes now in use.

6. Causes Not Responsive to Normal Suppression Methods.

Under this heading are causes attributable to **high tension interference** not economically curable, **local absorption effects and defective receiver installations.**

In these circumstances improving reception conditions in practically every case depends on some form of aerial re-arrangement or in isolated instances, treatment to the incoming supply mains.

The noise level in receiver adjacent to high tension lines may be due to direct radiation or conduction. In localities where the high tension mains pass through the main thoroughfare a combination of both may be the cause. The erection of high tension lines and low tension mains on the same poles, separated by approximately 12 feet, is now a standard practice. Any direct radiation from the H.T. lines is quite capable of being induced into the low tension lines, which ultimately feeds into the listeners' dwelling and even into the radio set power pack itself.

To prove whether the disturbance is radiated or conducted, both aerial and earth should be removed from the set and the terminals bridged. Absence of noise will indicate the trouble to be radiated, but a continuance will prove that the disturbance is being brought in by some other means—namely, the supply mains.

To check this channel for trouble reaching the power pack, high frequency chokes should be inserted in the mains to the set. Filter chokes are available on the market or a pair of 150 or 200 turn honeycomb coils (wound with fairly heavy wire) are quite suitable.

To reduce the effects caused by direct radiation, it is advisable to utilise an aerial erected outside the dwelling as high as convenient, and, if possible, at right angles to the power supply or H.T. line, and to screen, balance or neutralise the lead-in portion of the aerial.

Absorption of signals due to "looping" of supply wire has some weird effects on reception, and, as such, must be treated on its merits. Instances have been met when the signals from some stations are completely absent on a particular receiver and in other instances predominate. The effect can only be described or compared to that of a wave trap of the Rejector or Acceptor types when incorporated in the aerial system of an installation.

It is interesting to note, however, that all instances so far met have concerned installations using indoor or enclosed aerials. The frequency of the desired station in these instances happens to have coincided with the frequency of some portion of the electric wiring in the house, which absorbs energy (in the case of the "rejector" phenomena) and deprives the indoor aerial from obtaining its fair share of the radiated signal. In the case of the acceptor action, the wiring tends to function as a tank circuit assisting the enclosed aerial; rendering reception of a particular station more than ordinarily strong. In each case, however, operating a switch on any other portion of the same electric light circuit completely upsets the "tuning" of the supply circuit and invariably changes the effect from one station to another.

In cases where the complaintant for some personal reason desires to retain the indoor aerial, though the inadvisability of such is apparent to him, it becomes necessary to deliberately upset the circuit resonance by introducing additional inductance in the form of a H.F. choke. This choke should be specially made to carry the total current likely to be necessary on the circuit. Such an expedient, however, is entirely uneconomical.

Other instances of a peculiar nature and with somewhat similar effects are to be found in dwellings with iron roofs, where a poor shielding effect is brought about. The result is to create a noise similar to that one would expect to find on faulty electric mains.

The existence of this peculiarity is usually not discovered until something abnormal happens in the building itself, such as the structure of the house becoming in some way slightly dislocated or intermittently altered.

For example, one would never imagine that the operation of a bath-heater would render broadcasting almost unrecognisable, but this is true in every detail.

(Continued overleaf.)

ELECTRICAL INTERFERENCE (Continued)

The case in point was a dwelling with an iron roof through which passed the regulation flue with an inner flue from the bath-heater. The water rushing through the pipe caused the inner flue, which was naturally earthed, to contact intermittently with the outer flue, which was a permanent fixture to the metal roof through the normal flashing. The intermittent earthing of the roof gave an intermittent shielding effect to the indoor aerial, and reproduced the same noise as would be heard when two telephone wires are rubbing together.

Another interesting case was that of a crystal set being the direct cause of interference to an all-electric set in the same house. The confusing fact that only one station was affected made the investigation rather difficult, but it ultimately transpired that a member of the family had a crystal set installed in his own room, which was tuned to the particular station in question. On each occasion that his room was passed a vibration was set up, causing the point of the crystal to make and break. The noise in the loud speaker was similar to that indicated by a broken connection in the electric set itself.

In absorbing and shielding effects of the nature mentioned, outdoor aerials completely overcome the trouble.

Bad receiver installation is, unfortunately, a cause for considerable time being spent by investigators. In addition, numerous instances of defective receivers exist.

The subject of faults in broadcast receivers could very well be made the subject of an interesting paper.

7. Aerial Treatment.

It was pointed out earlier in these notes that a high signal to noise ratio depended on the ability of the receiver's amplification to increase the signal to a desired level, and that aerials erected indoors were situated within the electrical field of interference re-radiated from the house wiring. Outdoor aerials, too, can be similarly affected, but to a lesser degree, due to the fact that more of

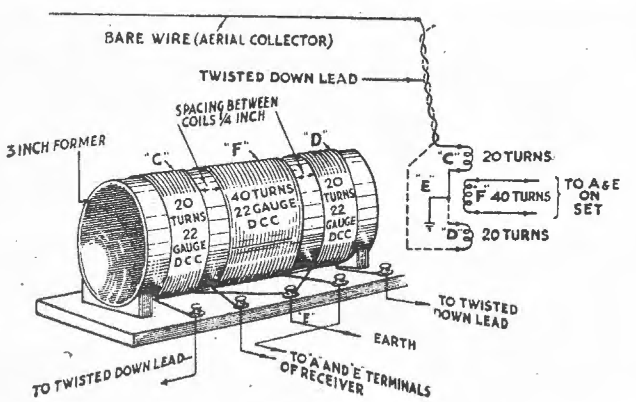


Figure 13.

the open wire is available for normal pick-up of the desired signal.

The lead-in of the ordinary outside type of aerial must come within the influence of re-radiated noise from a position approximating its point of entry to the building till it reaches the receiver. It will be apparent then that if some treatment is made to the "down-lead" or "lead-in" of the aerial, an improvement in conditions should result.

Placing the aerial, therefore, electrically speaking, as far from interfering mains as possible is what is desired. This may be accomplished by employing an aerial of slightly different design to the normal types of inverted "L," "T," the popular "picture rail" type, indoor or enclosed aerial.

Several types of aerial are now available in kit from which, by their use, it is claimed, will banish all forms of interference. The merits and demerits of the types and claims mentioned will not be discussed, but mention might be made of the simple arrangement which in a number of instances has been suggested by investigators as a possible remedy. The "neutralised" aerial is the one referred to and is shown in Fig. 13.

The arrangement consists of a flat top about 30 feet in length to which is attached as a "lead-in," a pair of twisted and insulated conductors of equal length, one wire of which is only connected to the bare or open portion of the aerial. (Twisted twin flex is quite suitable). The other ends of the "lead-in" are connected, via a coupling unit to the receiver. The coupling unit is a coil wound on a 3in. former comprising a split primary with centre point earthed, and a secondary for connection to the aerial and earth terminals of the set.

As each of the wires of the twisted pair is connected to each of the primaries, and only one of the pair connected to the aerial, a neutralising effect of the "lead-in" is brought about, which renders the effective pick-up only on that part of the aerial electrically exposed—namely, the flat top or open part.

It is admitted that this arrangement weakens signal strength when compared with that received on an ordinary aerial of similar physical dimensions, because its effective length has been reduced by the length of the neutralised "lead-in," but the proportion of noise reduction more than recompenses the decision to make the change. The question, therefore, is whether one prefers strong signals and high noise, or weaker signals and low noise. This arrangement is the one found quite effective in overcoming the trouble caused by trams in Melbourne, as referred to earlier.

8. Tracing Causes of Interference.

Complaints of interference are investigated individually, and are always commenced at the listener's address. If the disturbance is present at the time of the visit, the cause is sought without further delay. If not in evidence at the time of calling, a further visit is arranged depending on the circumstances which the investigator will ascertain. Instances are common where a number of visits is necessary.

Each investigator is equipped with sensitive detecting equipment. Two types are at present in use. The Tobe model 233 Noise Locator is designed to respond to extremely weak radio frequency impulses. The set employs three stages of R.F. amplification, detector, a stage of resistance-coupled and a stage of transformer-coupled A.F. amplification, and signals are picked up on a collapsible rod aerial. A loud speaker is internally fitted and an a.c. voltmeter used for giving visual indication of noise intensity.

Volume control is obtained by a potentiometer varying the voltage applied to the screens of the amplifying tubes. The average sensitivity of the set is from one to five microvolts over the 1600-500 KC/s. band. The set operates from dry cells which are contained in the set case.

Another Tobe model incorporating a signal generator and calibrated in modulated microvolts per metre is also used. The type 233, which is now normally used, does not contain that refinement. The advantage of being able to measure the intensity of a signal in modulted microvolts per metre at any particular location is that tests can be repeated with reasonable accuracy, a ratio of wanted signal to unwanted noise can be compared, and that means are available for determining what signal is desirable in a particular locality for overcoming what may be regarded as the normal noise level.

In addition to being able to pick up signals on the special collapsible aerial supplied with the Tobe set, provision is also made for a "mains aerial." The advantage of such an arrangement is that while tests may indicate a clear condition when the normal aerial is used, interference may still be conducted to the complainant's set. The mains aerial, therefore, is capable of detecting this cause, as it enables tests to be made with the Locator connected to the mains. The arrangement of connections is shown in Fig. 14.

ELECTRICAL INTERFERENCE (Continued)

The second type of detector, the Siemens-Halske interference locator, is a 2-circuit receiver using a screened grid valve in the H.F. stage, a detector, and transformer coupled L.F. stage. Two frequency ranges are covered; a change-over switch providing for 1500 to 500 KC/s, and 400 to 150 KC/s. ranges. Headphones are supplied, and the instrument operates from dry cells contained in the carrying case.

Pick-up is provided either by an enclosed loop or flexible extending aerial. The flexible aerial permits the investigator to trace comparatively weak noise by placing the end near to lines or conduits suspected as potential conductors of noise.

The natural directive properties of the enclosed loop aerial in certain favourable conditions enable a rough bearing to be taken.

Each of the motor cars employed for interference investigation is equipped with a standard car radio superheterodyne, arranged for cutting out the automatic volume control when desired. This feature is designed to circumvent false indications which would prevail if A.V.C. were used.

Noise in a complainant's set is reproduced in the test set, first alongside the complaintant's receiver, then outside the premises, and the supply line traversed in a direction in which the intensity of the noise shows an increase. If the complainant resides between the source of supply and the source of noise, the intensity of disturbance will fall off sharply as the position of disturbance is passed. If the complainant resides beyond the source of noise (in relation to the source of supply and his own location), then the noise increase on approaching the position where the offending appliance is installed, maintains that condition for a considerable distance in the direction of the source of supply.

The investigator will satisfy himself by repetition of tests that the offending appliance is in a particular premises, and permission will be sought from the proprietor to allow the investigations to be carried out in the establishment. It may be necessary to request that certain appliances be switched off, until the one causing the trouble is ultimately found. In the case of more than one cause, each appliance will be tried in turn, and proved troublesome or clear. The owner will then be invited to listen to the noise caused, and his permission sought to have a suppressor temporarily fitted. When this is done, he will then be invited to listen to the results, and the suggestion is then made to have installed a suppressor of the type demonstrated.

The foregoing notes refer to the average type of complaint.

In the cases of major causes where power supply authorities or other similar concerns are involved, the co-operation barrier has not to be encountered. All concerned are aware of what is necessary and efforts are centred in the one direction.

In the case of H.T. troubles, the disturbance is usually severe enough to be followed for a considerable distance in the car. Where there is a gradual rise and fall in noise intensity, it is fairly definite that the cause is some considerable distance away, or that a tributary line is responsible.

On approaching a tributory or spur line, which may be causing the trouble, a sharp increase in noise will be noted as it is passed. If, while traversing this spur line for a short distance to prove its condition, the noise rapidly attenuates and is lost before any appreciable distance is covered, it is clear that the fault is elsewhere. The main line is then approached and followed. As the fault becomes closer the rise and fall of the noise energy become more frequent until a fairly regular intensity is attained.

This intensity is increased until the proximity of the disturbance necessitates a reduction in the volume control. The actual cause may then be approached on foot by the aid of the Locator until the locality is reached.

It may be necessary to isolate certain sections of the line to prove on which side the trouble exists. This, of course, is a matter which the supply authorities must decide before investigations are commenced, for it must be remembered that opening a line will probably affect a number of towns on that circuit, and interruptions are in no way popular. For that reason, therefore, these tests are usually carried out after midnight and before 6 a.m.

The suppression of interference discussed in this paper has regard to that experienced on the ordinary broadcast wave band. There are occasions when the reception of signals on other bands may be similarly affected, and short wave reception may be that most seriously interfered with. Generally speaking, the problem does not

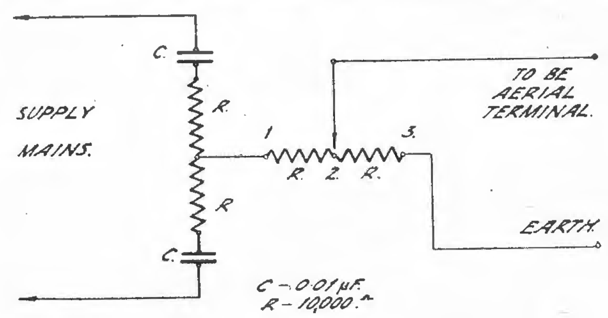


Figure 14.

arise to the same extent, for experience has shown that as the wavelength is reduced the interfering noise is less intense. If, therefore, the remedies adopted for the broadcast band are effective in eliminating the cause in that case, it should be equally effective on short waves. Having due regard to the fact that interference on short waves is more likely to be due to direct radiation, the importance of screening the equipment cannot be too strongly stressed.

Comparatively speaking, little experience has been gained in suppression of interference affecting short waves, and, incidentally, if this does become an urgent necessity, one wonders how a commencement is to be made when nearly 200,000 motor cars in Victoria alone will more or less all require individual attention. Aerial treatment appears to be the only means of reducing the noise affecting short wave reception at present.

9. Co-ordination of Interests.

The responsibility for tracing causes of interference and arranging for its elimination is undertaken by the Postmaster-General's Department, and the duties associated with the work are carried out by the Wireless Branch. Percentages of causes for the last twelve months appear as Appendix C.

The personnel of the investigating staff has been carefully chosen from those officers in the Department who have show a particular aptitude in radio and electrical technology. An important factor in the selection of these officers is the evidence of discretion and tact in their work. It is realised by the Department that the success in inducing owners to adopt the remedial measures rests mainly with officers, and it is through their zeal that the present satisfactory position has been attained

The generous co-operation extended by the S.E.C., power supply authorities, municipal undertakings, railway and tramway authorities and the very many owners of electrical appliances and devices merit the keenest appreciation of listeners who have benefited by the unselfish attitude in assisting to make conditions better for their entertainment.

The continuance of this co-operative spirit is much to be preferred by all parties concerned, to seeking improvement by some legal procedure. The fact that some countries in Europe have instituted legal codes to cope with cases of refusal to adopt measures of suppression is no excuse or inducement for similar action to be adopted in this country. Difficulties do exist in Australia where no juris-

(Continued overleaf.)

ELECTRICAL INTERFERENCE (Continued)

diction is available, as difficulties exist in those countries where there is legal provision. This aspect of legislation is one that cannot be instituted without the most serious consideration, and in spite of the fact that many municipalities in the Commonwealth have regulations, there are no records of proceedings having been taken. The whole question of legislation is an international one, to which a formula for an agreed permissible noise level value has so far been unobtainable.

The S.E.C. wiring regulations make it an offence for any new appliance to be installed that is capable of causing interference, and the Commission has the power to refuse to supply current. This regulation, however, is not retrospective and applies only to that equipment installed since July. 1934.

In this connection it might be mentioned that many manufacturers and importers of electrical equipment have arranged for suitable suppressing devices to be incorporated in the construction of their appliances. This is a hopeful sign, and with the increasing replacement of obsolete apparatus it might be expected that the present types of offending appliances will be reasonably free from interference characteristics.

Nevertheless, it does not appear that broadcast reception will be entirely free from this menace of man-made static, and therefore continual and, indeed, intensified co-operative effort by all concerned in the radio and electrical industries will be needed.

APPENDIX "C"

PERCENTAGES OF CAUSES AND CURES FOR THE YEAR 1935/36.

Sources of Interference:

D.C. Industrial Equipment	18%
A.C. Industrial Equipment	14%
Domestic Apparatus	2%
Electro-medical Equipment	1%
Private Lighting Plant	2%
Departmental Equipment	3%
D.C. Low Tension Services	1%
A.C. Low Tension Services	11%
High Tension	16%
Traction Services	4%
Listeners' Receivers	14%
Miscellaneous	14%
	100%

Summary of Results Achieved:

Suppressors Fitted	73%
Remedied without Suppressors	23%
No remedy owing to owners declining to co-operate	4%
	100%

ELECTRICAL INTERFERENCE DISCUSSED

FOLLOWING on the delivery of Mr. Conry's paper, members of the Institution and visitors, who were present at the meeting, joined in an interesting discussion of the subject matter of the paper. As this discussion elaborates several points of the paper and reveals various points of view on the subject of electrical interference, we present relevant abstracts below:—

Mr. J. Malone (Chairman) opened the discussion and went on to say that the work of interference investigation and suppression was one of the very great importance and the problem involved legal as well as technical considerations. While at present the method of mutual co-operation between the interests concerned, as followed in Australia, seemed to be the most generally satisfactory, the legal aspect was interesting and complicated. We who are radio-minded and may be apt to thing along our own lines only, should reflect on the other fellow's point of view. While the electrical manufacturers and supply undertakings are co-operating to a very satisfactory extent, it is obvious that there are economic difficulties which are included in the legal aspect before a solution on that basis could be reached. While it is obvious that noise is the main trouble in all radio reception, it is not so clear how the noise could be usefully defined and measured. Some noise is tolerable and some intolerable. How to reach definitions and to measure the noise are matters which has not yet been settled. Some people have suggested that the noise may come under the heading of a municipal nuisance, but even so we are forced back to the question of what is an intolerable degree of noise.

As an example, one could take the case of a listener in Geelong (Victoria) who obtains a signal from a Melbourne station of a few millivolts. If the noise in his vicinity is higher than that signal level, he has a ground for objecting. If, however, he feels that he must listen to a very distant station, say, 6WF (Perth, W.A.), whose signal in Geelong is of a very few microvolts, it is evident that it would be extremely difficult to suppress or reduce the interfering noise safely below the signal, and it would be unreasonable to ask for that protection. This problem has been the subject of various international conferences, and, despite earnest endeavours to reach a settlement, there is still no agreement on the main points of the strength of signal which should be protected, the degree of interference which can be regarded as intolerable and whether the suppressive measures should be taken by the manufacturers of possible interfering equipment or elsewhere.

As an indication of the difficulties of settlement of these basic matters of agreement between the parties concerned, Mr. Malone mentioned that recently he wrote to an authority in America asking for advice and received replies from five separate bodies who are tackling the problem. Their information and the information from Europe also shows that the fundamental difficulties still exist. And where legislation has been introduced the law is rather vague. It is no use having a law that cannot be enforced, and therefore it seems that the co-operative method is still the most satisfactory.

As an indication of satisfactory results so far achieved, Mr. Conry's paper included a schedule (Appendix "C") showing that of the cases complained of in Australia, averaging about 6,000 or 7,000 a year, 73 per cent. are satisfactorily attended to. In Canada, about 10,000 complaints are dealt with annually, and in Great Britain an amount up to £80,000 a year is spent on investigating causes of interference and demonstrating suppressive measures on the same lines as those adopted in Australia. It is evident that interference is of large proportions, even in countries like England, where high power transmitting stations are used.

Other speakers' remarks were as follows:—

Mr. Hall (Member): "Setting aside for the moment the question of radical alteration necessary in receiver and transmitter design, would not a system of frequency modulation, instead of the present amplitude modulation, result in the elimination of interference without the necessity of suppressing parasitic radiations from electrical apparatus? I understand that Professor Armstrong, of Columbia University, has successfully demonstrated this system before the Federal Communications Commission (U.S.A.), but, along with other students, I would appreciate some explanation of the fundamental reason underlying the success of the scheme. Not only is the elimination of parasitic interference claimed, but also the elimination of atmospherics."

ELECTRICAL INTERFERENCE (Continued)

Mr. Mackay (Melbourne Technical College): "Regarding the reference to broken filaments in electric lamps. What particular type of lamp has been causing trouble? Mr. Whitelaw, of the Brunswick City Council, has raised the same query. A further question: Does the size of the motor or generator have any influence on the size of condenser chosen?"

Mr. Rogers (Metropolitan Electric Supply), referring to the broken filament trouble said: "The particular type was a 60 watt, gas-filled lamp. We had a fair amount of trouble with that type. The filament severs and the lamp continues to burn. This is a constant source of interference and very serious. The interference extends over a wide area and is very difficult to locate. The first indication you get is when a consumer reports the matter. You go out to his home only to find the trouble is off. The trouble might then be reported from some other part of the town. Perhaps the lamp has gone out and the trouble is off. Sometimes the interference is on and you start investigating. Now we are quite familiar with the type of interference and the cause."

Mr. Stevens (Member): "Mr. Malone touched on a subject which was of very great importance, that is, the effect of increasing power of stations. Whilst in England a year ago I spent about 2½ months touring England and Scotland and made it my business to have a portable radio set in my car. I found out what reception was like in different parts of England and took note of the particular country. I was in England when the change-over was made from Daventry to Droitwich. I was staying, near Bath, close to a tram terminus—very old-fashioned trams with lots of sparking. When Daventry (75 K.W) was on, the hotelkeeper was unable to listen. When the change was made to Droitwich (150 KW.) reception was very clear. When I came out as ship's operator, I kept a very detailed log of all English stations. Coming down to Gibraltar, I could hear all the medium-wave stations well. When we got into the Mediterranean I lost the medium-wave stations, but still held on to the 150 KW. station with perfect day and night reception. Atmospherics were so bad that we could not work Malta at 125 miles, but could hear Droitwich perfectly. Most country towns in England have very old lighting supplies and great interference is experienced on any station of low power. A power of 50 KW. seemed to be a great eliminator of small troubles."

Mr. Dobbyn (Member): "Following the Chairman's opening remarks concerning the difficulties in laying down definite rules and regulations, the treatment of appliances at the factory may not, in many cases, be as suitable as treatment in situation after installation. I think there has been quite a lot of discussion taking place overseas on that aspect. If appliances are treated at the factory, the electrical characteristics of the circuit to which the unit is connected may be such that the suppressor device may be the cause of aggravating the form of interference. Whereas if appliances are treated at installation you could combat it without difficulty by selecting the right type of suppressor. Tests were made and from them it appeared that of 100 devices treated at the factory probably about 10 per cent. were more serious sources of interference with suppressor devices on than if they were removed. Perhaps Mr. Conry could check those percentage values.

"Some types of short-wave transmitters could be regarded as being practically the same as modern valve-type short-wave diathermy, as mentioned by Mr. Conry. Almost world-wide interference was experienced on the 20 to 30 metre band recently. I believe the trouble was traced to the training rooms of a baseball team in New York where diathermy apparatus was used. Perhaps similar troubles may arise here. In such cases the interference may be more troublesome in a neighbouring country than at close range to the source. Legislative action in such cases would, of course, present extreme difficulty."

Mr. Cullinan ("Listener In"): "I can verify Mr. Dobbyn's remarks about short-wave diathermy. The offending apparatus was located at the baseball headquarters in Baltimore by a special study employing a cathode-ray oscillograph. The trouble was on for some time and was the cause of widespread investigations."

Mr. Mackay: "We experience a lot of diathermy trouble from the Melbourne Hospital. Overseas reception is rendered almost useless. Perhaps some member may be able to suggest some possible scheme. Although perhaps the Hospital authorities may not be able to do the screening, Mr. Conry mentioned that insulators were capable of treatment by using a metallic spray. After all, metallic spraying is not such a costly process, and some members might be able to get over the trouble by spraying walls of rooms used for diathermy work. It looks as if suppressors will not be sufficient."

Mr. Malone: "Regarding Mr. Stevens' reference to high power; in his very interesting tour through England, did he find much interference, even with the 50 KW. stations? The latest information we have shows that there are 225 investigators employed regularly."

Mr. Stevens: "Interference was very bad particularly in the town of Keswick. Nothing seemed to be done to eliminate these things locally. As soon as Droitwich went on to high power, that was the first really good reception that the people of Keswick had from English or Scottish Stations. Fading was completely eliminated day and night. The high-powered station was the only one you could listen to with perfect reception. Even with 50 KW I think there is a tendency to interference troubles. Here the authorities are very alert in dealing with interference. Although there are many more complaints in England, there are many more people. I think that power is a great help in the elmination of the trouble."

Mr. Witt (P.M.G.'s Dept., and Member): "One of the previous speakers referred to the benefits of high-power and long-waves in combating interference and his experiences in Great Britain were cited. It is necessary to remark that this is not a simple remedy, nor is it necessarily the best one. Great Britain is geographically a small country, comparable in area with the State of Victoria. There are approximately 13 stations, mostly of high power, but only nine channels to put them on. If the international frequency agreements permitted Great Britain to have a much larger number of channels, it would be preferable to have more stations, each of less power. There would be both improved coverage and better signal-noise ratio.

"So far as long-wave stations are concerned, England has only one channel and necessarily has to put all the power she can afford into the station on that channel. It can be readily shown by any systematic method that three stations, each of given power, on three channels, are superior to one station of three times that power from every service point of view. In considering increases of power to a given station, from the point of view of combating noise, it should be remembered that small increases are of no value. If a station of 10 KW. is increased to 20KW., a ratio of 1:2, the signal-noise ratio is improved by only 3 decibels, an amount inappreciable to the ear. If an improvement is to be discernible, the ratio must be improved by not less than 6 decibles and, as 6 decibels corresponds to a power ratio of 4, a 10 KW. would have to be increased to 40 KW. or a 50 KW. increased to 200 KW. to make it worthwhile. Improving the signal-noise ratio at places remote from the station by increasing the power of that station is an extremely wasteful process and would not be considered if it were possible to place another station nearer the listener. When examples in Europe are cited, it must be remembered that there are countries small in area which can have, under international agreement, only one or two channels assigned to them, and the Government of such a country is then forced to disregard economics and meet the situation with the only means at its disposal, namely, by installing an expensive station of great power. It is also urged to do this from the point of view of National prestige in relation to its neighbours." The speaker went on

(Continued overleaf.)

ELECTRICAL INTERFERENCE (Continued)

to refer to specific points in Mr. Conry's paper, which, he stated, was one of the most interesting lectures that had been given before the Melbourne Division. These points were:—

(1) It is suggested that in the observed experience of greater noise above 1000 KC. than below it there may be a factor related to the relatively short lengths of electric wiring associated with domestic electric appliances. This would tend to increase the fundamental frequency at which the noise disturbance is predominantly produced. It is known from other observations that Tramway Systems, where long lengths of wire are customarily associated with impulsing sources, produce noise the fundamental frequency of which is relatively low.

(2) Regarding the case of an objection to the use of condensers and suppressors where the objector believed they would add to his current consumption. It is pointed out that alternating current flowing through any reasonably good condenser is almost entirely wattless and therefore incapable of dissipating power. As Mr. Condry himself mentioned in the paper, the presence of such condensers may be of actual benefit in improving the power factor of a consuming device.

(3) Mr. Conry was asked whether he had occasion to compare the merits of screening wire of close mesh with that of wider mesh when shielding diathermy equipment, for example—"Is galvanised iron wire netting of about ½in. mesh effective?"

(4) In the neutralised lead-in aerial system shown in fig. 13, had the lecturer observed any increase in the pick-up by converting it from an unbalanced system to a doublet?

(5) With reference to the Tobe interference locator, Mr. Conry was asked whether his observations of a signal meter in this set had shown the signal-noise ratio below which interference was not deemed serious.

(6) In connection with references to legislation, Mr. Witt said that he believed in Germany manufacturers were allowed to apply to their apparatus a small red label bearing the legend "Radio Clear" if the apparatus was deemed by the Government incapable of causing audible interference.

Mr. Condry (in reply to the various points raised during the discussion):

"I am unable to supply the information desired by Mr. Hall. I was really hoping that someone would take it up, as it is interesting."

"I think Mr. Mackay has been very practically answered regarding the lamps. Regarding the size of condensers, I have found that the 0.5 mF. is the popular type and most effective, with bleachers, in some cases, 1 mF is necessary, but in the majority of cases, 0.5 mF. Usually, the smaller the appliance the smaller the capacity that is necessary."

"Mr. Stevens' remarks are very interesting. I think Mr. Witt has replied most effectively."

Mr. Dobbyn's remark on treating all plant at factories before it is put into circulation is an important one. There are many instances where so-called suppressed apparatus has been installed which has required further treatment after it has been allegedly treated, which would indicate that treating appliances at the factories are not always effective. Mr. Witt's remarks about the German type of apparatus are interesting. Imported barbers' clippers are allegedly clear, but sometimes have to be treated again here."

"Regarding Mr. Mackay's reference to the Melbourne Hospital diathermy plants, I can sincerely sympathise with him. We know how to treat diathermy, but there is only one obstacle, and that is "cash." Perhaps a conference, including Mr. Lindblade and others, may find ways of overcoming the difficulty, but they will have to include metal screening. If the supply mains to the Hospital were placed underground and the Hospital isolated, then the College would be free of trouble, provided that the diathermy chambers could be sprayed. There should be no difficulty in effectively screening the diathermy chamber, as it is not a very large room. Occasionally, however, a portable diathermy machine is taken into a ward. A solution of the trouble would primarily be the undergrounding of the mains from the sub-station to the Hospital and treatment of the diathermy chamber."

"I was interested to hear from Mr. Stevens that England is not free from interference. To some extent their conditions are somewhat similar to those obtaining here. The Melbourne stations, both National and Commercial, lay down a very heavy field strength in the city and suburbs. For that reason interference in the metropolitan area is, comparatively speaking, not as great as in the country, where there is a lower field strength."

"Replying to Mr. Witt regarding noise in the middle of the frequency band. The wiring of the house is likely to have a contributing effect. I am inclined to agree with Mr. Witt in theory that it is possible, but my experience has been that it is more on account of the popularity of stations around that portion of the band than anything else."

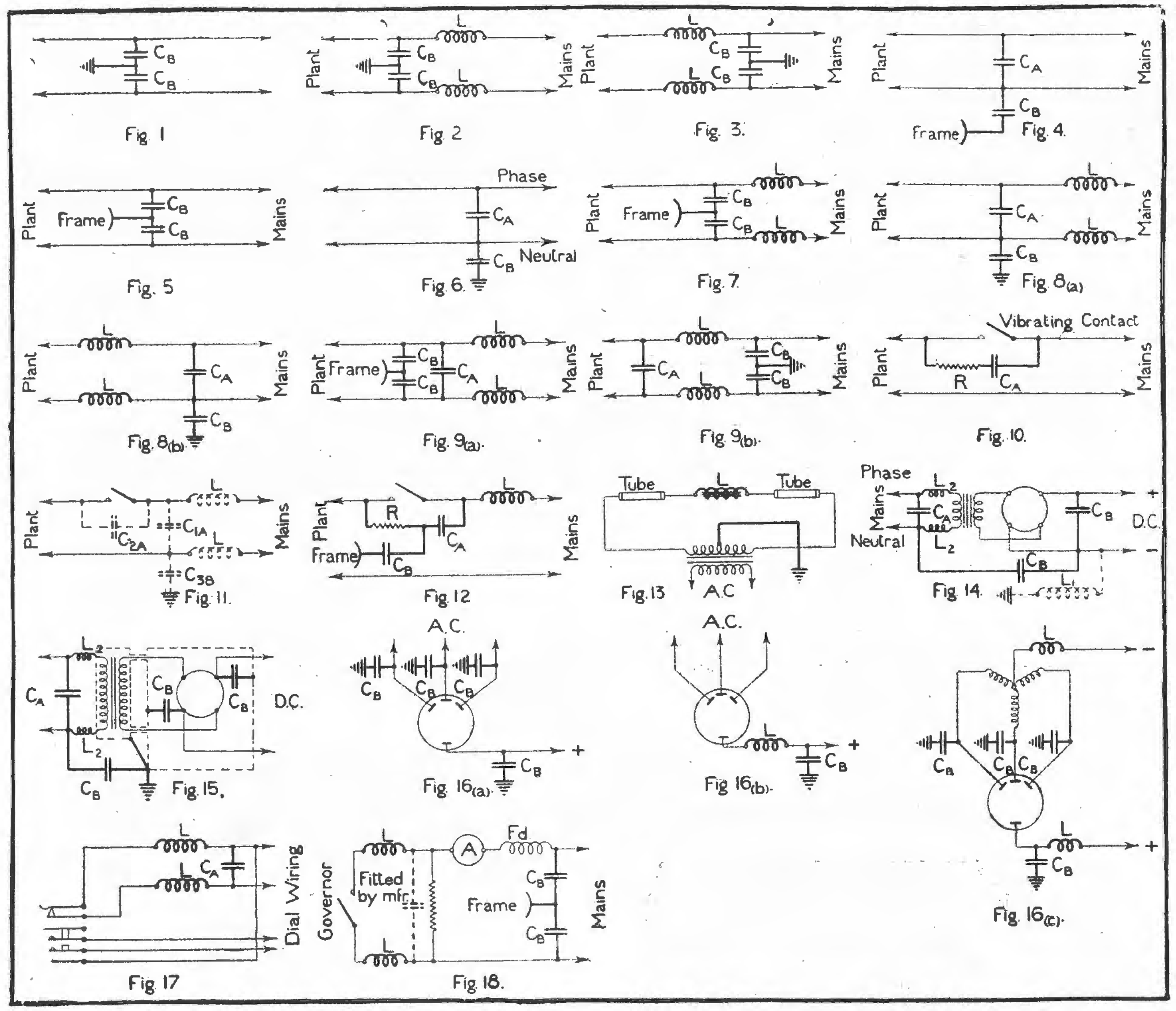
"Regarding the screening of diathermy equipments, we have had experience with chicken wire and have not found it satisfactory. There is insufficient screening quality compared with the very fine mesh. The only other substitute would be solid metal or metallised paper, or perhaps Mr. Mackay's spray method. The paper referred to is aluminium foil. Perforated metal has certain advantages. Provision will have to be made whereby an electrical contact with each sheet will be made. All corners should lap over."

"Regarding the neutralised aerial, the only reason for the scheme explained is its simplicity, easy construction and cheapness. We have not tried the method mentioned by Mr. Witt."

Mr. Mackay said that he had tried the method mentioned by Mr. Witt, but it was not more effective than the method explained in the paper.

Mr. Witt asked if the signal was many times greater than the noise. **Mr. Conry** said that he found it to be about 6 to 1.

BRITISH STANDARD SPECIFICATIONS FOR SUPPRESSION EQUIPMENT



ALTHOUGH the original British Standard specification for radio-inductive interference suppression equipment has now been replaced by a later edition (known as B.S.S. 727/1937) no copies of the new standard were available in Australia at the time this Annual went to press.

The fundamental suppression circuits which appeared in B.S.S. 613 are still correct, however, and are repeated herewith, together with the explanatory notes concerning their application.

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,

Suppression Equipment Specifications (*Continued*)

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.

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.

A careful perusal of these circuits should be of great value to any engineer or serviceman who has anything to do with the 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.

RADIO LABORATORY *and* SERVICE EQUIPMENT

MEASURING INSTRUMENTS

AS measuring instruments of all kinds are basically dependent on some form of indicating meter for their operation, a description of the basic principles underlying meter operation forms a fitting preface to any discussion of measuring instruments. The most commonly used types of indicating meter utilize the moving coil, or D'Arsonval, principle for their operation. This will be dealt with first and will be followed by an outline discussion of several other types of meter movements which are in use.

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.

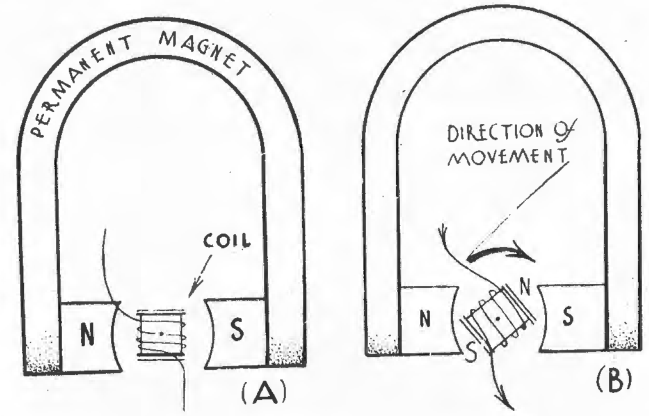


Fig. 1.

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 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 succeds 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 betwen 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 the 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. measure-

(Continued overleaf.)

MEASURING INSTRUMENTS (Continued.)

ments. 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, and require 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 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.

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.

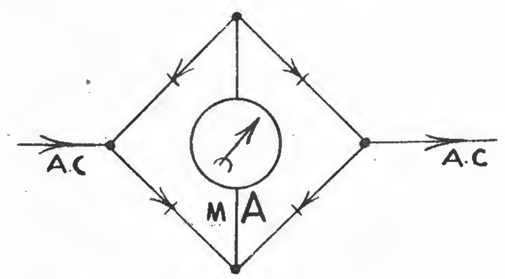


Fig. 2.

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.

Piezo-Electric Movements.

A recent addition to the range of indicating meter movements available is a development of the well-known piezo-electric principle used in microphones and pick-ups.

For meter work, a "twister" type of crystal assembly is used instead of the "expander" or "bender" assembly employed in acoustic devices; that is, the application of electrical energy causes angular displacement of opposite edges of the crystal plates in the assembly instead of merely causing the plates to buckle or expand.

It follows from this that if one edge of the assembly is fixed, a pointer attached to the opposite edge will rotate through an arc of a circle if electrical energy is applied to the flat sides of the crystal plates.

A device such as this would find many applications in radio work as its characteristic would be very nearly capacitative and practically no current would be drawn. However, no commercial examples of meters operating on this principle are yet available; the matter is mentioned purely as an indication of current development in the measuring instrument field.

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 convential moving coil unit which registers the D.C. produced by a small copper-oxide rectifier built into 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

(Continued on Page 200.)

RECTIFIER METERS (Continued.)

bridge should be low, as the apparent resistance of the set-up to A.C. 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.

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 th "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 r.m.s. value of the A.C. flowing through the rectifier system.

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 beginning 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 rectifier-type 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 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:—

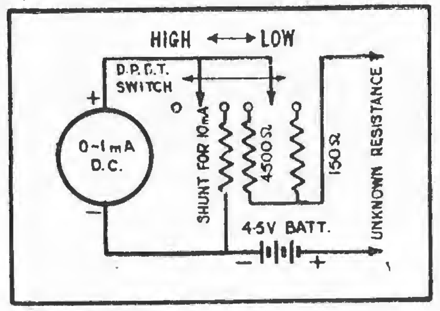


Fig. 3.

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 1000 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.

(Continued on Page 202.)

Multipliers.

The value of this resistance must be such that practically the whole of the voltage drop wil 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.

H. R. Voltmeters Essential.

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 necessary. Even a meter of this type will be almost useless for measurements at points such as the plate of a resistance-coupled amplifier valve and to cater for requirements such as these, commercial voltmeters having resistances as high as 20,000 ohms per volt have been introduced. A meter such as this is built up around a 50 microampere moving-coil movement and places so little load on the circuit that, when used intelligently, measurements accurate to within 5 or 10 per cent. may be obtained at most points in a radio receiver.

Shunt Determination.

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.

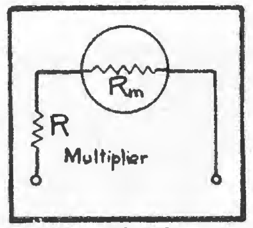


Fig. 4.

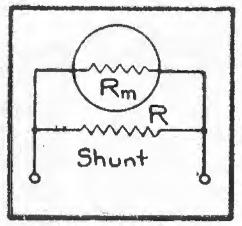


Fig. 5.

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) = 0.551 ohm. For the 100 and 500 mA. scales the shunt resistance should be 0.2727 ohm and 0.0541 ohm respectively.

The general formula is:—

$$R_s = \frac{R_m \times I_m}{I - I_m}$$

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).

SHUNTS AND MULTIPLIERS (Continued.)

It will be noted from the above that meter shunt values, especially for the higher current ranges, are extremely low in resistance and, moreover, decidedly awkward to handle.

In order to overcome this difficulty, it is becoming increasingly common practice to use meters of higher movement resistance for applications where a number of current ranges must be obtained by means of shunts. This procedure is also quite in order for voltage measurements (unless millivolt indications are required), the only adjustment necessary being to the multipliers.

It is quite evident that if a meter having a movement resistance of, say, 100 ohms, instead of the usual 20 to 50 ohms, is employed, the shunts necessary for multiplication of the current ranges will be proportionately higher in resistance. An example of the improvement in this respect is afforded by a calculation to determine the shunts required for a 100 ohms meter to give the same current ranges as the 27 ohms meter mentioned above. This will show that the shunts required are:—

10 mA.	11.11 ohms	(3 ohms)
50 mA.	2.04 ohms	(0.551 ohm)
100 mA.	1.01 ohms	(0.2727 ohm)
500 mA.	0.2 ohm	(0.0541 ohm)

The values shown in brackets are the shunts specified previously for equivalent ranges on a 27 ohms meter. The advantages of the 100 ohms meter for this class of service are self-evident. If a 100 ohms meter is not available when making up an instrument of any description, any meter that is handy can be used, merely by measuring the resistance of the meter accurately and connecting in series with it sufficient resistance to make up a total value of 100 ohms or thereabouts. The two ends of the series resistance-meter combination are then regarded as the meter terminals.

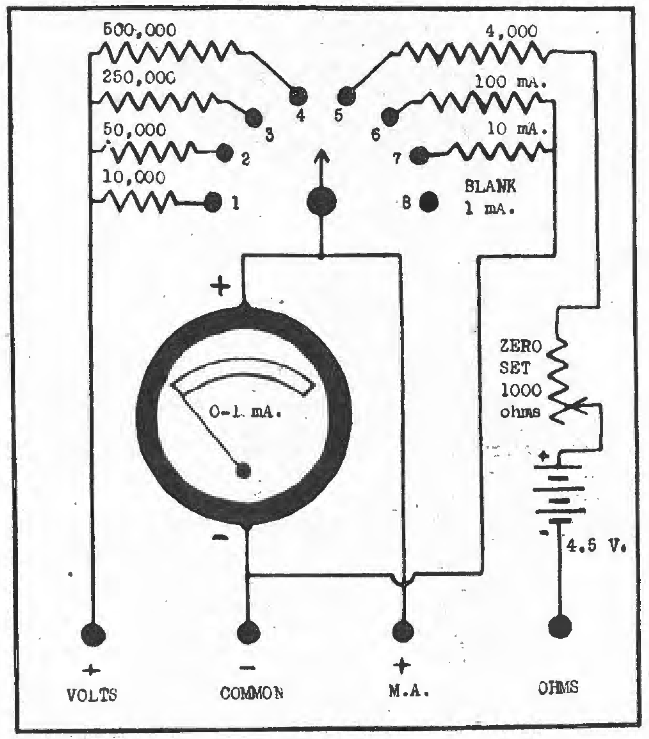


Fig. 6. Circuit diagram of simple D.C. "Multimeter."

When using an arrangement such as this as the basic indicating instrument in a "multimeter" it is desirable, in the interests of voltage-reading accuracy, to allow for the meter resistance in the multipliers for ranges of 10 volts or under. The error introduced in the 10 volt range will only be about one per cent. if this is not done, but when this error is added on to the usual scale-reading inaccuracy of the meter and possible errors in calibration, it can be seen that the overall effect is far from negligible.

A further factor in favour of using a fairly high meter movement resistance is that, as the shunts are relatively higher in value, the effects of lead and switch contact resistance in "multimeter" assemblies are not so important. In contrast to this, it is quite evident that a large proportion of the shunt value (0.0541 ohm) required for a 500 mA. scale with a 27 ohms, 1.0 mA. meter movement would be made up of lead and switch contact resistance—both of which are not susceptible to accurate determination and maintainence.

A Simple "Multimeter."

A simple "multimeter" circuit which will enable voltage readings up to 500 volts; current readings up to 100 mA; and resistance readings up to about 100,000 ohms, to be obtained with the aid of a 1.0 milliampere meter and a few extra components, is shown in fig. 6. The ranges actually obtainable with this instrument are as follows:—

Voltage.

Switch position 1 .... 0—10 volts
" " 2 .... 0—50 "
" " 3 .... 0—250 "
" " 4 .... 0—500 "

Milliamperes.

Switch position 6 .... 0—100 mA.
" " 7 .... 0—10 mA.
" " 8 .... 0—1 mA.

Resistance.

Switch position 5 .... 100 to 100,000 ohms.

The values of the multipliers will be as shown in ohms alongside the resistances. A correction can be made on the 10 volt scale, if a "100 ohms' meter is used by making the multiplier 9,900 ohms instead of the specified 10,000 ohms.

The value of the shunts will be dependent on the meter resistance, but if this is 100 ohms (or a lower resistance unit built up to 100 ohms as previously described) the required values will be 11.11 ohms for the 10 mA. range and 1.01 ohms for the 100 mA. range.

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.

(Continued overleaf.)

Resistance Bridges.

A fundamental circuit diagram of a Wheatstone Bridge intended for resistance measurement is shown in Fig. 7. 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.

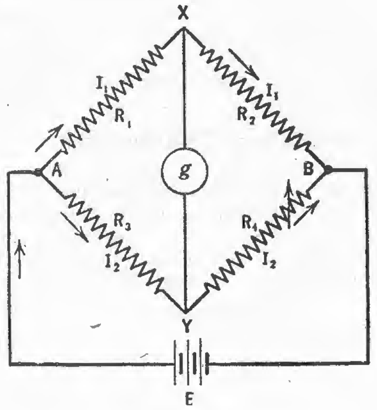


Fig. 7.

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. 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. 8. In this case, however, other characteristics of the condenser under test may be determined at the same time and the bridge proves doubly useful.

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 electro-statically 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."

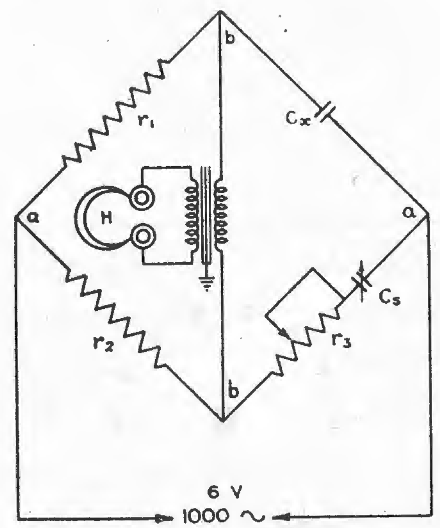


Fig. 8.

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 that 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**

(Continued on Page 206.)

CAPACITY BRIDGES (Continued.)

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 calibratd 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 500 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 cycles A.C. acts in the same way as the D.C. resistance of R3 and R4 in the first example dealt with.

It is of interest to note that the wave-form of the 1000 cycles A.C. supplied to the bridge is not important. As the current passes through both "standard" and "unknown" arms, its effect on both is the same and no inaccuracies will result. In practice the A.C. is usually supplied by a valve oscillator or a buzzer.

The type of bridge shown in fig. 8 is only suitable for checking mica or paper dieletric condensers. Electrolytic condensers, which are designed for operation on D.C. only with perhaps a small superimposed A.C. ripple voltage, must be tested on a special type of bridge. A suitable circuit is shown in fig. 9. The operation of this circuit is as follows.

The amplifier is desirable where a high degree of accuracy is required.

The A.C. testing voltage is obtained through an input transformer "T," which also has an earthed electrostatic shield betwen its windings and a potentiometer and A.C. voltmeter across its secondary to regulate the voltage, which depends upon the capacity being measured.

The D.C. polarizing voltage is applied from a power pack through the medium of a heavy duty potentiometer "P" to the junctions C.B. This is blocked from the output by the condenser "K." A high inductance (1000 Henry) choke is placed in series with the D.C. supply to block A.C. from the D.C. circuit.

A D.C. milliameter "M" is used to indicate D|C. leakage. If a potentiometer P is used the polarizing voltage may be maintained at the desired value and a D.C. milliameter having a 50 or 100 milliampere scale with a pushbutton controlled 5 or 10 milliamp scale may be used.

Except for initial charging and dynamic forming current the leakage in the D.C. milliameter should be low enough to be read on the 10 m.a. or 5 m.a. scale at working voltages.

The relations for this bridge circuit are

$$c^1 = c \frac{r}{r^1}$$

Equivalent series resistance of

$$c^1 = R \frac{r^1}{r} = q^1$$

Inductance Bridges.

The circuit and operation of an inductance bridge is identical with that of fig. 8, 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

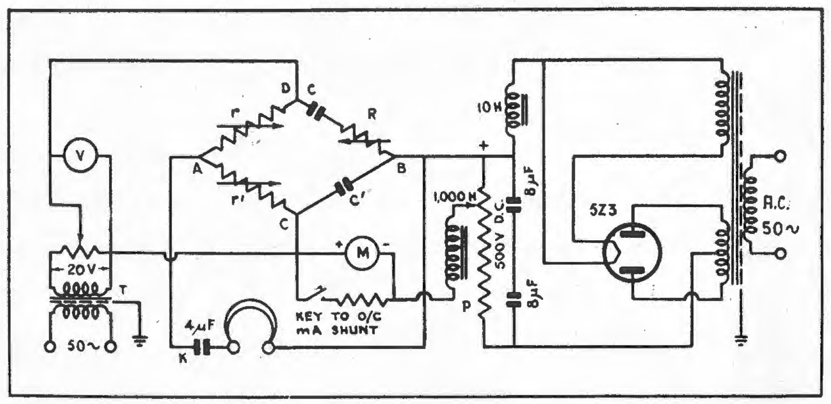


Fig. 9. Circuit of bridge type condenser tester.

The bridge arrangement consists of two parts (1) a D.C. power pack for supplying polarizing voltage to the electrolytic under test, and (2) a simple A.C. bridge. The object of the polarizing voltage is to maintain the anodic film in the electrolytic condenser so that the reversals of potential in the super-imposed A.C. testing voltage will not destroy the film. This method has been proved satisfactory in practice.

Resistances "r" and "r¹" constitute the ratio arms, "c" the standard condenser, "R" the power factor adjusting rheostat, and "c¹" the test condenser.

The output of the capacity bridge is taken from the junctions A, B, and either headphones or an amplifier and output meter may be used as an A.C. Null indicator.

If an amplifier is used it should be coupled to A, B, by a suitable input transformer having an earthed electrostatic shield between the two windings.

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

INDUCTANCE BRIDGES (Continued.)

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 input.

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 single or multiple A.C. waves.

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. In its simplest form, the vacuum-tube voltmeter consists merely of a diode rectifier with a microammeter connected in series with its load resistor. This type is used for special applications, but is limited in its scope on account of its low sensitivity, the sensitivity being that of the indicating meter used.

Much wider application is found for the types in which the indicating meter is placed in the plate circuit for an anode-bend or a grid-circuit valve rectifier. The sensitivity in this case is a function of the indicating meter sensitivity and the mutual conductance of the valve employed and it is quite evident that under these circumstances appreciably higher sensitivity than that of the meter employed can be achieved.

Several representative examples of the anode-bend rectifier type of V.T.V.M. are shown in Fig. 10, and a brief description of each follows. Although the circuits shown employ triode valves, this is only as a means of basic representation and tetrodes or pentodes may be used instead, providing that arrangements are made for feeding the extra electrodes with the necessary potentials. The use of such valves in these circuits can be definitely advantageous for some classes of service and considerably improved efficiency will result. An example of this is found in a V.T.V.M. intended especially for radio-frequency measurements where it is desirable that the input capacity be kept as low as possible.

(Continued Overleaf.)

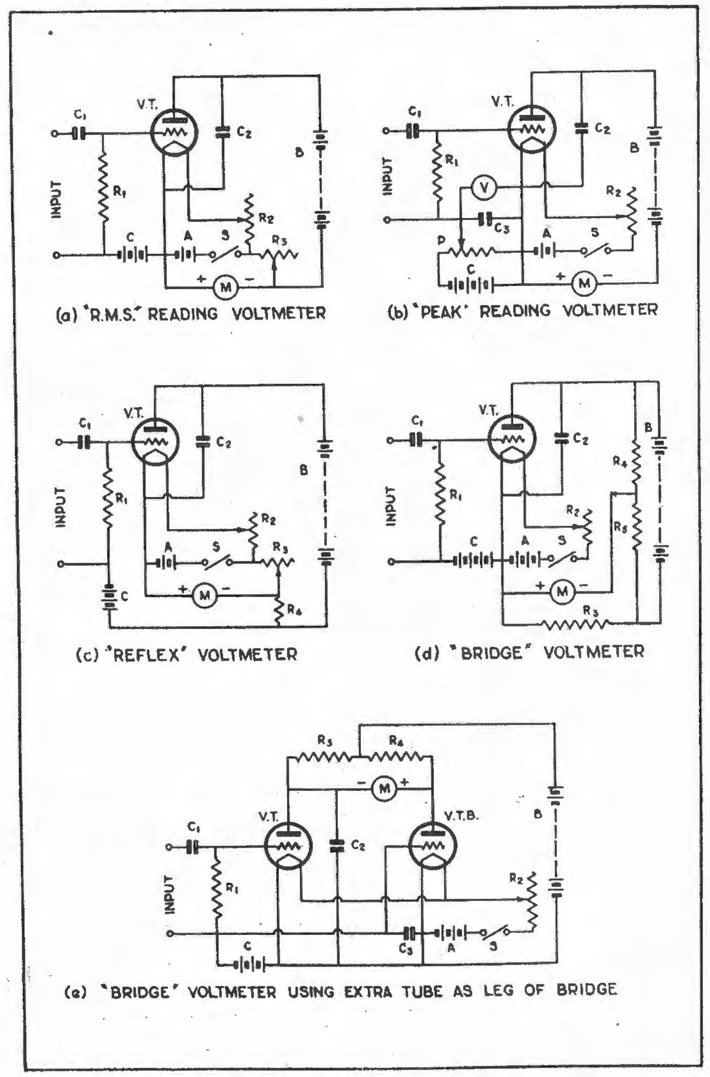


Fig. 10.

"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 valve 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 valve 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 valve, 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 at 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 valve. 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 valve used. The capacitative shunt effect under these conditions is also very low (that of the valve 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.F. 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.

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 characteristic, 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 with 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 valve 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 and "B" supply voltage 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 Fig. 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

(Continued on Page 210.)

PEAK VOLTMETERS (Continued.)

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 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 a self-bias resistor and its function is the same, that is, to regulate the bias applied to the valve. 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 valve 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 valve 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 valve, R3, R4 and R5 are arranged in the form of a bridge, with the meter M in the usual indicating position for a bridge. R3 is given a value equal to the plate resistance of the valve 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 of the bias. Application of a signal to the grid of the valve 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 valve 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.

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 valve (V.T.B.). Common A, B and C supplies are used for the "balance" and rectifier valves, 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 valves (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 valves. Alternatively, separate bias batteries may be used for the two valves 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 valves are matched. Variations in plate, filament or bias supply will affect both valves 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.

"Goose-Neck" V.T.V. Meters.

The use of "goose-neck" or extension-type V.T. voltmeters is becoming increasingly popular, especially for radio receiver measurements.

This type of V.T.V.M. is fundamentally the same as any other thermionic rectifier type voltmeter and may take any of the forms illustrated in Figs. 10 (a) to 10 (e). The only point of difference is in the physical arrangement of the components and the "goose-neck" instrument gets its name from the fact that the "rectifier" valve is mounted at the end of a flexible extension of some kind. This extension may be of the flexible tube variety or may be merely a shielded bundle of wires.

The instrument is wired up in exactly the same manner as a complete assembly of the required type, the leads for the "rectifier" valve being taken to the socket through the flexible extension tube or cable. The indicating meter, plate, circuit components, and power supplies are housed in any convenient container.

The advantage of this system is, of course, that the grid connection of the "rectifier" valve may be connected direct (or through an isolating condenser if necessary) to the circuit point where it is desired to take measurements. The wiring required for the input circuit of the V.T.V.M.

RADIO LABORATORY EQUIPMENT— (Continued from Page 210)

is therefore at an absolute minimum and losses are reduced accordingly, a great advantage (and in some cases, a necessity) when R.F. measurements are being made.

Several popular commercial instruments of this type use a "metal" R.F. pentode (type 6J7) as the "rectifier" valve and thus have the grid contact in a convenient position for connection to the circuit under measurement.

6E5 As Indicator.

The versatile 6E5 (magic eye) tuning indicator may be used as an extremely sensitive and accurate indicating "meter" in V.T.V.M. circuits of the "peak reading" or "slide-back" type.

Reference to preceding paragraphs dealing with instruments of this type will show that the meter merely serves as a referenc to indicate when the bias has been adjusted to exactly the same value as the peak potential of the signal; in other words, when the plate current has been returned to its no-signal value.

It follows from this that any device which will perform this function visually will be satisfactory, providing it is sensitive enough to respond to small variations.

The 6E5 is a voltage-operated device, and before this can be used as an indicator it is necessary to convert the current fluctuations in the plate circuit of the rectifier valve into voltage variations. This can be effected quite simply by replacing the meter by a resistor.

If a 6E5 is then wired up in a conventional circuit arrangement and sufficient bias applied to its grid to just close the pattern, it follows that small variations of the 6E5 bias will be readily discernible. These changes can be effected by connecting the resistor in the plate circuit of the V.T.V.M. rectifier in series with the bias supply to the 6E5. If this connection is so arranged that potentials developed across the V.T.V.M. plate circuit resistor are in opposition to the 6E5 bias supply, the pattern on the 6E5 will open when a signal is applied to the V.T.V.M. Adjustment of the "slide-back" potentiometer on the V.T.V.M. will then result in closure of the 6E5 pattern in the same manner as the plate circuit meter indication returns to zero if a meter is used.

The above notes on vacuum-tube voltmeters by no means cover the complete subject but will serve to demonstrate the principles upon which the operation of these instruments are based.

CATHODE-RAY OSCILLOGRAPH

Fundamental Principles

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.

A "fundamental" 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. Variable D.C. voltages 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

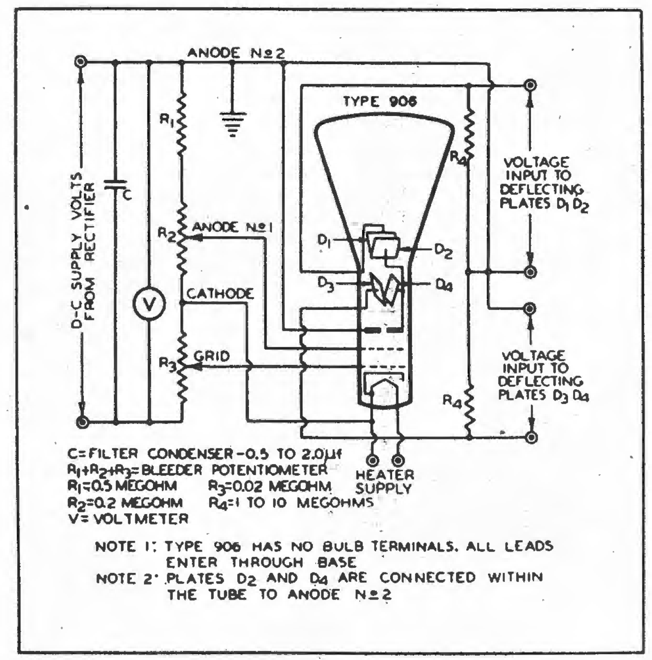


Fig. 11.

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

(Continued Overleaf.)

CATHODE-RAY OSCILLOGRAPH.

Fundamental Principles (Continued.)

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.

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.

The most usual form of time-base circuit consists of a tuneable oscillator delivering a voltage of "saw-tooth" wave form. A "saw-tooth" wave-form is desirable because the deflection representing time must start at some predetermined 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 may be satisfied by a gas-triode operating in a "relaxation" oscillator circuit, or by a special type of "trigger discharge" hard-valve oscillator circuit. The latter is most desirable for work where a wide-range of frequencies must be covered, but for normal work (up to about 20,000 cycles) the "relaxation" oscillator circuit is entirely satisfactory. Suitable "gas triodes" for this class of service are the Radiotron 885 and the Philips 4686.

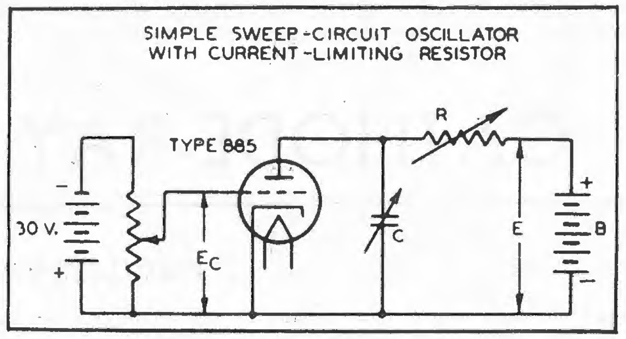


Fig. 12.

A "basic" sweep-circuit oscillator, using the Radiotron 885, 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, where the plate-cathode conductivity of the valve becomes high. At this point, the condenser discharges through the tube and loses its potential. As soon as the condenser voltage drops below the ionisation 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.

CATHODE-RAY CURVE-TRACING APPARATUS (Continued.)

3. The apparatus can be made portable.

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. Electronic means of frequency sweeping have also been developed. The fluctuating output voltage of the stage is then amplified, rectified, and 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.

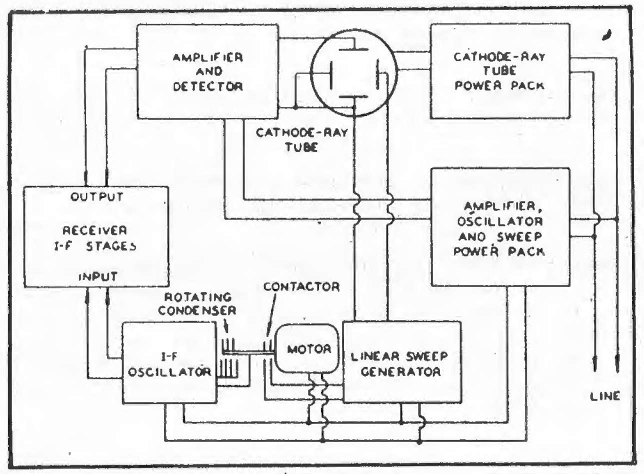


Fig. 13.

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 milliametres 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 divided 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; electro-luminescence—the luminescence given off by ionized gas; bio-luminescence—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, cathodeluminescence is principally involve; 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.

(Continued Overleaf.)

CATHODE-RAY TUBE TERMINOLOGY

(Continued from Page 213.)

Pattern distortion: When the electron beam is moved by changing fields, a pattern is formed on the screen; the waveform 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 arbitary 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.

Special 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 wavelengths in angstroms, microns, or millimicrons. "Relative actinic energy" is obtained by multiplying the relative radiant energy value (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.

THE DESIGN AND CONSTRUCTION OF A CATHODE-RAY OSCILLOGRAPH

Practical Details of a Useful Instrument

IN order to further demonstrate the principles upon which the cathode-ray oscillograph operates, a practical application of these principles is given in the following notes, which describe the design and construction of a simplified oscillograph unit using the recently-introduced 913 type cathode-ray tube. This design is quite practical and will serve as an excellent guide to the technician who wishes to possess himself of a most useful addition to his range of testing equipment.

The subject matter and diagrams which are presented in these notes are reprinted from the April and May, 1937, issues of "Radio Review of Australia" (Volumne V, Nos. 4 and 5).

The circuit arrangement of the complete oscillograph is shown in Fig. 1. Inspection of this will show that the instrument embodies most of the features found in the larger commercial instruments which are available, so that, actually the only respect in which it differs from units using a three-inch (or larger) tube is in the size of pattern available. Experience shows that, for all normal applications the one-inch pattern on the screen of the 913 is quite large enough to provide an accurate indication, so no qualms need be entertained on that score.

Design of the Instrument.

Apart from the basic circuit for operation of the 913 (power supply and pattern control arrangements) the oscillograph contains:—

(1) A linear time-sweep oscillator;

(2) An amplifier for (1), which is also capable of being used to amplify any required "horizontal" deflection voltage.

(3) Means for synchronising the output of (1) with the voltage under examination.

(4) An amplifier for increasing the voltage of any signal it is desired to apply to the "vertical" deflection plates for examination.

These four functions enable the instrument to be used for almost any of the measurements or observations possible with the most elaborate of cathode-ray equipment.

So that the functioning of the instrument may be properly understood and that the operator may have an intelligent appreciation of its principles, we will now describe the various functions of the instrument, as outlined above.

Power Supply and Pattern Control.

The power supply of the instrument as can be seen from Fig. 1, uses two type 80 rectifiers in conjunction with a multiple-winding transformer.

The specifications of the power transformer can be followed fairly well from the circuit diagram, but to prevent any errors in this respect, they are as follows:—

Primary: To suit mains voltage in particular district.

H.T. Secondary: To deliver 350 volts r.m.s. on each side of centre-tap, when the rectifiers are delivering a total load of about 25 mA.

L.T. Secondaries: Two 5-volt, 2 amp. (one C.T.); two 6.3-volt, 1 amp. (one C.T.); one 2.5-volt, 1.5 amp., C.T.

The insulation between each of these windings should be capable of withstanding a peak voltage of at least 500 volts.

The "full-wave connected" 80 is used to supply approximately 450 volts above ground for the 885 (sweep oscillator) and 6C6 amplifiers. A tapping approximately 100 volts above ground is also taken from the divider network associated with this rectifier, for the "pattern shift" controls. This circuit is filtered by means of the choke "L" and the electrolytic condensers, C9 and C10.

As it is desirable that a "grounded" reference point be available for applying deflection voltages to any cathode-ray tube, it is standard practice to earth the high-voltage anode of these tubes and feed the various electrodes from a power supply **below** earth potential.

The 913 has been designed to suit this practice and, as a result, anode No. 2, together with deflection plates D2 and D4 (one from each pair), has been connected to the metal shell of the tube. This provides the earthed reference point which is connected to terminal "G" on the right-hand side of the circuit diagram. (In practice, two "G" terminals will be fitted, one for each deflection terminal.)

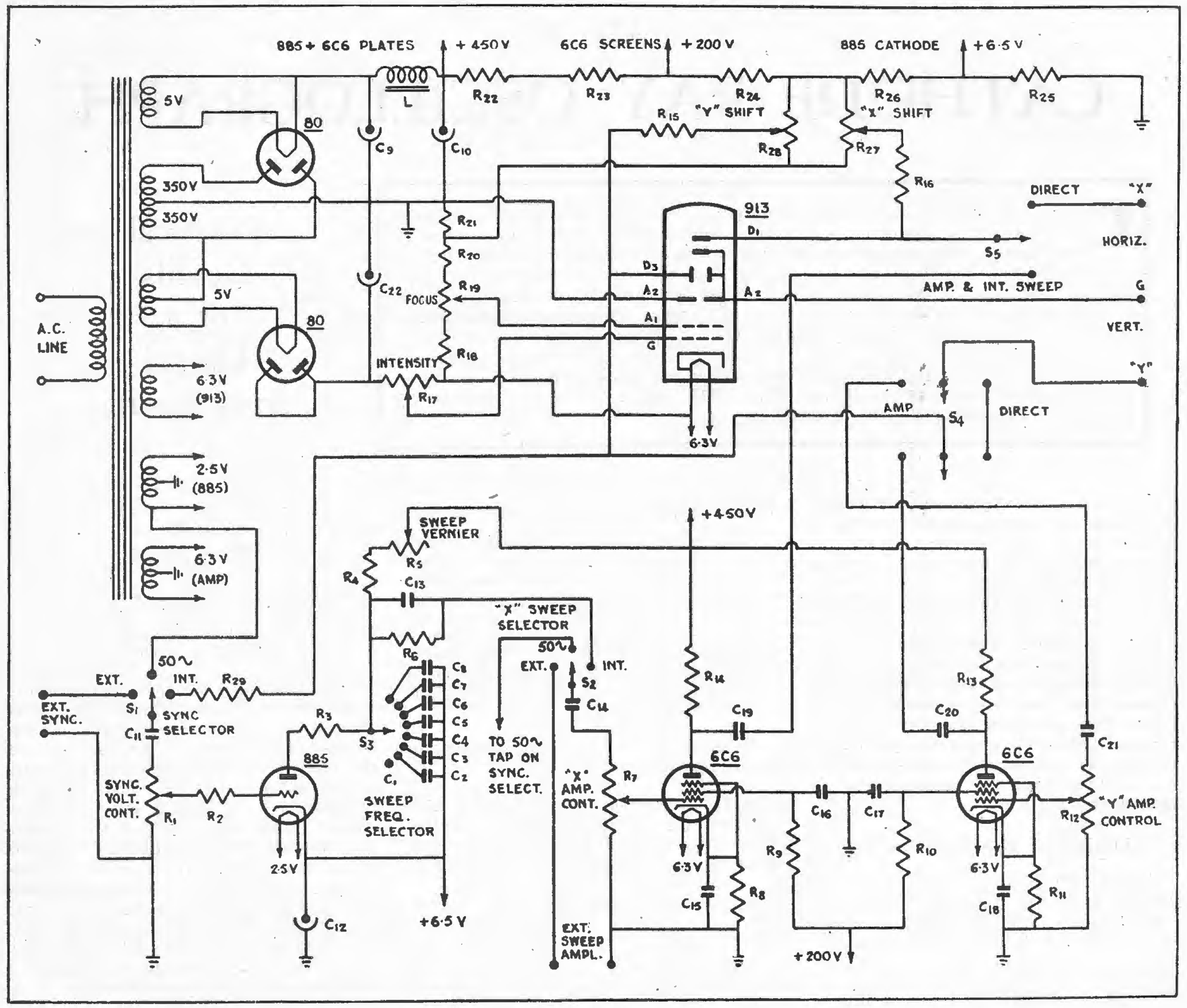
It is therefore necessary to provide a potential of about 450 volts **below** ground for feeding the various electrodes of the 913. This is done in the circuit under discussion by means of the second type 80 rectifier, which is operated in a half-wave rectifier circuit from one half of the power transformer H.T. secondary. Filtering is provided by the electrolytic condenser, C22, and it is well to remember that the **positive** terminal of this is earthed. This means that the can, or negative electrode is a full 450 volts "hot" and should be insulated accordingly.

The voltage output from this half-wave rectifier is developed across the divider system, made up by fixed resistors R18, R20 and R21, and potentiometers R17 and R19.

The junction of R20 and R21 provides a tapping about 100 volts negative for the "pattern shift" controls (R27 and R28) and, as the other end of these is connected to the 100 volts positive tapping on the "above ground" divider, it can be seen that "bias" ranging from minus 100 volts to "plus" 100 volts can be applied to the vertical and horizontal deflection plates through the resistors R15 and R16, respectively. Normally, the "pattern-shift" controls are left in an intermediate position, but their use is necessary should an external D.C. potential be applied to the deflecting plates. Under these circumstances the pattern will be thrown "off-

(Continued on Page 217.)

Oscillograph Circuit using 913 Tube



CONDENSERS.

C1—Stray wiring capacity.
C2—0.0008 mfd., 500-volt.
C3—0.002 mfd., 500-volt.
C4—0.005 mfd., 500-volt.
C5—0.015 mfd., 500-volt.
C6—0.05 mfd., 500-volt.
C7—0.1 mfd., 500-volt.
C8—0.25 mfd., 500-volt.
C9, C10, C22—8 mfd., 475-volt (electro).
C11, C16, C17—0.25 mfd., 250-volt.
C12—25 mfd., 25-volt (electro.)
C13—25mmfd., 500-volt.
C14, C21—0.5 mfd., 500-volt.
C15, C18—0.003 mfd., low voltage.
C19, C20—0.25 mfd., 500-volt.

RESISTORS.

R1—250,000 ohms potentiometer. Synchronising voltage control.
R5—1 megohm potentiometer. Sweep frequency vernier control.
R7—500,000 ohms potentiometer. Horizontal ("X") amplifier control.
R12—500,000 ohms potentiometer. Vertical ("Y") amplifier control.
R27—500,000 ohms potentiometer. Horizontal ("X") pattern shift.
R28—500,000 ohms potentiometer. Vertical ("Y") pattern shift.
R17—15,000 ohms potentiometer. Spot intensity control.
R19—25,000 ohms potentiometer. Spot focus control.
R2—25,000 ohms, 0.5 watt.
R3—500 ohms, 0.5 watt.
R4—250,000 ohms, 1 watt.
R6—1 megohm, 0.5 watt.
R8, R11—1,000 ohms, 0.5 watt.
R9, R10—200,000 ohms, 0.5 watt.
R13, R14—100,000 ohms, 1 watt.
R15, R16—2 megohms, 1 watt.
R18—15,000 ohms, 0.5 watt.
R20—50,000 ohms, 1 watt.
R21—40,000 ohms, 1 watt.
R22, R23—30,000 ohms, 1 watt.
R25—1,500 ohms, 0.5 watt (see text)
R24, R26—25,000 ohms, 1 watt.
R29—5 megohms, 1 watt.

SWITCHES.

S1—3 position rotary. Synchronising voltage selector.
S2—3 position rotary. Horizontal ("X") sweep selector.
S3—8 position rotary. Sweep frequency band selector.
S4—D.P.D.T. toggle. Vertical ("Y") input selector.
S5—S.P.D.T. toggle. Horizontal ("X") input selector.

SUNDRY COMPONENTS.

1—Power transformer (see text.)
1—30 henry, 20 mA. filter choke.
1—Ceramic octal socket for 913.
2—4-pin "UX" sockets for 80 rectifiers.
2—6-pin sockets for 6C6 amplifiers.
1—5-pin "UY" socket for 885.
2—Valve shields for 6C6 amplifiers.
2—Grid clips for 6C6 amplifiers.
11—Knobs for controls.
8—Insulated terminals.
1—Chassis and panel (see text).
1—Box to house instrument (see text).
1—Light shield for 913 (see text).

VALVES.

1—Radiotron 913, C-R tube.
1—Type 885, gas triode.
2—Type 6C6, pentode amplifiers.
2—Type 80, rectifiers.

C.R.O. DESIGN
(Continued.)

centre" and re-centreing by means of the "pattern-shift" controls is called for.

The potentiometer R17 acts as bias control for the grid of the 913. This controls the number of electrons entering the anode structure (or "gun") of the tube and so regulates the **intensity** of the spot on the screen. The voltage variation obtainable by means of this control is from zero (with relation to the cathode) to minus 45 volts.

Potentiometer R19 provides the **focussing** potential to anode No. 1 of the 913. The range of this control is from approximately 45 volts to 120 volts positive (with relation to the cathode.) By means of this the definition of the spot on the screen of the 913 may be regulated from a pin-point to a decided "blur."

Actually, the above portions of the circuit are all that are necessary to operate the 913 as a modulation indicator in a transmitter or as any type of indicator where adequate and suitable deflection voltages are available.

For normal radio design and service applications, however, some basis of reference (such as a linear time-sweep) will be necessary, together with means for amplifying the relatively small potentials encountered factors, the accessory functions previously outlined have been included in radio receivers. Because of these in the complete design.

These will now be detailed.

Linear Time-Sweep.

A saw-tooth wave-form voltage which increases linearly with time is developed by the 885, which operates as a relaxation oscillator. This oscillator is tuned by the condensers C2 to C8 in conjunction with the potentiometer R5 and the fixed resistor R4. The various condensers are selected by the 8-position switch (S3) and variation over the bands so selected is effected by the potentiometer, which gives sufficient control to overlap the bands. Position C1 on the switch is left blank as a means for cutting the oscillator out of operation when it is not in use.

Bias for the 885 is obtained from the plus 6.5 volt tapping on the "above ground" divider. A 1500 ohms resistor is specified to provide the necessary voltage drop, but as this voltage is somewhat critical, it is suggested that a "semi-fixed" resistor having a total value of about 2000 ohms be used in this position.

Resistors R2 and R3 are included in the oscillator circuit purely for purposes of stabilisation.

The frequency range of this oscillator is from about 30 to 18,000 cycles but above about 7,500 cycles the linearity of the output voltage is not very good. However, as the majority of observations will be made on frequencies below 7,500 cycles, this defect is not serious.

Horizontal Sweep Amplifier.

The output from the 885 oscillator is not high enough to sweep the spot across the full width of the 913 screen and some amplification is necessary. Actually, a medium-gain triode would provide all the "lift" necessary for this particular purpose, but it must be remembered that, for some applications, it may be necessary to amplify a low, external voltage for "horizontal sweeping." A fairly high-gain stage is therefore desirable. A pentode-connected 6C6 is ideal for this purpose and has been used.

It will be noted that this valve is operated from the 450-volt "above ground" supply through a 100,000 ohms plate load resistor (R14). As a result, a considerably greater distortionless output is obtainable than would be the case if the valve was operated under normal "250-volt" conditions. A degree of low frequency degeneration is introduced in this stage by the use of a low value bypass condenser (C15) across the cathode bias resistor. This has the effect of sustaining the amplifier response at the higher frequencies and this factor, together with the low plate load resistor, ensures that virtually "flat" amplification between the limits of 20 to 20,000 cycles is secured. Above the upper limit the response gradually drops off until at 70,000 cycles it is down about 50 per cent.

The gain of this amplifier is considerably higher than is required to lift the output of the 885 to the necessary level, and to avoid working the gain control (R7) too low down, and also to avoid excessive loading of the 885 circuit, the output from the 885 is fed to R7 through a one megohm resistor (R6). This resistor together with R7 forms a voltage divider and makes a third of the 885 output available for amplification. Condenser C13 is a 25 mmfd. mica unit and is shunted across R6 to keep the attenuation constant at the higher frequencies.

In order to make this amplifier available for use with an external horizontal sweep, a switch (S2) is inserted. This switch enables the amplifier to operate on either the internal sweep, 50 cycle A.C., or an external sweep voltage injected at the terminals marked "EXT. SWEEP AMP."

Should this amplifier not be required for any of these services it can be cut out of circuit by placing the S.P.D.T. toggle switch S5 in the "Direct" position. This connects the "D1" or "X" plate of the 913 direct to the "X" terminal and a horizontal sweeping voltage may be supplied direct to the 913.

Synchronisation.

It is often necessary to synchronise the output of the 885 with some voltage under examination for the purpose of "locking" the pattern in the centre of the 913 screen. The synchronising voltage is selected by means of the "Sync. Selector" switch (S1), and may be either the voltage under examination ("Int." position), 50 cycle A.C., or an external supply. The amplitude of the synchronising voltage supplied to the 885 is controlled by the potentiometer marked "Sync. Volt. Cont." (R1). Details of the operation of this control will be given later.

Vertical Amplifier.

As the majority of the voltages encountered by the radio design or service engineer will be lower than that required to fully sweep the screen of the 913, an amplifier is desirable for the purpose of boosting these voltages to the required level.

Such an amplifier is provided by the 6C6 at the lower right of the circuit diagram. The characteristics of this stage are in every way identical with those of the horizontal sweep amplifier dealt with previously, so there is no necessity to elaborate further on that point. This amplifier is brought into circuit by the D.P.D.T. toggle switch (S4) and the gain of the stage is controlled by the potentiometer (R12) marked "'Y' Amp. Control."

This completes the descriptional matter dealing with the design of the instrument. Details regarding the choice of components and construction of the instrument will now be given.

(In connection with this it is of interest to note that the circuit of fig. 1 was published twice in "Radio Review." The parts list appened to the circuit as first published, contained a number of components which were difficult to obtain. Several revisions (mainly in connection with tolerances permissible) were made before republication and certain paragraphs in the following matter refer to these revisions).

Component Values.

Perusal of the parts list printed below the circuit diagram will show that several minor modifications have been effected in the values of the components since the original list was published last month.

These changes were dictated by the desirability of using standard, readily available components wherever possible and result in an appreciable simplification of the "obtaining parts" problem.

On looking over the list of components again, it will be noted that the only items which cannot be found in almost any "replacement" stock (with the exception of the power

(Continued on Page 218.)

C.R.O. DESIGN

(Continued.)

transformer and the eight contact switch) are the condensers C2 to C8, inclusive.

It must be admitted that condensers of the values specified for these positions, and with the original tolerances, are not easy to obtain. Granted that if the constructor has a large stock of condensers on hand and a "condenser analyser" available, he can sort out the required values, but everyone is not so fortunately placed. Consequently, the average constructor must rely on external sources of supply. This means that the parts required must be as non-critical as possible.

In order to satisfy this requirement, it was decided to provide a greater degree of overlap on the linear sweep frequency bands represented by the switch positions which brought C2 to C8 into circuit. The simplest way to do this is obviously to increase the range of the sweep frequency vernier control (R5).

Actually, however, this is not so easy in practice, as one megohm is the highest potentiometer value readily obtainable in Australia. This means that we have to fall back on indirect means of doing the job. Inspection of the circuit diagram will show that the 885 oscillator is "tuned" by R4 and R5 in series. R4 was originally specified as 500,000 ohms, and this value, in conjunction with a one megohm potentiometer (used as a rheostat) permits a total resistance variation in the ratio of three-to-one.

By reducing the value of R4, this ratio can be increased and a similar effect to that obtained by increasing the value of R5 is accomplished. In view of the high voltage from which the 885 is operating in this circuit, it is not desirable to reduce R4 by very much.

Working along these lines, a value of 250,000 ohms was finally decided upon for R4. This made it possible to obtain a resistance variation ratio of five to one without changing R5 at all. On replacing the original 500,000 ohms resistor in the experimental model oscillograph with a resistor of the new value, it was found that a frequency variation nearly 50 per cent. greater than previously could be obtained. The net result of this was, of course, that condensers C2 to C8 were no longer critical in value, and that units of "standard" (up to plus—minus 10 per cent. or so) tolerance could be used and still ensure overlap between the bands.

A further result, found by experiment, was that condenser C7, which previously had to be made up by placing an 0.1 mfd. and an 0.05 mfd. unit in parallel, could be reduced to 0.1 mfd. and still obtain overlap on the three lower frequency bands.

Condenser C5 in this bank of condensers is another "non-standard" value (0.015 mfd.) but can be easily made up by placing two units, of 0.01 mfd. and 0.005 mfd. capacity respectively, in parallel. Units of these capacities are quite compact in dimensions and their mounting in parallel presents no difficulty.

The remainder of the units in this bank are all standard, readily obtainable values, and now that ordinary "commercial" tolerances are permissible, no difficulty will be experienced in obtaining supplies.

While on the subject of condensers, it might be mentioned that, should any difficulty be experienced in obtaining a 25 mmfd. unit for position C13, no serious effects will result if a 50 mmfd. unit is used in this position. On no account should this latter value be exceeded, however, as the proportion of high sweep frequencies fed to the "horizontal" amplifier control (R7) will then be excessive. Conversely, do not fall into the error that, because 25 mmfd. is a very small value, the use of C13 is unimportant, and it can therefore be omitted. A condenser having a value somewhere between 25 and 50 mmfd. must be used in the position indicated.

Resistors.

All of the resistors used are standard in value and, with the possible exception of the potentiometer used as spot intensity control (R17), no difficulty should be experienced in obtaining the correct values. R17 has a value of 15,000 ohms and is rather critical as any appreciable variation in its value will upset the voltage distribution in the "below ground" divider (comprising R17, R18, R19, R20 and R21), which supplies the 913 electrodes.

As it happened, we had a 15,000 ohms carbon type potentiometer on hand when we built up the experimental model, and naturally assumed that supplies were generally available. Enquiry since that time, however, has elicited the fact that 15,000 ohms carbon potentiometers are distinctly rare at the present time; values up to about 25,000 ohms usually being wire-wound. Whilst there is no technical objection to the use of a wire-wound potentiometer (in some ways its use is to be commended) inspection of the circuit will show that the contact arm of R17 is operating at a potential considerably "Live" with regard to "ground." As by far the greater majority of wire-wound potentiometers have their contact arms electrically connected to the control spindle this mean that should a potentiometer of this type be used, the spindle will be "live" also, and with it, the mounting bush. Insulation of the mounting bush presents no great difficulty, but it is not desirable to have a "live" spindle projecting from the front of the panel, even if it is fitted with a bakelite knob.

For these reasons the use of a carbon potentiometer of the standard insulated spindle type is advisable. A satisfactory solution of the problem is readily available, and, should a unit of the correct value not be obtainable, it is quite in order to use a 25,000 ohms potentiometer with its element shunted by a 40,000 ohms fixed resistor. The final value of the parallel combination will then be very close to 15,000 ohms and the correct voltage distribution will be obtained.

Switches.

A word about the switches will be in order before detailing the actual construction of the instrument. S4 and S5 will present no difficulty as they are standard miniature "toggle" units of the type used for pick-up switches and a number of other everyday jobs. S1, S2 and S3 may at first appear to be "non-standard" but, actually, they can be made up from standard wave-change switches without any difficulty. As a matter of fact, the use of such switches is advisable, because they are usually equipped with a sturdy locating device ("clicker plate"), and this feature is very useful.

Switches S1 and S2 may be single sections (on separate wafers, of course), of one of the wave-change switch wafers which have three sets of three contacts on them. If wafers of this type are not available or if the constructor has wafers of the five-contact type on hand that he would like to use, the five-contact type may be used; the only alteration necessary being to fit an extra stop so that only three contacts are brought into circuit.

Switch S3 presents a little more difficulty if a standard eight-contact switch cannot be obtained. However, the ever-useful wave-change switch comes in useful here again, and by removing one stop from the clicker plate of a single wafer, five-contact, two-bank switch it will be found that a total of ten contacts is available, with a gap in the middle. Only eight contacts are required, however, so that it is advisable to fit another stop to limit the rotation to the desired degree. The gap in the contacts will not be objectionable, but the mechanically-minded constructor with a passion for detail will find that it is quite possible to transfer one of the blank contacts to the open position and so ensure a continuous sequence of switch contacts. A slight alteration to the contact strip will be necessary to effect this.

None of the remaining components present any difficulty so that assembly of the complete instrument may now be proceeded with.

C.R.O. DESIGN

(Continued.)

Assembly Details.

The chassis employed for assembly of the experimental instrument measures 8 ins. wide by 11 ins. long, and is 3 ins. deep. A half-size plan of the layout employed is shown in fig. 2, and as all of the components employed were of standard dimensions, no difficulty should be experienced in duplicating the original layout.

The power transformer is the only component likely to vary much in size, but as long as the core does not measure more than 4½ ins. by 4 ins. no trouble will arise from this angle. Actually, the unit used in the experimental model had a standard "radio power transformer" core measuring 3⅞ ins. by 3½ ins. with a 1½ inch stack, but even a core as heavy as this is not necessary. The entire load does not exceed 40 watts, so on this basis it can be seen that a power transformer built up on quite a small core (similar to those used for power transformers in midget receivers) will be satisfactory if the necessary insulation between the various windings can be accommodated.

The filter choke, also, need only be a small unite, and in the experimental model a choke having a core size of 2¾ ins. by 2¼ ins., with 11/16 in. stack, was used. The D.C. resistance of this unit is not at all important as the total current flowing is under 20 mA. and is substantially constant. The unit used had a resistance of somewhere around 500 ohms and proved quite satisfactory. If a choke of similar physical size to this is employed, it may be mounted on the side of the chassis, directly above, and centred between, the two rectifer sockets. This means that the sockets must be wired up first of all, but there is no reason why this should not be done. The particular location mentioned is advantageous because there is little or no likelihood of stray magnetic fields from the choke linking up with the signal input circuits of the instrument and so inducing "hum" voltages.

The chassis itself may be bent and punched from fairly heavy aluminium sheet or may be of plated steel; the actual material is not important. The positions of the components shown in the layout of fig. 2 are the same as those employed in the experimental model and, as the drawing is made to scale, the relative measurements and positions may be readily ascertained.

In addition to the component mounting holes, it will be necessary to punch several others for leads between the panel components and those under the chassis. It is advisable that these be made about half

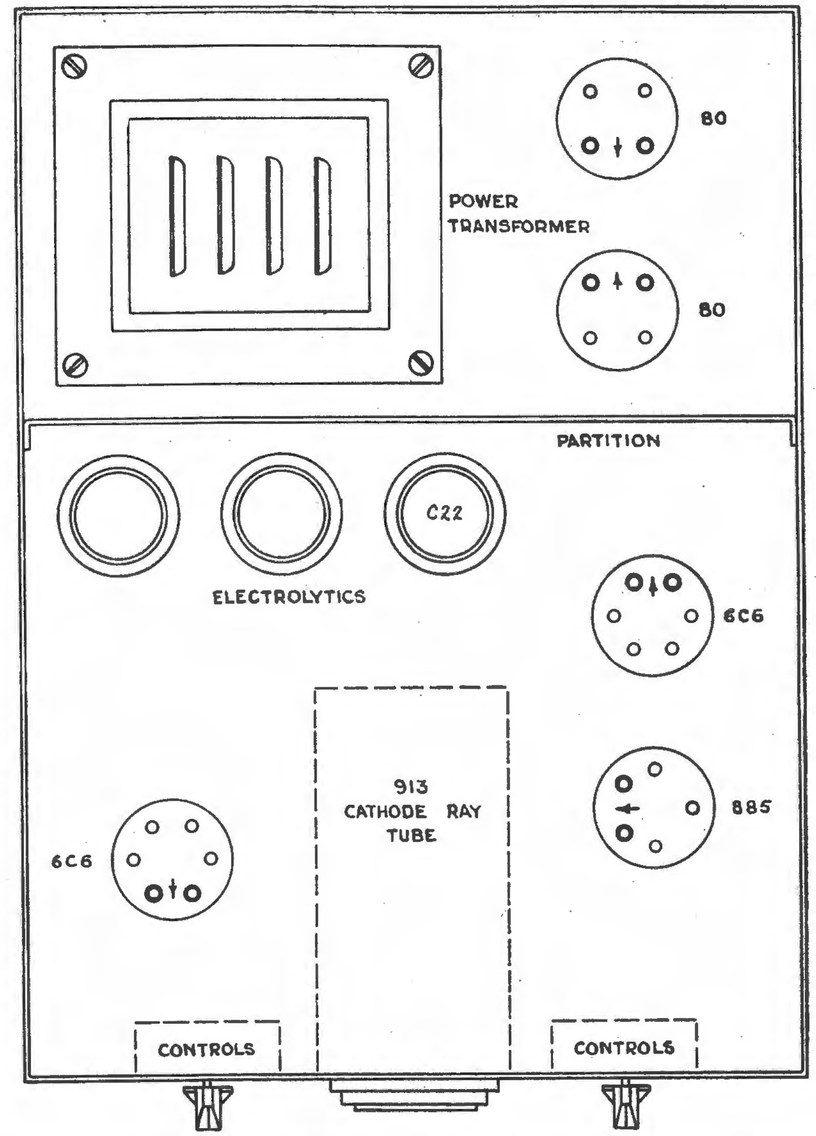


Figure 2—Suggested chassis layout forthe 913 oscillograph. The drawing is made to ½in. = 1in. scale.

an inch in diameter and fitted with rubber grommetts. Four of these holes should be sufficient and suitable locations for these are: One central between the two sides and about 4½ inches back from the front of the chassis, and the other three spaced equidistantly across the top of the chassis (directly behind the controls) and about one inch back from the front edge.

A suggested panel layout is shown in Fig. 3. This is the actual layout used for the controls of the experimental model and works out very nicely from a wiring viewpoint. This drawing is also half-size and, as all of the components used were of standard dimensions (wave-change switches were used for S1, S2 and S3), no difficulty in reproducing the layout should be experienced. It will be noted that this panel, in order to make a neat fit in the box, should actually be two thicknesses of metal wider than the chassis (approximately ⅛in. when using 16 gauge material). The panel dimensions given last month were 8in. by 9in., so that an ⅛in. should be added to each of these if a panel overlap is desired. These revised dimensions are those actually depicted on the drawing shown in Fig. 3.

The method of panel mounting employed is immaterial, but assembly will be simplified if the panel and chassis are made separately. This means that the five controls shown below the chassis level in the panel layout will be mounted through two thicknesses of metal, but that is no disadvantage. If this is done, the chassis proper will be a complete

(Continued Overleaf.)

C.R.O. DESIGN

(Continued.)

rectangular "dish" (turned upside down, of course) and will be much stronger.

For mounting of the 913 it will be necessary to make a "U"-shaped bracket three inches long and $1\frac{3}{4}$in. wide and with $\frac{1}{2}$in. flanges turned outwards at the ends of the long sides of the "U" for mounting the bracket to the panel. A strip of material $8\frac{3}{4}$in. long and about $1\frac{3}{4}$in. wide will be required to form this bracket. Before bending, a $1\frac{1}{8}$in. hole should be punched in the centre of the strip so that the 913 socket can be mounted at the bottom of the "U" when the bracket is complete. This bracket should be bolted to the panel so that it "straddles" the hole for the 913 viewing screen.

The hole for the 913 viewing screen need only be $1^{5}/_{16}$in. in diameter to take the body of the tube, but unless the hole is made sufficiently large to admit the flange at the base of the 913 it will be necessary to remove the bracket to insert the 913. To overcome this difficulty, the hole should be made $1\frac{5}{8}$in. in diameter and the vacant space filled in by a readily-detachable front plate or ornamental escutcheon of some kind.

Even if it is decided to make the bracket readily removeable from the panel to permit of easy removal or insertion of the 913 without a large panel hole, it will be necessary to make the hole slightly larger than the diameter of the tube in order to allow a sliding, tubular light shield to be fitted. This "light shield" merely consists of a piece of thin tubing with an internal diameter of about $1^{5}/_{16}$in. (so that it will slide easily over the 913) and about $3\frac{1}{2}$in. long. A section cut from the can of a faulty "wet" electrolytic condenser (some makes only) does the job admirably, but should be painted black before use. Failing this, a piece of thin-walled bakelite tube will do the job. The hole in the front panel must be made big enough to take the external diameter of this tube. When not in use, this light shield is slid back over the 913 until it reaches the flange at the base. It will then be almost flush with the screen and will not be in the way when handling the instrument. In operation, it is slid forward as far as desired and ensures that light is prevented from falling directly on the 913 screen. Less spot intensity will therefore be required to provide a useful pattern and greater tube life will result. An additional advantage is that a shield of this description forces the operator to look straight at the 913 screen and apparent pattern distorition is thus avoided.

While on the subject of the 913 it is as well to mention that a **rotatable** socket should be used. The reason for this is that, although the 913 is

(Continued on Next Page.)

Panel Layout for 913 Oscillograph

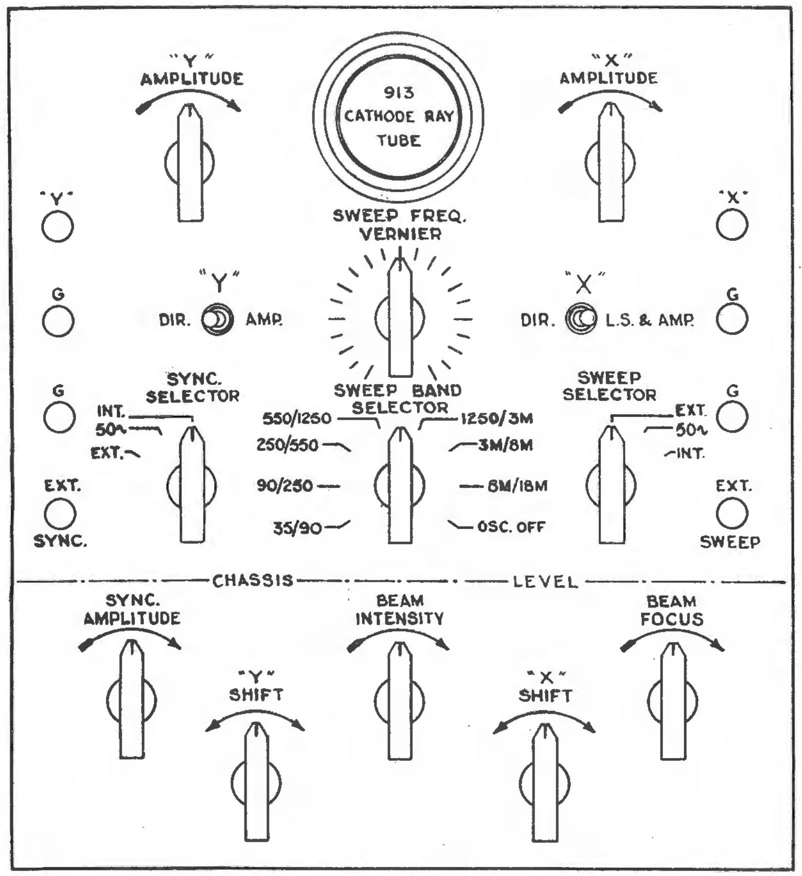


Figure 3. Suggested panel layout for the 913 oscillograph. The drawing is made to a $\frac{1}{2}$in.—1in. scale, and as all of the components used in the original were of standard dimensions, no difficulty in reproducing this layout should be experienced.

The various control designations shown are abbreviations of the titles given them in the text and, if engraved on the panel, will simplify handling of the instrument considerably. The sweep bands shown are in cycles per second, and are intended to serve as an indication only; actually, the bands overlap quite appreciably and the amount of this overlap (in cycles) becomes greater as the frequency is increased.

To avoid constant reference to the text when following this layout, the various controls, in terms of the titles given them in the text and their circuit diagram indices, are as follows:—

"Y" AMPLITUDE—Vertical amplifier control—R12.

"X" AMPLITUDE—Horizontal amplifier control—R7

SWEEP FREQ. VERNIER—Sweep frequency vernier control.—R5.

"Y," DIR., AMP.—Vertical input selector—S4.

"X," DIR., L.S. and AMP.—Horizontal input selector —S5.

SYNC. SELECTOR — Synchronising voltage selector —S1.

SWEEP BAND SELECTOR—Sweep frequency band selector —S3.

SWEEP SELECTOR—Horizontal sweep selector —S2.

SYNC. AMPLITUDE—Synchronising voltage control—R1.

BEAM INTENSITY—Spot intensity control—R17.

BEAM FOCUS—Spot focus control—R19.

"Y" SHIFT—Vertical pattern shift control—R28.

"X" SHIFT—Horizontal pattern shift—R27.

TERMINALS.—The "Y" terminal is for the connection of all voltages under observation; these may be amplified by throwing the "Y" switch to the "AMP." position or connected direct to the D3 plate of the of the 913 by using the "DIR." position. The "X" terminal is only used when it is desired to feed a horizontal deflecting voltage direct to the D1 plate of the 913. The "X" switch is placed in the "DIR." position under these circumstances.. Normally, the "X" switch is left in the "L.S. and AMP." position so that an amplified sweep voltage is fed to the horizontal plates.. The source of this voltage is selected by the "SWEEP SELECTOR" control and may be either from the 885 ("INT."), 50 cycles A.C. supply ("50c."), or an external source ("EXT.") In the latter case the external sweeping voltage is connected to the "EXT. SWEEP" terminal. The "EXT. SYNC." terminal is used should it be desired to synchronise the operation of the 885 with an external voltage source (such as a frequency sweep during receiver alignment) and is brought into circuit by placing the "SYNC. SELECTOR" control in the "EXT." position. Incidentally, this control also allows 885 synchronisation to be effected from the voltage under examination ("INT.") or from 50 cycles A.C. ("50c.")

C.R.O. DESIGN

(Continued.)

designed to provide a horizontal pattern when the locating key on the base is facing **downwards**, manufacturing tolerances are such that slight deviations from this occur from tube to tube. To correct this it is necessary to rotate the tube a few degrees and the only satisfactory means of accomplishing this is to use a rotatable socket. The only octal socket on the Australian market which permits this is the Amphenol, supplies of which can be obtained from International Radio Co. Ltd. A further point to remember in connection with this is that the leads to the 913 socket should have a little play. If they are made rigid, it will be impossible to move any kind of socket.

Finally, in order to make a neat job of the 913 assembly, and to prevent accidental shocks from the "hot" contacts on the socket, the back of the socket should be encased in a fitting of the type used to make "Magic Eye" assemblies more or less foolproof. These fittings can be obtained from most wholesalers, and the slight extra expenditure involved is amply repaid by the improved finish of the instrument.

Mention of accidental shocks brings to mind electrolytic condenser C22. This has been mentioned previously as a potential source of danger because the negative electrode or can is at a potential somewhere near 450 volts "below ground." As the frame of the instrument is "ground" it is fairly obvious that anyone touching the electrolytic can and instrument frame at the same time would receive a nasty burn. (We **know**, because we **did!**)

The only way to prevent this is to surround the can with an insulating shell, such as a piece of bakelite, or even cardboard, tube with a bakelite or cardboard disc cut to fit snugly into its open top end. If no tube is available which will fit the electrolytic can, wrap it with insulating tape or empire cloth. This will not look so good, but will eliminate the chances of shocks and short circuits. Incidentally, it will simplify wiring a little if C22 is mounted in the position indicated on the chassis layout (fig. 2).

Very little more remains to be said about assembly. The partition shown in the chassis layout is merely a flat piece of metal flanged on three sides for attachment to the chassis and sides of the box. If used, this partition should reach to the top of the box. While not strictly essential, the use of this partition will minimise any possibility of hum induction from the A.C. power end of the instrument.

The socket contact positions shown in the layout are those used in the experimental model and proved to be most satisfactory from a wiring point of view.

Wiring Details.

The actual wiring of the instrument presents no particular problems, but a few details concerning the layout of the wiring should be useful.

On assembly of the instrument it will be found that there is a clear space, some four inches in height, between the chassis and the 913 bracket. As this space is directly behind the "Sweep Band Selector" control (S3) it is recommended that it be used for the condensers C2 to C8, instead of mounting them under the chassis. This will make the leads to the switch considerably shorter and will keep the self-capacity of the sweep oscillator circuit wiring down as low as possible —a desirable feature on the higher frequency bands.

As will be noted from the panel layout, the sweep band tuning condensers are connected so that the frequency increases as the control is rotated to the right (clockwise). This means that condenser C8 will be connected to the first contact of the switch (the one on the right when looking at the **back** of the switch when wiring), and that the blank position will be on the extreme left. Wiring in this order is standard practise on the larger, commercial instruments and adherence to this rule will simplify handling of this unit.

In order to keep this frequency variation "law" uniform for the sweep circuits, it is necessary that the "sweep vernier" control (R5) be wired so that **maximum** resistance is in circuit when the control is turned fully to the **left**. Clockwise rotation of the control will then decrease the amount of resistance in circuit until it is at a minimum when the control is at the extreme right.

As the two 3-point switches (S1 and S2) are both calibrated in the same manner, it will simplify matters if they are both wired in the same order (same as shown on the panel layout) so that for "internal" operation they are both in the same relative position. It should be remembered that the "synchronising voltage selector" (S1) becomes inoperative when either "50 cycles" or an external sweep voltage is used. This should be self-evident, as the sole purpose of synchronisation is to keep the 885 "in step." This latter remark also applies to the "synchronising voltage control" (R1).

With the exception of the two "pattern shift" controls (R27 and R28), all of the controls rely on an increase of potential for their functioning and, to achieve some degree of standardisation, it will be as well to use a "clockwise increase" law throughout in the control wiring. This means that each of the controls (with the exception of the two mentioned) should be wired so that the point of highest potential is at the right-hand end of the control range (left-hand end when looking at the back during wiring).

The two "pattern shift" controls rely on variation of the 913 deflecting plate potentials on either side of "ground" potential for their operation. As it happens, the application of a positive potential to the D1 deflecting plate causes the pattern to move across the screen to the right if the 913 is mounted as previously indicated (base locating key facing downwards), it will be found convenient if the right-hand end of R27 is **wired** to the junction of R24 and R26. The ends of R28 should be wired to the same points, in the same order, as the ends of R27.

In order to keep wiring at a minimum, it will be found convenient if condensers C13, C14 and C21, together with resistors R4, R6 and R29, are mounted directly to their associated panel components above the chassis. This will "clean" the wiring up considerably and also ensure that stray couplings will be reduced to a minimum.

The question of "stray couplings" is rather important, especially with relation to the synchronising arrangements. It will be quite evident that very little unwanted induction of electrostatic coupling is required to upset the grid circuit of the 885, and for this reason it is desirable that all leads be kept as short and direct as possible.

The only "synchronising" lead which will be longer than an inch or so will be the connection between the contact arm of R1 and the 885 grid resistor (R2). This lead goes from one side of the chassis to the other, and should be made of shielded hook-up wire with the braiding earthed.

Under the chassis it will be found that quite a number of components have to be mounted in a limited space. In order to keep the assembly as firm as possible, a terminal board of the type used to mount components in radio receivers will be found useful. This board need only be about $3\frac{1}{2}$ inches long and 2 inches wide, and should be mounted between the 885 and left-hand 6C6 sockets. This board should carry six or seven contacts on each of its two long edges, and will be found most convenient if mounted about an inch and a half "up" from the underside of the chassis. Condensers C19 and C20 can then be accommodated underneath it and the associated resistors on top. This board will be found very useful when wiring of the various "divider" resistors is attempted.

Operation.

When the instrument is completely wired do not just put the valves in and hope for the best. Check over the resistance of all the circuits care-

(Continued on Page 222.)

C.R.O. DESIGN

(Continued.)

fully and make sure that all of the controls are functioning as they should. Make sure there are no stray "blobs" of solder in places where they might possibly cause trouble, and, above all, don't forget that close to **900 volts** is developed between the top end of R22 and the low end of R17.

Having made reasonably sure there will be no arc-overs or direct short-circuits, plug in the two rectifiers and switch on the power. The drains imposed by the various valves are so low that the voltages under "no-load" conditions will be very close to those under operating conditions, so that a fairly accurate check-up can be made.

A high resistance (at least 1000 ohms per volt) meter will be required to make the measurements and this should be used on the highest possible scale. With the **negative** side of the meter grounded, a potential between 400 and 450 volts should be obtained at the top end of R22; approximately 200 volts should be obtained at the junction of R23 and R24; about 100 volts at the junction of R23 and R26; and about 6 volts at the junction of R25 and **R26**.

The **positive** side of the meter should then be grounded and, using the negative lead as a probe, potentials of approximately 100 volts should be obtained at the junction of R20 and R21; 220 volts at the junction of R19 and R20; 320 volts at the junction of R19 and R18; and 370 volts at the junction of R17 and R18. The total potential across C22 will be approximately 420 volts.

If these voltages are realised, the power should be switched off, and all controls, with the exception of R27 and R28, should be returned to their minimum positions. R27 and R28 should be set at an intermediate position half-way between their extreme left and right settings. The "synchronising selector" and "sweep selector" controls should both be set at "internal" and the "sweep band selector" may be left on any of the active studs. The two toggle switches should be in the "Amp." position.

The remainder of the valves may then be inserted and the power switched on. After allowing a minute or so for the valves to heat up, the "focus" and "intensity" controls should be slowly advanced until a spot of light is seen on the screen. Immediately this appears, the "X" amplitude control should be advanced until the spot widens out to a line. The "focus" and "intensity" controls may now be adjusted until a clean well-defined line of the desired intensity is obtained.

The only remaining adjustment to be made is to see that the cathode potential of the 885 is adjusted to exactly 6.5 volts. If a semi-fixed resistor has been used (R25) as recommended, no difficulty will be experienced in doing this.

Calibration.

The instrument is now ready for calibration and use. The functions of the various controls have been dealt with fully in the preceding matter, and are summarised conveniently in the captional notes associated with Fig. 3. It is recommended that the constructor fully familiarise himself with the various controls and terminal arrangements before attempting to use the instrument.

Calibration of the sweep frequency controls is desirable, as if this is done identification of the frequency of any unknown voltage under examination is simplified and handling of the instrument is facilitated. Calibration of the "X" and "Y" amplifiers in terms of voltage input for a given pattern size is also useful and should be effected if possible.

The "sweep bands" shown on the panel illustration (Fig. 3) will be found substantially correct, although, as mentioned in the accompanying matter, the actual frequency range covered on each band is somewhat greater than shown. The following were the ranges actually covered by the controls on the experimental instrument:—

Band 1, (C8)	35—	95 cycles
Band 2, (C7)	90—	250 cycles
Band 3, (C6)	220—	600 cycles
Band 4, (C5)	500—	1400 cycles
Band 5, (C4)	1300—	3700 cycles
Band 6, (C3)	3000—	8200 cycles
Band 7, (C2)	7000—	18000 cycles

(The eighth position cuts the oscillator out of operation.)

It will be noted that the frequency ratio in each case is just under three to one. It is possible to obtain larger frequency ratios than this (instruments have been seen with frequency ratios as high as four to one on each band) but there is no particular advantage in doing so, apart from a reduction in the number of band switch positions. On the other hand, a higher frequency ratio on each band tends to make the setting of the "sweep frequency vernier" control to a desired frequency much more difficult. Even as it is, each degree of rotation of the "vernier" control changes the oscillator frequency by over 40 cycles when operating on the highest frequency band.

The above band coverages will apply, with slight variations, to any instrument built up to the specifications given in the circuit diagram of Fig. 1. However, the minor variations which undoubtedly exist (due to the tolerances of commercial parts) will have the effect of leaving the operator somewhat "at sea" when using the instrument unless it has been individually calibrated.

The simplest means of effecting this is undoubtedly by means of a beat-frequency oscillator, and, if one is available, this instrument should be employed for the job. The procedure necessary is to couple up the "Y" input terminals of the oscillograph to the output of the B.F.O. (after both have been thoroughly warmed up); switch in the "Y" amplifier; switch in the linear sweep and turn the sweep selector to the "internal" position; adjust the sweep frequency controls of the oscillograph to the lowest frequency setting, and rotate the B.F.O. dial until a single sine-wave pattern is seen in the screen of the 913. During this procedure the synchronising voltage selector should be on the "internal" position and the synchronising voltage control should be fully retarded. On locating the single sine-wave pattern, the B.F.O. dial should be adjusted until the pattern is as stationary as possible. It may not be possible to keep it absolutely still and, in this case, the synchronising voltage control should be advanced slowly until the pattern does keep still.

If everything is in order, the frequency so located should be between 30 and 40 cycles; if it is above or below these limits, the high frequency limit of the oscillator will be considerably different from the 18,000 cycles specified. To adjust the low-frequency limit to the required setting it will be necessary to alter the bias on the 885 slightly. This was specified as being 6.5 volts, and under most circumstances this will result in the lowest frequency setting falling within the specified limits.

However, it is possible that, due to minor circuit or valve variations, the lowest frequency obtainable will be above or below the limits mentioned. Adjustment of the 885 bias will correct this by altering the voltage at which the plate circuit tuning condenser discharges. If the lowest frequency obtainable is **below** 30 cycles it will be necessary to **reduce** the 885 bias slightly, and conversely, if it is **above** 40 cycles, the bias should be increased. This adjustment can be made with the oscillograph still in operation, and connected to the B.F.O., as long as due care is taken to keep away from the high-voltage leads. If this is done, the effect of very small changes in the bias may be noted immediately by keeping the B.F.O. dial adjusted to maintain a single-cycle pattern.

Once having arrived at the correct low-frequency setting, the sweep controls may be calibrated by advancing the B.F.O. frequency in small steps

C.R.O. DESIGN

(Continued.)

and "following" it with the sweep controls. An alternative procedure is to determine the limits of each band first and "filling-in" the sweep frequency vernier intermediate positions after the coverage of each band has been determined.

As the settings will not alter appreciably after the initial adjustment, it is suggested that the vernier control be fitted with an 0-100 scale and a "frequency/rotation"graph be prepared for each band. Calibration for frequencies over 12-15,000 cycles will be rather difficult as the majority of beat-frequency oscillators available do not go past the limits mentioned. However, an accurate calibration above about 10,000 cycles will rarely be necessary as the majority of work will be done on frequencies within the normal reproduction range of radio receivers and amplifiers.

If a beat-frequency oscillator is not available, quite a satisfactory job of the calibrations up to 6-8,000 cycles can be made by means of a constant-frequency record and a gramophone motor and pick-up assembly. The output from the pick-up is fed to the "Y" input terminals in the same manner as the beat-frequency oscillator.

Calibration of the "voltage-sensitivity" of the oscillograph calls for the use of a beat-frequency oscillator and a vacuum-tube voltmeter. It will be necessary to fit a piece of squared celluloid in front of the 913 screen for this purpose in order to provide a "yard-stick" for measurement of the pattern. The procedure necessary is to feed the signal from the B.F.O. into the "X" or "Y" input terminals; turn the oscillograph amplitude control hard on; adjust the B.F.O. output control until a line of convenient length is obtained on the screen, and measure the input to the oscillograph from the B.F.O. This should be repeated at a number of frequencies and the results tabulated. A calibration of this nature will prove very convenient and will obviate the necessity for connecting up both the C.R.O. and a V.T.V.M. when it is desired to obtain an indication of the amplitude of any small voltage under examination. The calibration may be in either r.m.s. or peak volts input, and depends on the type of V.T.V.M. used for the original measurement.

As indicated at the commencement of these notes, this instrument will perform any of the functions of the larger instruments and those not already familiar with the uses of these devices are referred to any of the standard manuals on the subject or the columns of "Radio Review."

The Determination of Receiver Characteristics

AN important phase of the radio laboratory technician's work is found in the determination of radio receiver characteristics, either of receivers under development or completed receivers. The major characteristics usually to be determined are the receiver's sensitivity and selectivity, but others, almost as important, are the determination of its "noise" output percentage at varying degrees of sensitivity; the characteristics of its automatic volume control system and its overall fidelity. The following notes describe how these various characteristics are determined with the aid of the equipment normally available in a fairly well-equipped radio laboratory.

The equipment normally needed for tests of this type consists of a "standard" signal generator with calibrated output up to about one volt and capable of external modulation; a set of "dummy" aerials for matching the generator to the receiver under test at various frequencies; an output meter of the copper oxide or thermionic rectifier type, and a beat-frequency oscillator.

The characteristics of a standard signal generator should be sufficiently well-known to all technicians to require no further description, but should any information be required on this subject, readers are referred to pages 206—218 of the 1936 edition of the "Radio Trade Annual" or to the July, 1935, issue of "Radio Review of Australia."

A beat-frequency oscillator is basically an audio-frequency signal generator and is usually capable of supplying a pure audio-frequency output of any frequency up to about 12-15,000 cycles with an amplitude of fifteen volts or more across a load in the neighbourhood of 5,000 ohms. Those requiring further information on this subject are referred to the October, 1936 issue of "Radio Review of Australia."

The output meter may be any type of A.C. voltmeter capable of providing accurate indications over a range of frequencies up to about 12-15,000 cycles. For preference, this voltmeter should have a practically infinite input impedance (such as a V.T.V.M.) or be capable of adjustment to provide any desired load. This latter is important as it can readily be appreciated that if the output valve in a receiver is "mismatched" the output indications obtained will be inaccurate.

The "dummy" aerial used for coupling the receiver and signal generator will depend on the frequency of operation and also the type of aerial to be used with the receiver.

For standard quantative comparisons of receiver characteristics on frequencies up to about 5 megacycles it is usual to employ a "4-metre" dummy. This consists of a series combination of inductance, capacity, and resistance arranged as shown in Fig. 1.

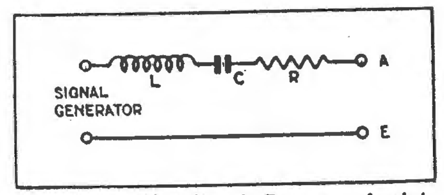


Figure 1—Circuit of Dummy Aerial.

The values for these are normally specified as being 20 microhenries, 200 micromicrofarads, and 25 ohms, respectively, but it should be remembered that there is already some resistance present in the form of the output impedance of the signal generator itself. This is normally somewhere in the neighbourhood of 10 ohms so that the "dummy" itself, in a case such as this, should only contain 15 ohms of series resistance. A combination such as the one just described will have characteristics similar to those of a fairly good outside aerial and will result in fairly accurate alignment of the receiver aerial tuning circuit to suit reception conditions when such an aerial is used.

(Continued Overleaf.)

RECEIVER CHARACTERISTICS

(Continued.)

For reception on frequencies above about five megacycles, an aerial becomes nearly a pure resistance in its behaviour and for this reason the standard "dummy" aerial for measurement and alignment at these frequencies is specified as being a non-inductive resistor of 400 ohms connected in series between the "hot" signal generator terminal and the aerial terminal of the receiver. It is worthy of note that the connecting cable for use on the higher frequencies should be of the low capacity shielded type and not more than fifteen to eighteen inches in length. The cable for use on lower frequencies should also be shielded, of course, but the capacity and length are not so important.

The use of short indoor aerials is becoming increasingly prevalent, and while a "4-metre" dummy is quite satisfactory for comparative measurements, it provides very little indication of the actual performance of the receiver when used on a short indoor aerial (especially if the aerial coupling coil of the receiver is designed to match a small aerial) and is, of course, useless for alignment of the receiver to suit service conditions.

This means that an alternative form of "dummy" is desirable when working on receivers designed for use with small aerials and, to meet this need, several suggestions have been made as to the form it should take. One fairly common system is to simply use a fixed condenser of about 50 micromicrofarads in series between the signal generator and the receiver. This will be fairly satisfactory under most conditions, but there is a distinct possibility that a resonant circuit will be set up at some frequency (especially with aerial coils of the "high impedance" type.) In order to prevent this, or at least reduce its effects, it is necessary to introduce some extra resistance into the circuit and this can be done by placing a resistance of ten to twenty ohms (exact value depends on output impedance of the signal generator) in series with the condenser and another resistance of 250,000 ohms, in parallel with the condenser. The combination then consists of a 10-20 ohms resistor in series with a condenser of 50 mmfd., with a high resistance of 250,000 ohms in parallel with the condenser.

Output Determination.

The standard method of receiver sensitivity determination calls for the development of 50 milliwatts of energy at the output terminals of the reciever.

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, either of which should be connected across the primary of the input transformer of the loud speaker. In either case it is necessary to connect a blocking condenser of at least 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 (or valves) 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.

It should be noted that if a measuring instrument which imposes a resistive load, equal to the rated load resistance of the output valve or valves, is employed, the voice coil circuit of the speaker should be opened when making tests of this nature. Otherwise, the speaker load and meter load will be in parallel and indications will be in error accordingly. This precaution is not necessary if a vacuum-tube voltmeter is employed for measurement purposes.

desired frequency and modulated 30 per cent. with a 400 cycles audio note, 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.

However, the figure so obtained is not necessarily the **effective** sensitivity of the receiver. It should be remembered that in any receiver, no matter how good, there is always a certain amount of inherent noise (due to thermal and "shot" effects, etc.) It is obvious that a signal which does not exceed this inherent noise level will be unintelligible, so that the bald statement that a receiver has "two microvolt sensitivity" (for example) means nothing.

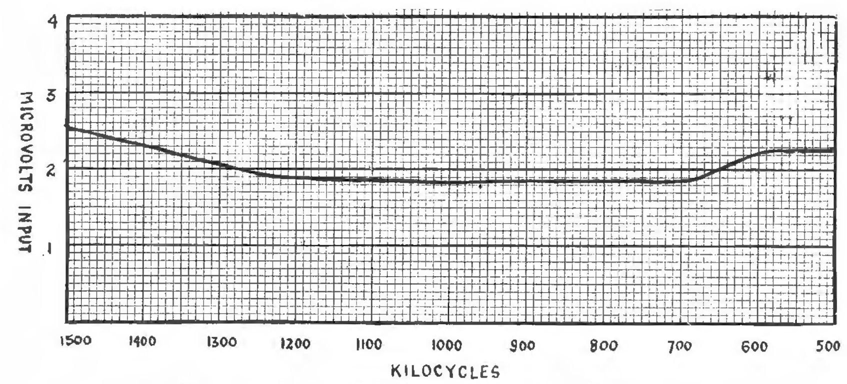


Fig. 2—Typical Sensitivity Curve of Receiver.

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, set to the

This inherent noise can be very misleading to a technician unfamiliar with its manifestations and the fact that no deflection of the output meter is noted when the receiver is switched on, but without the signal generator switched on or tuned to resonance, is often taken as an indication that the inherent noise level of the receiver is so low as to be negligible.

As a matter of fact, most of the inherent set noise does not appear until a carrier is tuned in, and if the signal generator is switched on with

RECEIVER CHARACTERISTICS

(Continued.)

its output already modulated, the noise will not be noticed. The correct procedure is to adjust the signal generator (with modulation on) until 50 milliwatts output is obtained and then switch the modulation off, leaving the carrier still tuned in at the same level as with modulation. In every case, an appreciable deflection of the output meter will still be noted and this will not disappear until the generator is either detuned or switched off. This residual indication is the noise level of the receiver at maximum sensitivity and must be taken into account when determining the **effective** sensitivity of the receiver. This means that an indication on the output meter equivalent to this residual "noise" indication plus another 50 milliwatts, due to modulation alone must be obtained. The procedure is quite simple and merely consists of determining the power output caused by noise alone, **adding** this to the 50 milliwatts originally required and determining the voltage equivalent to the **power** total so obtained. An example should clarify this.

Assume that we are working on a receiver using a type 42 output valve. The load resistance for the 42 is 7,000 ohms, so that, by using the formula for voltage determination given above, it can be found that the voltage indication equivalent to 50 milliwatts in the load is approximately 18.5 volts. The signal generator is connected up and the **modulated** signal adjusted until an output indication of 18.5 volts is obtained. The **modulation** is then switched off and the meter indication will drop back to say, 7 volts. This is the output caused by noise alone, and recourse to fundamental Ohm's law rules will show that this voltage across 7000 ohms is equal to a power of 7 milliwatts. In order to determine the effective **sensitivity**, we must develop 50 milliwatts of output due to modulation alone: therefore, as there will be 7 milliwatts due to noise, 57 milliwatts must be developed in the load of the output valve. Recourse to the voltage equivalent formula will show that, instead of 18.5 volts, the output meter must show an indication of very nearly twenty volts. By switching on the modulation and re-adjusting the output of the signal generator to give a twenty-volt receiver output indication we now obtain the **effective** sensitivity of the receiver.

As an alternative to this, the sensitivity may be expressed as first described (input for 50 mW. output including noise) and the residual noise level (after switching off modulation) expressed as a percentage of the total. Care should be taken to see that it is reduced to its power equivalent before resolving it to a percentage of the output. In the example quoted, the noise level was equivalent to 7 milliwatts. This is just over one-seventh of 50 mW., or 14 per cent.

Either means of expression is equally correct, but one or the other should be used in order to convey a complete picture of a receiver's performance.

These expressions both refer to the sensitivity of a receiver. Another expression, which may be confusing to one not well-versed in the subject is "microvolts per metre."

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 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 resonant frequency 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.

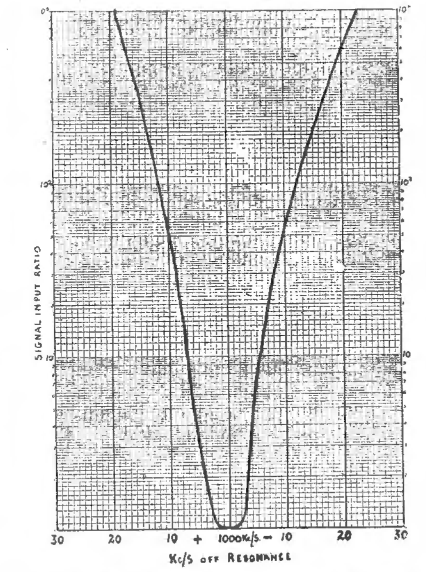


Fig. 3—Typical Selectivity Curve.

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, and the output noted for a given signal input. 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 bring up the generator output until the original output is obtained from 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.

(Continued overleaf.)

RECEIVER CHARACTERISTICS

(Continued.)

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 **low-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. higher in frequency 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 at the particular resonant frequency where the test was made. If desired, the "image ratio" of the receiver may be checked at several other points on the band. This is particularly necessary if the "adjacent channel selectivity" curves of the receiver show marked differences at various frequencies within the band. 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.

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.

A.F. Amplifier Tests.

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 or thermionic rectifier type output meter, which may be matched to the output valve or valves 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.

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

RECEIVER CHARACTERISTICS

(Continued.)

conditions to those applying at 400 cycles with 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 circuits 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 by means of a cathode-ray oscillograph and a special frequency modulated oscillator. The apparatus for this purpose is the same as that used for tuned circuit alignment with the cathode-ray oscillograph, and it can be seen that if an accurately-known frequency sweep is used the side-band cutting propensities of any tuned circuit may be predicted from the shape of the response curve on the screen of the C.R. tube.

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 rectifier type 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 threshold of sensitivity of the receiver. The volume control of the receiver is then adjusted to its maximum position and the reading on the output meter noted. The output of the generator is then increased in ratios of ten until a 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.

Stage Gain Measurements.

Measurements of this 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 these tests are the standard signal generator for radio frequency and intermediate frequency measurements, and 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 the input circuit of the stage. The output indication is then obtained across the plate load of the valve, whether it be a 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 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.

Alignment Procedure for Modern Receivers

MUCH of the performance of the modern radio receiver depends on the alignment of its tuned circuits and, consequently, it is particularly important that the technician have a sound knowledge of the procedure involved in correcting faults or errors in the adjustment of these circuits. The following notes are not new by any means, but are basically sound and will serve to provide any technician with a working knowledge of the principles involved.

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. It is possible that a little difficulty will be encountered here if no official data on the set in hand is available. The procedure in the latter case will be to connect up the oscillator to the grid of the I.F. amplifier valve (the first will do if there are more than one) after removing the grid lead already connected to it. The oscillator dial should then be rotated through a band of frequencies ranging from about 175 kc/sec. up to 475 kc./sec. Quite a number of responses will probably be heard, especially if the I.F. is somewhere near the higher limit, but one of these is bound to be a little louder than the others. If several appear to be equally loud, reduce the oscillator attenuator setting (not the receiver volume control) until only one is heard. Unless the I.F. transformers have been badly mishandled, the frequency at which this response occurs will be very close to the correct intermediate frequency. The procedure from this point on is the same as if the correct I.F. were known, and is as follows:—

The modulated oscillator should be connected to the grid of the first detector valve 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 (mentioned previously) connected in the plate circuit of one of the controlled valves as a resonance and level indicator, 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. The former method is to be recommended, as some receivers have no A.V.C. threshold.

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 miximum output and, for the time being, 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 tracing 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.

ALIGNING MODERN RECEIVERS

(Continued.)

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 end 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. 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 capcity 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 appeared to be tracking quite nicely, as far as indications by reception only showed, but the actual coverage was only from 1,450 k/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 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.

(Continued Overleaf.)

ALIGNING OF RADIO RECEIVERS

(Continued from Page 229.)

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, 3WV should come in between 93 and 95. If 3WV now tunes at 99, it is quite obvious that at least a five 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, at least five 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 are 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 five turns were added to the other coils, 60% of five, or three 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 five turns are taken off the aerial and R.F. coils in a 460 kc/sec. super three 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.

THE "Q" METER

THE Boontoon "Q" meter is undoubtedly one of the most outstanding instruments to be introduced to the radio receiver design engineer during the past few years. Although a number of these instruments are in use in Australia, very few technicians are fully conversant with the principles upon which the operation of the "Q" meter is based. A few notes on this subject should be of interest.

The "Q" meter, as its name implies, is an instrument designed to provide direct indications of the reactance/resistance ratio of a coil or condenser. It has already been shown in an earlier section of this Annual (see "Fundamental Electric Formulae," sub-section, "Resonant Circuits") that the reactance/resistance ratio of any reactive component may be taken as an accurate indication of its merit, so it is quite obvious that any instrument capable of indicating this ratio instantaneously will be of immense value to the radio engineer.

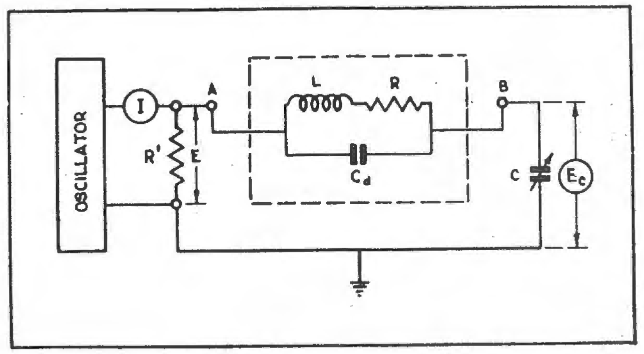


Fig. 1—Schematic diagram of the measuring circuit employed in the "Q" meter.

Description of the "Q" Meter.

Briefly, the Q-Meter contains: (1) a complete r.f. oscillator; (2) a measuring circuit consisting of a tuning condenser system and terminals for connecting the external coils and other components to be measured; (3) a vacuum tube voltmeter of special design which reads the voltage developed across the tuning condenser, and (4) a means for introducing a known amount of the oscillator voltage in series in the measuring circuit.

The oscillator frequency is variable from 50 kc/s to 50 mc/s, in seven ranges. A two-section tuning condenser is used to tune the oscillator, the higher frequency ranges using only the smaller capacitance section. Selection of the oscillator condenser sections is accomplished by the oscillator range-switch.

The oscillator is of ample power capacity and but a small portion of this power is consumed by the "Q" measuring circuit, thereby eliminating reaction of the "Q" measuring circuit upon the oscillator. This small portion of the oscillator output is introduced into the "Q" measuring circuit through a 0.04 ohm non-inductive coupling resistance, as shown in Fig. 1. The current through this resistance is indicated by a thermocouple meter which is calibrated at two settings, corresponding to the two scales of the "Q" voltmeter. The oscillator output voltage is controlled by a plate voltage rheostat.

The "Q" measuring circuit is composed of the resistance coupling unit, the "Q" tuning condenser system, terminals for connecting externally componets to be measured, a vacuum tube voltmeter and the associated leads.

The "Q" tuning condenser system is composed of a main tuning condenser of 450 mmfds. maximum capacitance and a vernier tuning condenser with a finely divided scale having a total capacitance variation of 4 mmfds. The vernier condenser is connected in parallel with the main tuning condenser and is idependently variable. The scale of the vernier condenser is calibrated directly in micro-farads from plus 2 to minus 2 mmfds. Each small division in this scale corresponds to 0.1 mmfds.

The vernier condenser serves a triple purpose: (a) it permits a very fine adjustment of tuning; (b) it permits the measurement of small values of capacitance, and (c) it permits accurate matching of coils or condensers. When

THE "Q" METER—(Description continued.)

the main tuning condenser is set to read 100 mmfds. the vernier may be used to read directly the percentage change in the total tuning capacitance, i.e., a change of 1 mmfd. in the vernier condenser produces a 1 per cent. change in the circuit tuning capacitance. Coils may be quickly matched for apparent inductance or arranged in specified groups by means of the vernier condenser.

The "Q" measuring circuit terminals furnished with the instrument are substantial binding posts which also provide for the insertion of conventional bayonet type plugs. Various plug-in fixtures may be readily constructed to permit the high-speed testing of coils, condensers, and other similar components.

The vacuum tube voltmeter, called the "Q" voltmeter, is specially designed to insure stability in the presence of line voltage fluctuations. A high-gain triode, type 2A6, is used in this circuit. It is calibrated directly in "Q." There are two "Q" scales: 0-250 and 0-500. It is also calibrated directly in volts.

Theory of the Method of Measurement.

The theory of the method of measurement employed in the Type 100-A Q-Meter may be explained with the aid the schematic diagram of the fundamental circuit of the instrument (Fig. 1).

The oscillator furnishes a current, measured by means of the ammeter, which flows through the resistor R^1. This resistance, R^1 (0.04 ohm), will usually be small compared with the other resistances in the circuit and can be neglected, or, if the circuit resistance is especially low, corrected for. A known voltage "E" is thus introduced into the series circuit comprising the variable condenser "C," and the inductive reactor under measurement, connected across the terminals AB. The condenser "C" is contained in the instrument and its effective resistance is negligible.

By way of illustration we shall consider the measurement of the "Q" of a coil having inductance "L", resistance "R" and distributed capacitance "Cd," as shown connected to the terminals AB.

In general, any two-terminal inductive reactor which might be connected across AB can be represented by an effective series inductance "Le" and effective series resistance "Re." At resonance the condenser reactance will balance the effective series reactance betwen A and B and the current will be (neglecting R^1), equal to E/Re.

The voltage (Ec) across the condenser "C" is measured by means of a voltmeter having negligible power consumption. As it has already been shown (see section referred to above, equations 32 and 33) that the developed voltage across a reactive circuit is a function of "Q" and the applied voltage (E), the following relation holds:

$$Ec/E = Qc = 1/2_{\pi}fCRe \quad \ldots \quad (1)$$

At resonance, the reactance of the condenser is equal to the reactance of inductance, that is:

$$1/2_{\pi}fC = 2_{\pi}fLe \quad \ldots \quad (2)$$

therefore

$$Ec/E = 2_{\pi}gLe/Re = Qe \quad \ldots \quad (3)$$

where "Qe" is the "effective Q" of the coil or other impedance connected to the terminals AB.

The effective "Q" differs somewhat from the true "Q" ($2_{\pi}fL/R$), and a detailed analysis shows that, in the case of a coil, the difference depends on the distributed capacitance of the coil.

The relation of the true "Q" to the effective "Q" is given very closely by the following:—

$$Q = Qe\ (1 + (C/Cd)) \quad \ldots \quad (4)$$

except for frequencies very near the natural frequency of the coil. Thus, the effective "Q" approaches true "Q" as the ratio of tuning capacitance to distributed capacitance increases.

From the practical viewpoint of this difference is of little importance since in the design of tuned circuits the minimum capacitance used to tune a coil is usually 10 to 20 times the distributed capacitance of the coil, so that the maximum difference between effective and true "Q" will be 5 to 10 per cent. when measured with the minimum tuning capacitance.

In special cases where coils having a high distributed capacitance are measured with low tuning capacitances and it is desired to know "Q" with high accuracy, the above equation (4) may be used.

MEASUREMENT PROCEDURE—COILS: A coil to be measured should be connected to the coil terminals provided on the Q-meter, the oscillator frequency set to the desired frequency, and the coil resonated by means of the "Q" tuning condenser. Resonance is indicated by maximum deflection of the Q voltmeter. The "Q" voltmeter reading at resonance is the "Q" of the coil.

The tuning capacitance required to resonate the coil may be read directly on the "Q" tuning condenser dial in micro-microfarads. This capacitance is the total circuit capacitance of the measuring circuit in the Q-Meter, including the voltmeter tube and terminals, but with nothing connected to the terminals.

This calibration obtains with the vernier condenser set at zero. With the vernier at some other position the total tuning capacitance is the sum of the readings on the main condenser dial and vernier dial.

When leads or fixtures having appreciable capacitance are connected to the Q-Meter terminals and it is necessary to know the tuning capacitance accurately, the capacitance of these should be measured and added to the capacitance indicated on the dials.

It is quite obvious that the above features may be used for other purposes than that of "Q" factor determination, or, alternatively, other functions can be performed at the same time as "Q" is being determined. An example of this is when "matching" coils in production, and it can be seen that the inductance of a coil under test can be noted, with relation to a pre-set standard, merely by noting the setting of the "Q" tuning condenser and comparing it to that while the "standard" was under test. Simultaneously with this the "quality" of the coil can be noted by checking the indication of the "Q" voltmeter.

MEASUREMENT PROCEDURE—OTHER COMPONENTS: To measure components other than coils—such as condensers, resistors, chokes, and insulating materials—it is necessary to provide a coil which will resonate to the frequency desired within the range of tuning capacitance of the Q-Meter (40 to 450 mmfds.) plus any additional capacitance of the components. This coil should be connected to the coil terminals of the Q-Meter and measurement of "Q" made as described in the foregoing. This value of "Q" is used as a standard of comparison.

The measurement of such components requires two observations, one with the component disconnected and one with the component connected either in parallel with the "Q" circuit or in series with the "Q" circuit. A series connection should be made in the coil circuit (between the coil and the "Q" meter terminals) and provision made to maintain a continuous D-C path through the coil and series component (by a leak not over 5 megohms if necessary).

"Q", capacitance and frequency may be recorded for each observation which provides the necessary factors to calculate the quantity desired.

For many purposes comparison between similar components is as useful as measuring a specific factor, in which case it is unnecessary to make any calculations. The change in "Q" and in tuning capacitance when the component is connected provides a rapid and accurate method of comparing a test component to a standard.

The above data are abstracted from a paper presented before the Institution of Radio Engineers, Australia, on March 25, 1936, by Mr. R. J. W. Kennell, M. Inst. R.E. (Aust.), and published in the May, 1936, issue of "Radio Review of Australia."

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 valve and receiver design calls for more detail than that, however, and to-day one must specify not only the type of valve 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 valve, or valves, 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.

When "dynamic" speakers were first introduced, 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 nomal "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.

Resonances.

There still remain to be considered the problems of speaker resonance and the varying impedance of the voice coil over the audio frequency range due to the inductive nature of the voice coil winding.

Reproduction resonance can be of two types: that known as "cavity resonance," and that due to the construction of the speaker itself. The first is set up by the fact that the back of a speaker cone fitted to a cabinet is feeding acoustic energy into a more or less confined space. Apart from any question of "back-pressure" being set up by this means, it must be remembered that the air enclosed in that space has a resonant frequency dependent on the dimensions of the containing sides. If the speaker is reproducing tones of this frequency, a pronounced resonance will be set up and, as the frequency is invariably low, "boomy" reproduction will result. The effect of this is shown in fig. 1. One means of overcoming this is dealt with in the appended description of the Acoustical Labyrinth; another, more of a palliative than a preventitive, is

(Continued on Page 234.)

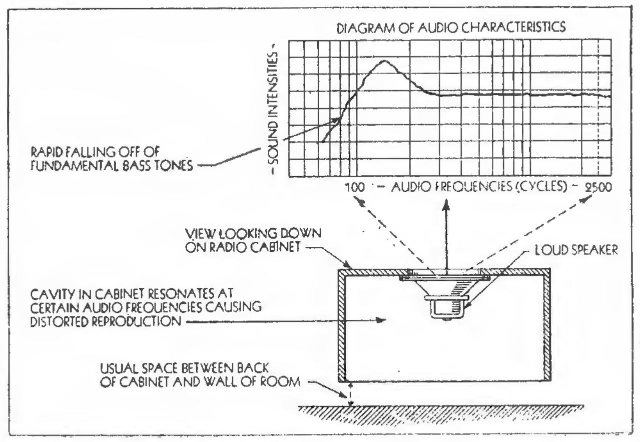


Fig. 1.

LOUD SPEAKERS.

Resonances (Continued from Page 232.)

to keep the back of the radio cabinet free from hangings, walls, or other objects which would tend to close in the space.

The second type of resonance, that due to the construction of the speaker itself, is divided into two parts. The first is inherent in the cone structure itself and is a function of its mass, dimensions and mounting. With popular types of speakers, this resoance usually falls in the region of 100 cycles and quite often coincides with the "cavity resonance" set up by the cabinet. Its effect is to impart a pronounced "boom" to the reproduction. The obvious remedy is, of course, to alter the speaker design so that this resonance falls below the lowest frequency reproduced by the amplifier system, and this is done in the better quality speakers. With the popular commercial types, however, some other way must be found out of the difficulty and suggested means are tapering of the low-frequency response of the amplifier so that the speaker resonance will serve to bring the overall response up to reference level again; acoustic loading of the speaker to rapidly damp any resonance peaks; and the use of any of the "inverse" or "negative" feedback systems which have been introduced recently.

In addition to the cone resonance, there is usually a secondary resonance evident in the neighbourhood of 3000 cycles. This resonance is usually very distressing, especially if the response of the amplifier tends to rise at the higher frequencies. Inverse feed-back will help to overcome this trouble, but the most satisfactory means appears to be some form of filter which introduces an intentional "dip" in the amplifier response at the speaker resonant frequency. A very complete discussion of this subject is presented in the July, 1936, issue of "Radio Review of Australia," in the form of a paper delivered before the I.R.E. (Aust.) by Mr. F. Langford Smith, B.Sc., B.E., M. Inst. R.E. (Aust.).

The question of varying voice coil impedance with frequency only assumes importance when tetrode or pentode output valves are used. As is generally known, the power output of these valves increases with load resistance. This might be useful, but, unfortunately, the distortion content of the output also increases, and for acceptable reproduction, the load must be held constant within fairly close limits.

This characteristic of tetrode and pentode output valves means that with normal speaker designs, and a constant signal input to the stage, the power output rises with frequency. But for the simultaneous distortion increase, this would provide a simple means of "tone compensation" in amplifier systems following narrow-band R.F. and I.F. amplifiers. As it is, some means must be found to prevent this rise. The small fixed condenser often used across the speaker transformer primary to by-pass stray R.F. from the speaker helps in this respect, but a more satisfactory correction network is provided by a condenser of somewhat larger capacity in series with a resistance. This combination is connected in parallel with the speaker input transformer primary. A network of this type will also tend to prevent the development of high transient voltages across the speaker transformer. Correct proportioning of the network is arrived at by making the resistance about one and one-third times the recommended plate load for the valve in use and adjusting the condenser until the frequency response is flat. Typical valves for use with a type 42 pentode are 10,000 ohms and 0.02 mfd. A network of this type will make the impedance of the load substantially independent of frequency at all frequencies above about 400 cycles. The application of inverse feed-back also assists materially in the prevention of power output rise at the higher frequencies.

SPEAKER FIELD ENERGISATION

The problem of providing adequate field energisation is complicated somewhat by the present-day trend 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 specify 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 account, 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

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 stage.

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 stage 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.

LOUD SPEAKERS.

Coupling Transformers (Continued.)

The data necessary for the determination of transformer ratio are the optimum plate load of the output valve, or valves, (supplied by the valve 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 valve plate load to the voice coil impedance. An example will help to clarify this. We will assume that the valve 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 valve.

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, at frequencies up to about 400 cycles, is 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 ACOUSTICAL LABYRINTH

All radio engineers will be interested in the following description of the Acoustical 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. 2.

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.

Besides completely doing away with the boomy reproduction produced by cabinet cavity resonance, the Acoustical Labyrinth makes it possible 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 difficulties of sound wave interference that often occur with 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.

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

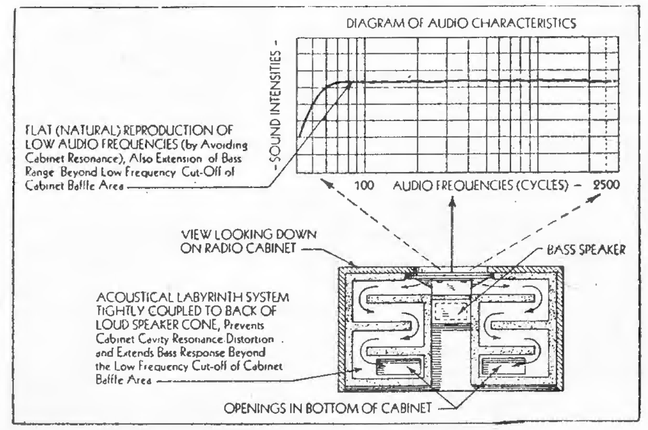


Fig. 2.

cabinet. This is clearly shown by comparing the flat and extended low frequency (bass) audio characteristics of the speaker system employed in fig. 2 with the limited and sharply sloping low frequency (bass) audio characteristics of a regular speaker system, as shown in fig. 1. The cabinets employed in both of these examples are of the same size and shape, so that the excellent performance shown in fig. 2 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

(Continued on Page 242, Col. 2.)

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 maintenace should provide a basi of kowledge which will assist materially in the better understanding and handling of battery receivers and associated equipment.

THE "A" SUPPLY

The filament, or "A" supply, for a battery receiver may be obtained from either "primary" or "secondary" type cells. The former, which are self-generating (i.e., they develop their own power by chemical reaction) have made remarkable strides forward in Australia during the past few months and bid fair to become the standard type of "A" supply in districts where charging of secondary cells is inconvenient or unduly expensive. This is by no means the case as yet, but even so, a few notes concerning the types available and their operation should be of interest.

"Carboncels"

The first type of primary cell especially designed for radio "A" power supply was the air-depolarizer "Carboncel." 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 by the oxygen of the atmosphere and a steady flow of current over long periods may be obtained.

Typical ratings for air depolarizer cells of this type are 300 and 500 ampere hours at average drains of 0.3 to 0.5 amperes. It will thus be seen that a "Carboncel" 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 these cells 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.

"Air-Cells"

The second type of primary battery generally available in Australia is the Eveready "Air-Cell." The principle of operation of this type of cell is somewhat similar to that of the "Carboncel," but it features an entirely different form of construction. Instead of a glass container being used and two separate cells being necessary to make up the two volts required for filament supply to a radio receiver, this type of battery is made up of two cells assembled in a one-piece moulded container. The external appearance is not unlike that of a six-volt accumulator. The two cells are internally connected in series so that only two terminals are provided for connection purposes.

This type of battery uses a sodium hydroxide (caustic soda) solution as its electrolyte and is not refillable; the electrodes being so proportioned that they disintegrate at about the same rate as the electrolyte weakens. The "Air-Cell" is shipped dry and in a sealed condition. The active material of the electrolyte is contained in the cells and as long as the seals are not broken, the battery will stand indefinitely without deterioration. An advantage of this system is that the user only needs to break the seals and fill the cells with water (ordinary drinking) when he wishes to place the "Air-Cell" in operation. The battery is ready for use about fifteen minutes after filling with water.

The terminal voltage of an "Air-Cell" battery immediately after activation is approximately 2.53 volts. After twelve to fifteen hours use at maximum load (0.65 ampere), this voltage drops to about 2.45 volts. This voltage is held constant for an appreciable length of time, whether the battery is used continuously or intermittently, and then commences to drop gradually till it reaches 2.25 volts at the end of 1000 hours of service. At this point, the voltage drops off rapidly and the cell becomes completely exhausted. It should be noted that the terminal voltages given above are totally independent of the load imposed on the "Air-Cell" (as long as the load is kept below the rated maximum of 0.65 ampere).

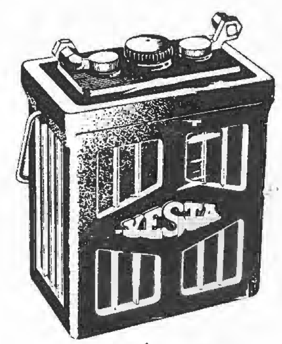
"Air-Cell" Application

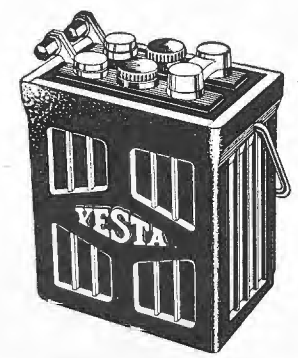
On account of the small variation between the activation and exhaustion voltages of the "Air-Cell" it has been found possible to use a resistor of fixed value for voltage-dropping purposes instead of a variable rheostat. This simplifies matters considerably as it means that the resistor can be built into a receiver designed for "Air-Cell" operation and no adjustment is necessary at any time, even when a new "Air-Cell" is connected to the receiver.

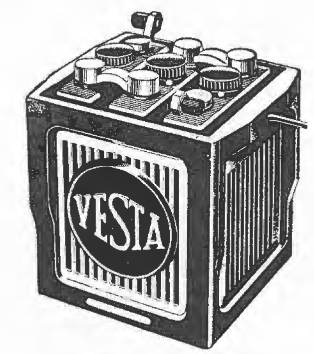
To proportion this resistor, it is necessary to take into account both the permissible filament voltage variations and the filament current of the valves used in the receiver. Most two volt valves operate quite satisfactorily between the limits of 1.8 and 2.2 volts. The maximum voltage is of immediate importance and as the terminal voltage of a freshly-activated "Air-Cell" is 2.53 volts, it can be seen that 0.33 volts must be dropped in the series resistor to ensure that the valves being fed are not over-loaded. A resistor capable of dropping 0.33 volts from a fresh "Air-Cell" will ensure that a maximum voltage of 2.2 is applied to the valves. After the initial discharge period, when the voltage drops to 2.45 volts, approximately 2.12 volts will be delivered at the valve filaments, while towards the end of the "Air-Cell's" life the valve filament voltage will be approximately 1.92 volts. Actually, the 2.12 volts and 1.92 volts figures will be a little higher than this as the valves will draw slightly less current at these lower voltages than at the original 2.2 volts, and, consequently, the drop in the resistor will not be quite as great. The error will not have any serious effect (as a matter of fact, it will be beneficial toward the end of the "Air-Cell's" life) as it can be seen that in any case the voltages supplied to the valves, after the initial peak has passed, are well within the rated limits.

The proportioning of the resistor value is a little more difficult than just deciding the voltage drop required. To ascertain the correct value of resistance required it is first essential to determine the total current drain of the receiver, including all dial lamps. This drain at a filament supply of two volts can be ascertained by reference to valve makers' data. It must be remembered, however, that the initial voltage supplied to the valves is intended to be 2.2 volts and, consequently, the current drain will be higher than at two volts. The extent to which it will increase will not be directly proportional to the voltage increase, as the increased voltage will increase the tem-

(Turn to Page 238.)







POWER SUPPLY FOR COUNTRY RECEIVERS (Continued.)

perature of the valve filaments and so increase their resistance slightly. The net result is that the **ten per cent. increase in voltage will increase the rated current drain of the valve filaments by six per cent.**

This is most important and very little calculation is required to show that the maximum **nominal** current drain of a receiver to be fed by an "Air-Cell" must not exceed 0.61 ampere (610 milliamperes).

The multiplying factor required to determine the **actual** initial current drain of a receiver, fed by an "Air-Cell" through a resistor providing a voltage drop of 0.33 volts, is 1.06. For example, a receiver having a **nominal** current drain of 500 milliamperes (0.5 ampere) will draw 500 × 1.06, or 530 milliamperes under actual initial "Air-Cell" operation conditions.

Continuing the example further it will be found that the total resistance required to provide the necessary voltage drop of 0.33 volts will be 0.33/0.53 or 0.622 ohm. This is the **total** resistance, however, and includes the wiring betwen the "Air-Cell" and the valve filaments. Assuming that the resistance of the wiring is 0.14 ohm (a fair average value), it can be seen that an additional series resistor having a value of 0.582 ohm will be required. This must be permanently wired into circuit to avoid accidental overload of the valves by connecting up an "Air-Cell" without any provision for voltage drop. In practice, of course, the value of the wiring resistance should be determined accurately and not just assumed.

Accumulators

The lead-acid type accumulator still remains extremely popular as a means for providing "A" power to radio receivers and the growing popularity of the "vibrator-powered" receiver, which obtains all of its power from the "A" battery, ensures that this type of "secondary" or rechargeable battery will be in use for a long time yet. In addition, the strict limitations on the amount of current which can be drawn from any type of primary battery tend to keep a large field of application clear for the familiar accumulator, which is only limited in this respect by the charging facilities available.

Until twelve or eighteen months ago practically every type of battery receiver used a two-volt (single cell) accumulator. Nowadays, however, series-parallel filament wiring of two-volt valves, particularly in connection with "vibrator-powered" receivers, is becoming increasingly popular, and many six-volt batteries are in use. For this reason, the notes on accumulator maintenance and charging at the end of this section will be found particularly useful.

THE "B" SUPPLY

The high-tension supply for battery-operated radio receivers is obtainable from three general sources; primary batteries of the dry-cell type, secondary batteries of the rechargeable type, and mechanical converters which obtain their power from the filament supply of the receiver. The first and last of these are in general use to-day, but a few special applications of the second type still exist.

Dry Batteries

"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.

An alternative to the "lead-acid" high-tension supply 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.

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-interrupter unit which operates from a 6 volt "A" battery and supplies the necessary high-tension voltage for the set.

The vibrator-interrupter type of unit consists basically of a transformer connected across a low-voltage supply and having its primary circuit interrupted in order to provide the variations of magnetic flux necessary for transformation. It is thus possible to "step up" the low voltage direct-current primary supply to any required voltage; the final voltage obtained being dependent on the turns ratio of the transformer windings and the characteristics of the primary circuit interrupter. The voltage obtained from the secondary will be alternating in character and must be rectified before application to the receiver. Rectification may be effected by means of an extra set of contacts on the interrupter; or by a valve or a copper-oxide rectifier.

In actual practice, both primary and secondary windings of the transformer are centre-tapped and the interrupter is so arranged that an actual reversal of current flow takes place in the primary winding. The induced alternating current in the secondary winding is, as a result, of better wave-form and filtering after rectification is simplified. The centre-tapping of the secondary permits of "full-wave" rectification and, in general, improves the efficiency of the unit appreciably.

(Turn to Page 240.)

POWER SUPPLY FOR COUNTRY RECEIVERS (Continued.)

The interrupters, or vibrators, as they are generally known, are normally built up in a cushioned case fitted with a pin type plug so as to enable simple replacement to be effected. The "cushioning," which usually consists of sponge rubber, serves a dual purpose in that it prevents the mechanical vibration from being imparted to other portions of the assembly, and also serves to prevent the mechanical "noise" of the vibrator from being heard.

Vibrators which incorporate a separate set of contacts for the purpose of high-tension rectification are known as "synchronous" types, while those which merely interrupt the primary circuit are known as "non-synchronous" types. The latter, of course, need a separate rectifier.

Opinion as to the relative merits of the two systems appears to be fairly evenly divided.

A high degree of overall efficiency has been achieved by the designers of "vibrator" power units and examples are to be found which will provide 150 volts of rectified and filtered high tension with sufficient current to adequately feed a five-valve, pentode-output receiver, from a primary input of only 0.6 ampere at six volts.

As a six-volt battery is usually used for the operation of these units it is convenient 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 valves at present available are comparatively wasteful of filament power and it is usually found advisable to use two-volt valves 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 somewhere in the region of 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 no longer as essential as it was a few years ago.

For small sets using a pentode output valve, 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 valves 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 valve filaments are wired in series across a six-volt battery the negative end filament of the valve at the positive end of the combination is four volts positive with relation to the negative battery lead. Consequently, four volts bias for that valve 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 valve 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 vibrator-powered 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" valves for battery receivers. These valves are designed to operate satisfactorily without the application of grid bias at all.

MAINTENANCE AND CHARGING OF ACCUMULATORS

As accumulators of the lead-acid type are almost universally used for "A" supply to radio receivers of the "battery-operated" type, some details concerning their 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.

(Continued on next Page.)

POWER SUPPLY FOR COUNTRY RECEIVERS (Continued.)

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 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 Sp. Gr. 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
1.270	29.0	by volume of concen-
1.260	30.0	trated sulphuric acid.
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.

The following table, which takes into account the varying climatic conditions in Australia, will provide a reliable indication of the specific gravities which should be found in an accumulator under various conditions and states of charge.

When Battery is	In Q'land, W.A., and N.T.		In N.S.W., Vic., S.A. & Tas.	
	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.

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 of rheostat or 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 battery charging systems, 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.

For locations where no power supply of any kind is available, there are now on the market two forms of battery charging device which will often be found particularly suitable to the individual set owner or small radio dealer.

(Turn to next Page.)

POWER SUPPLY FOR COUNTRY RECEIVERS

Charging Plants (Continued.)

The first of these is the wind-operated generator which is essentially a D.C. generator with a "propellor" direct-coupled to its armature shaft. By special design of the "propellor" and generator, these devices can be made to commence charging in breezes as light as 8 m.p.h.

Some form of governor is essential with these units to prevent overcharging in strong winds, and also, it is desirable that some means be provided to lock the "propellor" or take it out of the wind when the battery is fully charged. The average wind-driven charger available in Australia is capable of delivering up to 10-15 amperes to a six-volt battery in a 20 m.p.h. wind.

An alternative to this is provided by the petrol-driven generator. Units of this type are available in a variety of forms, but basically, they consist of a small petrol engine (three-quarter horsepower, or thereabouts) with a D.C. generator directly coupled to its crankshaft.

These units are surprisingly efficient and easy to handle. The smaller units available have a power output of about 150 watts, while larger units with ratings up to about 300 watts can also be obtained.

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 removed 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.

LOUD SPEAKERS.

(Continued from Page 235.)

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."

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.

RECEIVER DESIGN TRENDS

ALTHOUGH receiver design in Australia still remains fairly straightforward, a number of features have been introduced in the better-class receivers overseas which show promise of great usefulness. Some of these are likely to be found in Australian models before the next edition of this Annual appears, and a brief description of some of the most interesting should be of value for reference purposes. The circuits presented are quite practical and will be of interest to the experimentally-inclined.

Automatic Selectivity Control—A.T.C.

A natural outcome of the move towards manually-variable selectivity (examples of which are already to be found in some Australian receivers) as an aid to better reproduction fidelity is found in the "automatic selectivity control" systems which have been developed overseas during the past year or so.

The elaborate and expensive system of shunt loading the tuned circuits, which was described in the last edition of this Annual, has given place to much simpler arrangements whereby one valve may be used to vary the coupling of each pair of tuned circuits. Experience has shown that a very appreciable variation of overall receiver selectivity may be achieved by altering the coupling of even one I.F. transformer, so it can be seen that the latest A.S.C. circuits make it possible to incorporate this feature with only one extra valve. An even simpler system has been proposed, which makes it possible to achieve a reasonable degree of A.S.C. without any extra valves at all—merely by using the versatile 6L7 as a combined I.F. amplifier and A.S.C. valve.

These newer A.S.C. systems fall back on the basic selectivity variation idea—varying the coupling of the circuits which comprise an interstage coupler.

It is fairly well-known that a valve can be made to function in somewhat the same manner as an inductance. It follows from this that if this "valve inductance" be used to replace, or supplement, the mutual inductance between two coupled circuits, a readily controllable means of varying the coupling of those circuits is available. The necessary control is furnished by the receiver A.V.C. and is so arranged that coupling is at its greatest when a strong "local" is tuned in. As a result, the tuned circuit band-width is greatest when stations nearby (and, presumably, free from interference) are tuned in.

A number of variations of this system are possible, and it is claimed that it is possible to arrange the control so that gain and selectivity are at their highest under "distant" reception conditions. The normal arrangement, of course, reduces the overall gain of the controlled stages when selectivity is at its highest, due to the low coupling coefficient between the tuned circuits.

The combined control valve—I.F. amplifier arrangement is most ingenious, and makes use of the extra control electrode in the 6L7. This electrode is coupled to the grid circuit of the next I.F. amplifier valve (two stages are required) and provides the necessary coupling variation by virtue of its relationship to the anode of the 6L7. The high internal screening of the 6L7 prevents any possibility of regeneration.

These circuits are discussed in detail in the June, 1937 issue of "Radio Review of Australia" (Vol. 5, No. 6).

Automatic Frequency Control—A.F.C.

Automatic frequency control, or automatic tuning correction systems have likewise been considerably refined since the first circuits were introduced.

Instead of the old twin-filter idea described in the last edition of this Annual, the latest type of A.F.C. circuit (due to Messrs. Seeley and Foster, of the R.C.A. Licence Laboratory, U.S.A.) makes use of the phase relationships between two inductively coupled circuits to develop the necessary control voltage for the frequency correction circuit. Furthermore, the frequency correction circuit itself makes use of the inductance which can be simulated by a valve under some conditions. A practical application of this system, as applied to an American Crosley receiver, is seen in Fig. 1.

The system, as shown, requires three extra valves—a 6K7, or other R.F. pentode, as A.F.C. signal amplifier; a 6H6, as control voltage rectifier; and a 6J7, or other sharp cut-off R.F. pentode, as control valve.

The operation of the circuit is, briefly, as follows: Signals at intermediate frequency are amplified by the 6K7 and fed to the double-tuned, centre-tapped secondary coupler. The constants of this are so arranged that an "on tune" signal develops equal voltages in the two halves of the secondary, consequently equal voltages are developed in the two diode load resistors and no voltage appears between the top end of the 3 megohm resistor and earth. An "off-tune" signal (due to the oscillator section of the 6A8 being slightly mistuned from the wanted signal) will cause uneven voltages to be fed to the two diodes and, consequently, a resultant voltage is fed to the 3 megohm resistor

(Continued overleaf.)

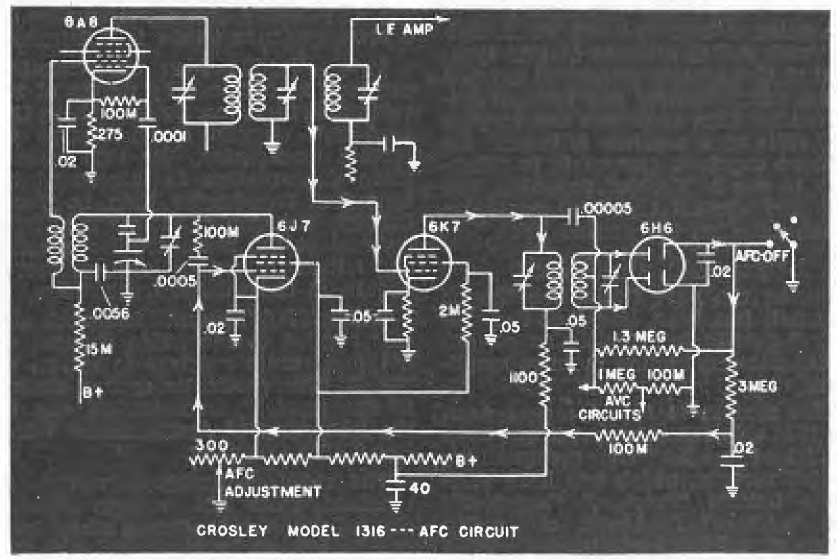


Figure 1. Automatic frequency control system as used in American Crosley receiver.

RECEIVER DESIGN TRENDS

(Continued from Page 243.)

which serves to decouple the A.F.C. lead to the control valve (6J7). The polarity of this voltage will depend on the direction of mistuning.

This control voltage, when fed to the grid of the 6J7, will alter the value of the inductance simulated between the control grid and plate of the 6J7 and, as this inductance is in parallel with the oscillator tuned circuit, the frequency generated by the oscillator will also alter until the correct I.F. is developed. A "mean" grid voltage for the 6J7 is set by the 300 ohms rheostat marked "A.F.C. Adjustment," and control can therefore be exerted in either a positive or negative direction, depending on the control voltage developed by the 6H6. The "AFC Off" switch is provided for use when no control is desired or when lining up the receiver.

It should be noted that the output from either diode is identical with that obtained from an ordinary diode detector so that, if desired, the third winding feeding the normal I.F. amplifier at the top of the diagram can be dispensed with and the amplifier and rectifier system used to supply A.V.C. and audio voltages. It will be noted that the system, as depicted, is used to supply A.V.C. voltages. A separate channel, comprising two stages, was used for normal signal amplification in the Crosley receiver, but if simplification is desired, there is no reason why the signal should not be taken from the control voltage rectifier, as mentioned above. If this is done, only one extra valve (the 6J7) is needed.

For the benefit of those who would like to learn more about the fundamental theory of this circuit, a complete description will be found in the August, 1936, issue of "Radio Review of Australia" (Vol. 4, No. 8).

A point to bear in mind, when dealing with A.F.C. circuits of this type, is that the frequency control exerted is not constant over any band of frequencies. This is due to the varying L/C ratio as a receiver is tuned. To achieve constant control it is necessary to use a "double" super-het. circuit and control the fixed oscillator which develops the second I.F.

"Inverse" Feed-Back

During the past twelve months or so much has been heard of the "inverse" feed-back principle as an aid to distortion reduction in valve amplifiers.

This system is by no means new, but it is only recently that it has been publicised much. The potentialities of this system, which has been variously termed "inverse," "negative," and "reverse" feed-back, are really rather surprising, and already several receivers are available on the Australian market which take advantage of the benefits it offers.

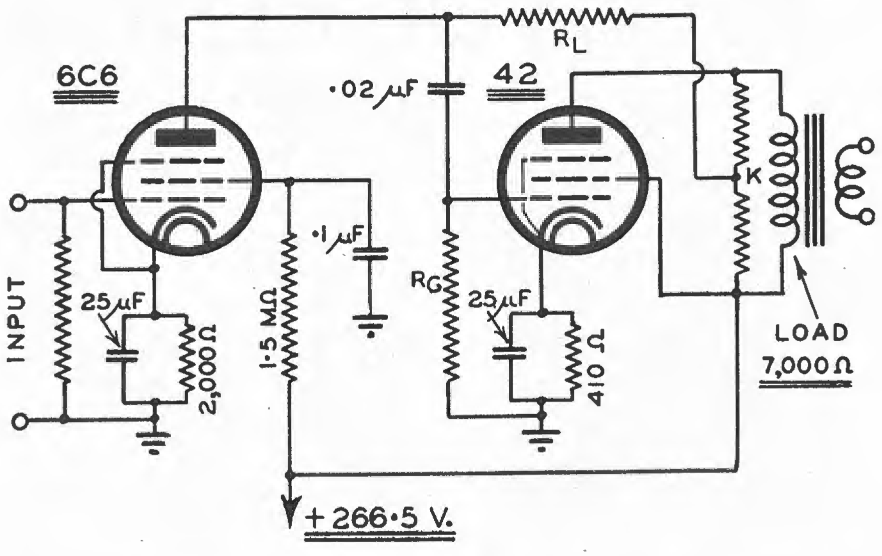


Figure 2. Inverse feed-back circuit of the "series" type developed by A.W. Valve Co. Ltd.

Basically, the system consists of feeding a portion of the output of an amplifier stage back to the grid circuit in reverse phase. **Degeneration** is thus introduced and the power sensitivity of the stage reduced accordingly. At the same time, the harmonic distortion introduced by the stage is also reduced and a greater amount of power output, for a given distortion percentage, is made available. To obtain this, it is necessary to feed a greater signal to the stage, but this not difficult in these days of high gain valves.

By correct connection of the circuits, it is possible to obtain appreciable reduction in the output impedance of a stage. The effect of this is particularly noticeable in the case of output tetrodes and pentodes, as, by this means, speaker resonance damping very nearly equivalent to that of a low-impedance triode is obtainable.

Very effective tone compensation can also be obtained by means of inverse feed-back, merely by making the feed-back circuits discriminative to certain frequencies. By this means, more degeneration is introduced at unwanted frequencies than at those desired; the gain of the stage is thus reduced at the unwanted frequencies and left at its normal level, or thereabouts, at the wanted frequencies.

A simplified "inverse" feed-back circuit applied to the audio channel of a typical radio receiver is shown in Fig. 2. The particular system shown is the "series" arrangement due to the laboratory of Amalgamated Wireless Valve Company.

The required feed-back voltage is obtained from the voltage divider shunted across the output stage load and is effectively in series with the load resistor (RL) of the 6C6 audio amplifier. The amount of feed-back is controlled by the ratio of the voltage-divider. About ten per cent. feed-back is usually found satisfactory. The actual values of the two voltage-divider resistors are not important as long as they are in the correct ratio and their combined resistance is high enough to avoid power loss by reducing the effective load presented to the 42. (About 90,000 ohms and 10,000 ohms will be found satisfactory. The 10,000 ohms resistor should be connected at the high-tension end of the network.)

The system described and illustrated is only one of a large variety of circuits available. For further information on the subject readers are referred to current literature.

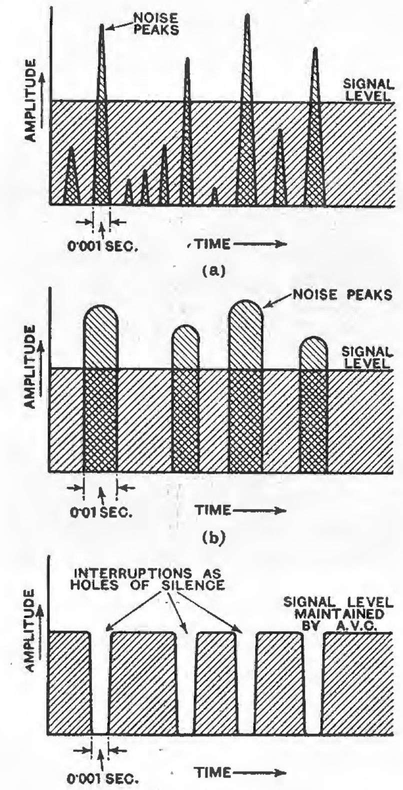
Noise Suppression.

Although a large number of circuits have been proposed and used for the reduction of inter-station "noise" ("muting" arrangements, etc.), it is only fairly recently that successful attempts have been made to suppress noise interference actually being received with a wanted signal. Even these circuits are not entirely successful and will only suppress noise of a certain nature. (Contrary to popular belief, noise interference varies widely in its characteristics. For further information in this regard, refer to I.R.E., Aust., paper by Dr. G. Builder, and Mr. E. G. Beard, which are presented in the December, 1936 and January, 1937 issues of "Radio Review of Australia," respectively.)

One of the most successful "noise suppressors" yet to be introduced is that attributed to Mr. J. J. Lamb, of the editorial staff of "Q.S.T." (U.S.A.). This system has been widely used in "communications" type radio receivers and has proved efficacious in reducing the intensity of noise impulses of the high-amplitude, short-duration variety.

RECEIVER DESIGN TRENDS (Continued.)

The system, which is illustrated in Fig. 3, consists of a 6L7, used as the second I.F. amplifier in a receiver, with a low-time-constant diode rectifier connected to its No. 3 grid. This diode rectifier is fed by a high-gain I.F. amplifier, which obtains its signal from the tuned circuit which feeds the 6L7. Signals and noise are amplified equally by this stage, but a delay voltage is applied to the diode so that no rectification takes place on signals of normal amplitude.

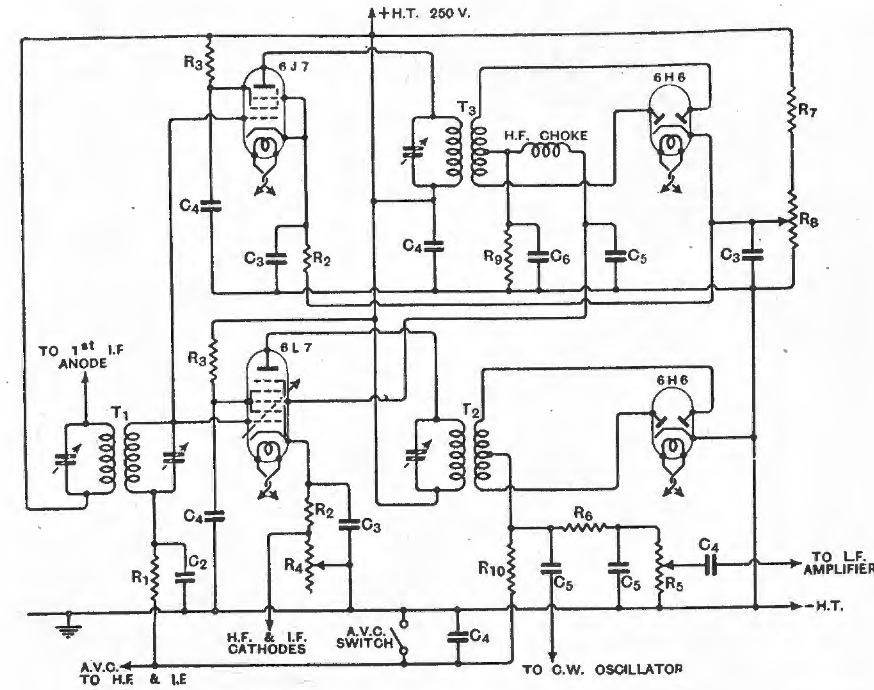


The relationship between signal and noise in a typical case at the input of a receiver is shown at (a), and the form in which they appear from the loudspeaker at (b). The effect of the noise suppressor is indicated at (c) and it can be seen to remove the worst noise peaks.

Figure 4.

Noise peaks which exceed the delay voltage are, however, rectified, and the resultant D.C. impulses are fed to the No. 3 grid of the 6L7. This has a fairly steep cut-off characteristic and the effect of the "noise peak" voltages is to partially or completely block the 6L7 stage during the duration of the noise. The effect is to punch "holes of silence" in the signal, as illustrated in Fig. 4.

From the above, it is fairly obvious that the suppressor does not affect noise of equal or lower amplitude than the wanted signal, while noise interference of higher amplitude, but low



The circuit of the noise suppressor applied to a superheterodyne. The 6L7 valve is the second I.F. stage of the receiver and its output feeds a diode detector in the usual way. The 6J7 valve and the second diode form the noise suppressor. R_1—100,000Ω, ½ Watt; R_2—350 to 1,000Ω, ½ Watt; R_3—100,000Ω, ½ Watt; R_4—5,000 Ω I.F. Gain Control; R_5—1,000,000Ω L.F. Vol. Control; R_6—50,000Ω, ½ Watt; R_7—20,000Ω, 1 Watt; R_8—5,000Ω, Noise Threshold Control; R_9—100,000Ω, ½ Watt; R_{10}—1,000,000Ω, ½ Watt; C_2—0.01 μF 200 v.; C_3—0.1 μF 200 v.; C_4—0.1 μF 400 v.; C_5—50 μμF (mica); C_6—0 to 250 μμF (mica); T_1—Double Tuned I.F.T.; T_2—Either centre-tapped or normal single or double tuned I.F.T., T_3—Tuned Plate, very tight coupling, broad tuned; H F.C. 20 mH Choke

Figure 3. Circuit arrangement of the Lamb Noise Suppressor as applied to a receiver intended for C.W. reception. For ordinary broadcast use the "C.W. Oscillator" coupling is omitted.

decrement, would result in almost continuous cut-off of the 6L7, with resultant loss in the intelligibility of the wanted signal. However, on noise of the right type, the device is useful and wellworth experimenting with.

Queensland Radio Award

Part 2—Radio Industry.

NEW RATES AS FROM MARCH 22, 1937.

15 (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) £5/11/10; (Mackay Division) £5/17/4; (Northern Division) £6/1/10.

Day workers: Radio mechanics, per week (Southern Division) £5/2/1; (Mackay Division) £5/7/7; (Northern Division) £5/12/1.

(3) Except as to the definition and wages the provisions of Part 1 of the Electrical Engineering Award of Queensland shall apply to radio mechanics.

AERIAL SYSTEMS

EVEN though some people are inclined to doubt it, no radio receiver is better than its aerial, and it is safe to say that many cases of unsatisfactory reception are due to non-recognition of this basic fact. One of the major problems encountered is that created by electrical interference and, in an earlier section of this Annual ("Electrical Interference"), it has been shown that proper attention to the aerial system in use can have a marked effect on the quality of reception.

The advent of dual-wave receivers has accentuated the difficulty considerably, as such sets are usually more sensitive than straight "broadcast only" receivers and so are more apt to pick up noise and mush hitherto unheard. The only remedy is to use an aerial system which will pick up more signal than noise and this means that some form of outside aerial must be employed.

Inspection of the sketches shown in Fig. 1 will clarify the position considerably. The upper sketch shows a receiver in use with an indoor aerial. Obviously, the noise level will be high under these circumstances, as the aerial is completely surrounded by electrical wiring, all of which is connected, directly or indirectly, with some noise-producing appliance.

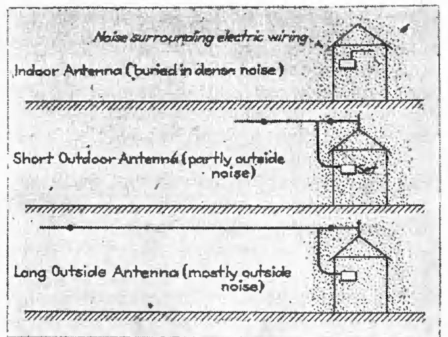


Fig. 1.

As will be seen from the second sketch, the use of a short outside aerial helps matters somewhat as a portion, at least, of the aerial system is outside of the noise area. The third sketch shows that by using a long outside aerial quite a big improvement can be effected, most of the aerial system being outside the noise area in this case.

"Noiseless" Down-Leads.

It will be noted, however, that there is one thing common to both of the lower sketches; the down-lead, or lead-in, is still "submerged" in "noise." This fact has given rise to the modern "noise-reducing" or "anti-interference" aerial systems, which use a shielded, transposed or twisted-pair down-lead. It is fairly obvious that if the down-lead can be made "dead," so that it will not have any effective pick-up at all, the signal/noise ratio of the aerial system will be improved enormously. Actually, some signal will be lost, due to the fact that the down-lead was previously part of the aerial itself, but, as it is quite possible that the noise pick-up on the lead-in will be greater than the signal pick-up, especially on weak stations, the signal loss will not be noticed.

Before proceeding further with a discussion of the various special aerial systems, it will be as well to outline the characteristics of the three down-lead types mentioned above.

Shielded Leads.

The first type of "noise-reducing" lead-in to be generally adopted was the "shielded" type in which the lead-in proper is surrounded by an earthed screen of copper, or tinned copper, braid. This type of lead-in is very effective on "broadcast" frequencies, providing it is installed correctly, but is useless on short-waves, due to its high self-capacity and incidental losses. These losses can be serious on broadcast frequencies, but are minimised by the use of "matching" transformers at either end of the lead-in, or "transmission line" as it is usually known. These transformers consist of a "step-down" R.F. transformer at the aerial end and a "step-up" R.F. transformer at the receiver end. The incoming signal is thus reduced to a low potential for transmission along the line and increased to its normal potential again before application to the receiver. The "shunting" effect of the line is very much less evident at the lower potential and practically no signal loss occurs (apart from that mentioned before as being lost along with the noise). The transformers, incidentally, are broadly "peaked" to somewhere near the centre of the broadcast band.

This type of "noise-reducing" lead-in, when installed with a "flat-top" of reasonable length in a clear location is capable of providing quite a surprising increase in signal-noise ratio and has proved very popular, both in Australia and overseas.

Transposed Leads.

The "transposed" type of lead-in was introduced in response to the demand for a "noiseless" transmission line which would operate on short-waves without introducing too many losses. Basically, the transposed lead-in consists of two parallel wires, one of which is connected to the aerial and is the down-lead proper. The other wire of the pair is connected to spacing insulators which keep it parallel to the down-lead. The top end of this wire is left free. The lower ends of the two down-leads are connected to the two ends of the receiver aerial input coil; the end of this coil which is usually earthed is left free for this purpose.

Occasionally a special "matching" transformer is interposed at this point so that the parallel pair may be connected to the aerial and earth terminals of an ordinary receiver. Details of such a transformer are shown in Fig. 2. The switches S1 and S2 are employed for the purpose of "tuning" the transformer to broadcast or short-waves, and may take the form of a double-pole double-throw switch of the "toggle"type. The entire assembly should be shielded.

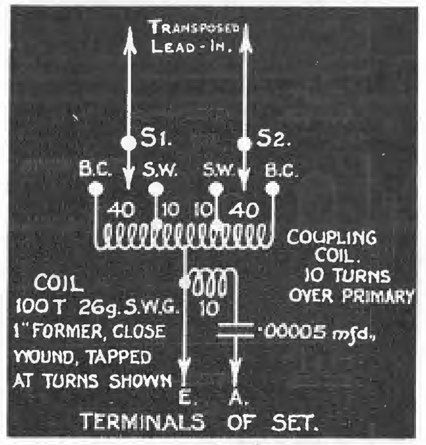


Fig. 2. Matching transformer system.

Whichever method of coupling to the receiver is employed, the principle of operation for this type of lead-in remains the same. Noise-reduction is obtained by the fact that both down-leads pass through the noise area and, consequently both pick up equal amounts of noise. The two noise components will be out-of-phase in the coupling coil or matching transformer and will cancel out. The same applies to any signals picked up on the down-leads, but the signal collected by the flat-top will be unaffected as there is no out-of-phase component to balance it out.

The term "transposed," in connection with this type of lead-in, is derived from the fact that, in practice, the two down-leads are crossed over at regular intervals, the object being to keep the two leads electrically identical in their relationship to any source of noise interference. Special insulating 'transposition blocks" are used for this purpose and are available from any of the better-known radio distributing houses.

This type of lead-in has proved very effective on both "broadcast" and "short-waves," the transmission loss under the latter conditions being ex-

AERIAL SYSTEMS

Continued.)

tremely low and the effective "noise" pick-up negligible. The disadvantage of the "transposed" type of lead-in is that it must be erected in a clear space and, furthermore, is difficult to install inside a house (between the point where it enters the house and where it is attached to the radio receiver).

Twisted-Pair Lines.

The installation difficulties associated with the "transposed" lead-in, or transmission line, led to the introduction of the "twisted-pair" type of line. The "twisted-pair" line consists of a pair of insulated wires, twisted together in the same manner as ordinary lighting flex. Special weatherproofing is necessary to prevent deterioration of the insulation and also variation of the insulation resistance between the leads under wet weather conditions.

In its basic form, the twisted-pair line is connected to a flat-top aerial in the same manner as a "transposed" line, i.e., one lead is connected to the aerial and acts as the "down-lead" proper, the other being left free. The two leads are connected to the receiver by means of a special matching transformer or, in some receivers, by making use of a special aerial connection provided. "Noise-reduction" is achieved by this type of line in the same manner as the "transposed" type.

The major difference between this type of line and the "transposed" type is found in the "surge impedances" of the two types, the impedance of a twisted-pair line being much lower than that of the transposed type. One result of this is that "matching" of the line is a little more difficult than with a transposed line, but, if this is done correctly, the line may be run almost anywhere (along walls, ceilings, etc.) without introducing any losses other than those inherent in the twisted-pair line itself. This feature is, of course, a great advantage and enables a really effective "noise-reducing" aerial system to be erected in practically any location. Another feature of the twisted-pair line (shared to some extent by the transposed type) is that it can be "tuned" by its length so that it peaks in the neighbourhood of some desired frequency band. If this is done, a definite signal build-up results on the frequency to which the line is "tuned" and a greater increase in the signal/noise ratio results, than if the line were used for its "noise-proof" qualities alone. It is mainly on account of this feature that commercial "noise-reducing" aerial systems are sold with a definite length of transmission line, with specific instructions not to cut the line any shorter and only to add to it in specified lengths.

This type of transmission line has been adopted almost universally, both in Australia and abroad, for use with commercially-produced "anti-noise" aerial systems, and results have shown that its characteristics, when correctly used, are practically ideal for modern "all-wave" reception conditions.

Aerial Types in Use.

The only type of aerial mentioned so far has been the "basic" flat-top, or single horizontal wire, type. This type is usually quite satisfactory for "broadcast only" reception, and can also be employed on short-waves with a fair degree of success.

At this point, it is of interest to note that the Wireless Branch of the P.M.G.'s Department in Victoria have developed an extremely simple, but effective, "noise-reducing" aerial system of the "flat-top, twisted-pair" type for use by listeners in electrically "noisy" locations. This system is illustrated in Fig. 13 of the "Electrical Interference" paper which appears earlier in this Annual. The illustration referred to is on Page 190.

The "flat-top" itself may be of any convenient length but should, of course, be erected as far away as possible from any electric light wiring or telephone lines. The instructions for the use of this system say that the twisted-pair may be ordinary lighting flex, one lead of which is connected to the aerial proper, the other being left free. The lower ends are connected to the transformer, as shown in the diagram.

Several "composite" types of aerials have been developed, for use on short-waves, which will often be found somewhat more effective in operation than the basic flat-top type.

The first of these is the simple "doublet." This consists of a horizontal length of wire cut at its centre and having the two leads of a "twisted-pair" transmission line connected to the two halves of the aerial. The signals picked up by the two halves of the aerial will be cumulative in the matching transformer at the set, while the signals and noise picked-up on the down leads will still cancel out, as in the basic flat-top type where the top end of one down-lead is left free. The total length of the doublet is usually arranged so that it is equal to a half-wavelength of a frequency near the centre of a desired band, and the tuning effect thus obtained often gives a useful signal build-up. For short-wave reception on the 16-50 metre band the doublet should be tuned to about 31 metres, i.e., the total length should be half of 31 metres or approximately 50 feet. Each half will then be 25 feet long.

For best results with this type of aerial and down-lead it is usually desirable that a matching transformer be used at both top and bottom of the down-lead. The one at the aerial end will have a step-down ratio and that at the receiver end a corresponding step-up ratio. The transformer at the aerial end can often be dispensed with especially if only a short transmission line is being used, without any appreciable loss in signal strength. The length of the down-lead is an important factor, however, and this should be arranged so that it is an uneven quarter-wavelength of the resonant frequency of the aerial, with a minimum length of three-quarters of a wavelength. For example: with a 31 metre half-wave doublet (two 25 feet sections the down lead should have a minimum length of 75 feet. The next length is 125 feet (five quarter wavelengths) and the next 175 feet. If the length required is less than any of these, but greater than the next below, the longer length should be used and the spare coiled up in the bottom of the cabinet. The down-lead lengths for an aerial resonant to a longer wavelength than 31 metres will be correspondingly longer, and vice versa.

Double-Doublets.

A variation of the simple doublet 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.

"V" Doublets.

An efficient method of matching the transmission line to the aerial (instead of a transformer at the aerial end) is found in the "V" doublet. This type of aerial is an ordinary 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

(Continued overleaf.)

AERIAL SYSTEMS

(Continued from Page 247.)

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 is accomplished at all frequencies.

For the best matching the spacing between the two halves of the doublet and the two spaced-out portions of the down-lead should form an equilateral triangle. A suitable set of constants for a 16-50 metre "V" doublet are shown in Fig. 5. "Matching" to the receiver may be accomplished by means of the usual unearthed aerial coupling coil, or by means of a special matching transformer.

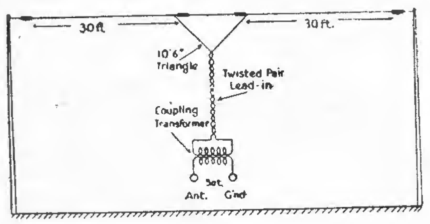


Fig. 3.

Directional Properties.

A feature of the various "composite" aerial systems often lost sight of, is that they are all moderately directional, maximum pick-up being in a direction at right angles to the direction of the aerial. This feature may be used, and is often successful, in cases of severe localised interference, the aerial being pointed towards the source of interference. As maximum pick-up is at right angles to the aerial direction, it can be seen that there is a reasonable chance of the interference pick-up being minimised by this means.

The main point to remember about all "noise-reducing" aerial systems is that the aerial itself must be erected clear of any power and telephone lines, otherwise all the lead-in shielding and transposition in the world will not make any difference, and an ordinary inverted "L" aerial might as well be erected.

Lightning Arrester.

An efficient lightning 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 a fully-enclosed 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.

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.

-- RECEIVER SPECIFICATIONS --

THIS, and the following pages, contain tabulated details of the great majority of brand line receivers available on the Australian radio market. Some 300 models are listed, representing the most complete tabulation produced to date. The information is made available in this form through the courtesy of the various manufacturers concerned, who have supplied the necessary particulars.

"Power Source" may be interpreted as A.C., Bat (Battery), Uni (A.C./-D.C.) and Car (Auto Radio).

Under "No. Valves and Coverage," coverage refers to wave range and is given as B (broadcast), D (dual wave), A (all wave). Yes in indicated by Y and no by N.

Under "Size Speaker and Field Resistance" the diameter is given in inches followed by resistance of field in ohms or alternatively PM (permag).

Columns "Tone Control?", "Sensitivity Control?", "Tuning Indicator?" and "A.V.C.?" enquire if a given model is fitted with such devices, the answer being given by yes or no.

Under "A Volts and A/H Capacity", the accumulator voltage is followed by capacity in ampere hours based on the 100 hour rate.

Under "C Bias", the voltage is given where batteries are used. In battery powered sets not requiring C batteries this is shown as "Auto."

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
AIRZONE—Airzone (1931) Ltd., Sydney.																
452	Man*	AC	4B	456	6A7, 6F7, 42, 80	N	6/1500	3	Y	N	N	N	—	—	—	12/19/6
550	Man*	AC	5B	456	6A7, 6D6, 75, 42, 80	N	6/1500	3	Y	N	N	Y	—	—	—	15 gns.
560	Man*	AC	5D	456	6A7, 6D6, 75, 42, 80	N	6/1500	4	Y	N	N	Y	—	—	—	19 gns.
569	Man*	Uni	5B	456	EK2, CF2, CBC1, CL2, CY2	N	6/1500	3	Y	N	N	Y	—	—	—	19 gns.
453	Man*	Bat	4B	456	IC6, IC4, IK6, ID4	N	6/PM	4†	Y	N	N	Y	2/100	135	Auto	19 gns.
566	Con	AC	5B	456	6A7, 6D6, 6C6, 42, 80	N	8/2500	4	Y	Y	N	N	—	—	—	21/10/6
567	Con	AC	5B	456	6A7, 6D6, 75, 42, 80	N	8/2500	4	Y	Y	N	Y	—	—	—	22 gns.
568	Con	AC	5D	456	6A7, 6D6, 75, 42, 80	N	8/2500	4	Y	N	Y	Y	—	—	—	26 gns.
850‡	Con	AC	8D	456	6K7, 6A8, 6K7, 85, 76 2/42, 80	Y	12/600	5	Y	Y	Y	Y	—	—	—	42 gns.
559	Con	Uni	5D	456	6A7, 6D6, 75, 43, 25Y5	N	8/2000	4	Y	N	N	Y	—	—	—	29 gns.
574	Con	Bat	5B	456	IA4, IC6, IA4, IB5, 22A	N	8/PM	4†	Y	N	N	Y	2/100	135	9	29 gns.
664	Con	Bat	6B	175	IC4, IC6, IC4, IB5, 30, 19	Y	8/PM	4†	Y	N	N	Y	2/120	135	9	33 gns.
751	Con	Bat	7D	456	IC4, IC6, 2/IC4, IB5 30, 19	Y	10/PM	5†	Y	N	N	Y	2/140	135	9	39 gns.
572	Man	Bat	5D	456	6D8G, 2/IC4, IK6, ID4	N	8/PM	5†	Y	N	N	Y	6/140	Vib.	Auto	33 gns.
562	Con	Bat	5D	456	6D8G, 2/IC4, IK6, ID4	N	8/PM	5†	Y	N	N	Y	6/140	Vib.	Auto	36 gns.
593	Con	Bat	5B	175	IC4, IC6, IC4, IB5, 22A	Y	8/PM	4†	Y	N	N	Y	6/140	Vib.	Auto.	33 gns.
594	Man	Bat	5B	175	1C4, 1C6, 1C4, 1B5, 22A	Y	8/PM	4†	Y	N	N	Y	6/140	Vib.	Auto	30 gns.

* Mantel Cabinet moulded of "Zonite." † Has independent dial lamp switch; battery control switch is integral with volume control. ‡ Has two-speed tuning; band-spreader; push-pull audio.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
ARISTOCRAT—Electrical Specialty Manufacturing Co., Ltd., Sydney.																
517	Man	AC	5D	452	EK2, 6K7G, 6Q7G, 6F6G, 5Y3G	N	6/2000	4	Y	N	N	Y	—	—	—	19 gns.
.553	Con	Bat	5D	210	1C4, 1C6, 1C4, 1K6, 1D4	Y	10/PM	5	Y	N	N	Y	2/100	135	4.5	32 gns.
553V	Con	Bat	5D	210	1C4, 1C6, 1C4, 1K6, 1D4	Y	10/PM	5	Y	N	N	Y	6/120	Vib.	Auto	38 gns.
552	Con	Bat	5B	210	1C4, 1C6, 1C4, 1K6 1D4	Y	8/PM	3	N	N	N	Y	2/100	120	4.5	27 gns.
516	Con	AC	5D	452	EK2, 6K7G, 6Q7G, 6F6G, 5Y3G	N	10/2500	4	Y	N	N	Y	—	—	—	26 gns.
651	Con	Bat	6D	210	1C4, 1C6, 1C4, 1B5, 30, 19	Y	10/PM	5	Y	N	N	Y	2/—	135	9	38 gns.
518	Con	AC	5B	452	EK2, 6K7G, 6Q7G, 6F6G, 5Y3G	N	8/2500	3	Y	N	N	Y	—	—	—	21 gns.

(Continued Overleaf.)

ARISTOCRAT——Continued.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
516S	Con	AC	5D	452	EK2, 6K7G, 6Q7G, 6F6G, 5Y3G	N	10/2500	4	Y	N	Y	Y	—	—	—	28 gns.
801	Con	AC	8D	452	EK2, 6K7G, 6H6G 2/6C5G, 2/6F6G, 5Z3,	N	12/1500	4	Y	N	Y	Y	—	—	—	38 gns.
552M	Man	Bat	5B	210	1C4, 1C6, 1C4, 1K6, 1D4	Y	6/PM	4	Y	N	N	Y	2/100	120	Auto	25 gns.
552V	Man	Bat	5D	210	1C4, 1C6, 1C4, 1K6, 1D4	Y	6/PM	3	N	N	N	Y	6/120	Vib.	Auto	34 gns.
651V	Con	Bat	6D	210	1C4, 1C6, 1C4, 2/1K6 19	Y	10/PM	4	N	N	N	Y	6/120	Vib.	Auto	43 gns.

ASTOR—Radio Corporation Pty., Ltd., Melbourne.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
M.M.	Mid*	AC	5B	456	6A8, 6K7, 6Q7, 25A6, 5Z4	N	5/1350	2	N	N	N	Y	—	—	—	12/19/6
M.G.	Man	AC	5B	456	6A7, 6D6, 75, 43, 80	N	6/1350	2	N	N	N	Y	—	—	—	14/19/6
340	Con	AC	4B	472.5	6A7, 6B7S, 42, 80	N	8/1350	3	Y	N	N	N	—	—	—	17 gns.
550	Con	AC	5D	456	6A7, 6B7S, 6B7, 42, 80	N	7/1900	4†	Y	N	N	Y	—	—	—	23 gns.
450‡	Con	AC	5B	472.5	6A7, 6D6, 75, 6L6 80	N	8/600	3	Y	N	Y	Y	—	—	—	24/10/-§
450DW‡	Con	AC	5D	472.5	6A7, 6D6, 75, 6L6, 80	N	8/600	4	Y	N	Y	Y	—	—	—	27/10/-§
560DW‡	Con	AC	6D	472.5	6D6, 6A7, 6D6, 75, 6L6, 80	Y	8/600	5	Y	Y	Y	Y	—	—	—	30 gns.
560DW‡	Con	Uni	6D	472.5	6D6, 6A7, 6D6, 6B7S, 18, 25Y5	Y	8/11000	5	Y	Y	N	Y	—	—	—	30 gns.
88	Con	Uni	5B	472.5	CK1, CF2, CBC1, CL2, CY2	N	8/11000	3	Y	N	N	Y	—	—	—	24 gns.
770DW‡	Con	Bat	5D	472.5	1C4, 1C6, 1C4, 1K6, 1D4	Y	8/PM	4	Y	N	N	Y	6/—	Vib.	Auto	32 gns.
77	Man	Bat	5B	456	1C6, 2/1C4, 1B5, 1D4	N	8/PM	4	Y	N	N	Y	6/—	Vib.	Auto	22/10/-

*Moulded mantel cabinet, optional colours. †Automatic two-speed tuning. microscope dial. ‡Auto. two-speed tuning, microscope dial, "nerve box" construction. Models 450, 450DW, and AC 560DW feature "focussed tuning" and degeneration. §Prices slightly higher in W.A. and N.Q. Model 450 is 24 guineas, and 450DW is 27 guineas.

BANDMASTER—Australian General Electric Ltd., Sydney.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
707DE*	Con	AC	11A	465	6K7, 6L7, 6J7, 6K7 2/6H6, 6L7, 6N7, 2/6L6, 5Z3	Y	10/—	5	Y	Y	Y	Y	—	—	—	55 gns.
177DB†	Con	Bat	7A	465	1C4, 1C6, 2/1C4 1K6, 1K4, 19	Y	10/PM	5	Y	N	N	Y	2/140	135	4.5	42 gns.
177DV†	Con	Bat	7A	465	As above	Y	10/PM	5	Y	N	N	Y	6/120	Vib.	4.5	48/16/6
197DE*	Con.	AC	9A	465	6K7, 6L7, 6J7,6K7 2/6H6, 6L7, 6L6, 80	Y	10/—	5	Y	Y	Y	Y	—	—	—	45 gns.
267DE*	Con	AC	6A	465	6D6, 6A7, 6D6, 6B7 42, 80	Y	10/PM	5	Y	Y	Y	Y	—	—	—	37 gns.
257DB†	Con	Bat	5D	465	1C4, 1C6, 1C4, 1K6, 1D4	Y	8/PM	5	Y	N	N	Y	2/100	135	4.5	34 gns.
257DV†	Con	Bat	5D	465	As above	Y	8/PM	5	Y	N	N	Y	6/120	Vib.	4.5	40/8/6
257DD‡	Con	DC	5A	465	6D6, 6A7, 6D6, 6B7, 43	Y	10/—	5	Y	Y	Y	Y	—	—	—	38 gns.
357ME	Con	AC	5B	465	6D6, 6A7, 6B7, 42, 80	Y	10/—	4	Y	Y	N	Y	—	—	—	23 gns.
367DE	Con	AC	6D	465	6D6, 6A7, 6D6, 6B7, 42, 80	Y	10/—	5	Y	Y	N	Y	—	—	—	29 gns.
357MB†	Con	Bat	5B	465	1C4, 1C6, 1C4, 1K6, 1D4	Y	8/PM	4	Y	N	N	Y	2/100	135	4.5	29 gns.
357MV†	Con	Bat	5B	465	As above	Y	8/PM	4	Y	N	N	Y	6/120	Vib.	4.5	35/3/6
457DE	Con	AC	5D	465	6A7, 6D6, 6B7, 42, 80	N	8/—	4	Y	Y	N	Y	—	—	—	23 gns.
447MB†	Con	Bat	4B	465	1C6, 1C4, 1K6, 1D4	Y	8/PM	4	Y	Y	N	Y	2/100	135	4.5	23 gns.
447MV†	Con	Bat	4B	465	As above	Y	8/PM	4	Y	Y	N	Y	6/120	Vib.	4.5	28 gns.

(Continued on Page 252.)

BANDMASTER—Continued.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
447DD	Con	DC	4D	465	6A7, 6D6, 6B7, 43	N	8/—	4	N	Y	N	Y	—	—	—	24 gns.
557DE	Man	AC	5D	465	6A7, 6D6, 6B7, 42, 80	N	6½/—	4	Y	Y	N	Y	—	—	—	19 gns.§
547MB	Man	Bat	4B	465	1C6, 1C4, 1K6, 1D4	Y	6½/PM	4	Y	Y	N	Y	2/120	120	4.5	19 gns.
547DD	Man	DC	4D	465	6A7, 6D6, 6B7, 43	N	6½/—	4	N	Y	N	Y	—	—	—	20 gns.
657ME	Man	AC	5B	465	6D6, 6A7, 6B7, 42, 80	Y	5/—	2	N	Y	N	Y	—	—	—	15 gns.¶

*These models have automatic interstation noise suppression, duo-vision dials, and high-fidelity speakers.
†These battery models are readily convertible from "B" Battery to Vibrator operation.
‡This model is also available for 32-volt D.C. operation at 49 guineas.
§Also available in alternative cabinets at 20 guineas.
¶Also available in alternative cabinets at 16 guineas.
"All-wave" models have three wave-bands and provide coverage between 13-39, 35-105 and 200-550 metres. The larger "dual-wave" models have 16-50 metres coverage, while the smaller cover the 19-50 metres band.

BEALE—Beale and Company Ltd., Sydney.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
751	Con	AC	5B	446	AK2, 6D6, 75, 42, 80	N	8/2000	3	Y	N	N	Y	—	—	—	on app.*
950W	Con	AC	5D	458	6A7, 6F7, 6B7S, 42, 80	N	8/2000	4	Y	N	N	Y	—	—	—	on app.*
650WU	Con	Uni	5D	458	6A7, 6F7, 6B7S, 43 25Z5	N	8/100	4	Y	N	N	Y	—	—	—	on app.*
960W	Con	AC	6D	458	6D6, 6A7, 6F7, 6B7, 6A3, 80	Y	10/2000	4	Y	N	N	Y	—	—	—	on app.*
953WB	Con	Bat	5D	458	1C6, 2/1C4, 1B5, 1D4	N	8/PM	4	Y	N	N	Y	—	—	—	on app.*
M53W	Man	AC	5D	446	AK2, 6D6, 6B7S, 42, 80	N	6/2000	4	Y	N	N	Y	6/100	Vib.	Auto	on app.*

*Each of these receivers is available in a wide variety of special "Beale" cabinets and retail listing depends entirely on type selected.

BREVILLE—Breville Radio Pty. Ltd., Sydney.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
81	Man	AC	5D	446	AK1, 6D6, 6B7S, 42, 80	N	6/2000	4	Y	N	N	Y	—	—	—	18 gns.*
85	Man	Uni	5D	446	6A7, 6D6, 6B7S, 43, 25Y5	N	6/1250	4	Y	N	N	Y	—	—	—	20 gns.†
89	Man	Bat	5B	182	1C4, 1C6, 1C4, 1B5, 1D4	Y	6/PM	4¶	Y	N	N	Y	6/110	Vib.	Auto	25 gns.‡
92	Con	Bat	5B	182	1C4, 1C6, 1C4, 1B5, 1D4	Y	8/PM	4¶	Y	N	N	Y	6/110	Vib.	Auto	31 gns.
93	Con	Bat	4B	182	1C6, 1C4, 1B5, 1D4	Y	8/PM	4¶	Y	N	N	Y	6/110	Vib.	Auto	27 gns.
94	Con	Bat	5D	182	1C4, KK2, 1C4, 1B5, 1D4	Y	10/PM	4¶	Y	N	N	Y	6/110	Vib.	Auto	34 gns.
95	Con	Bat	5D	182	1C4, KK2, 1C4, 1B5, 1D4	Y	8/PM	4¶	Y	N	N	Y	2/100	135	4.5	31 gns.
96	Con	AC	5D	446	AK2, 6D6, 6B7S, 42, 80	N	8/2000	4	Y	N	N	Y	—	—	—	23 gns.
97	Con	AC	5D	446	AK2, 6D6, 6B7S, 42, 80	N	10/2000	4	Y	N	N	Y	—	—	—	26 gns.
98	Con	AC	6D	470	6D6, 6A7, 6D6, 75, 42, 80	Y	10/2000	4	Y	N	N	Y	—	—	—	31 gns.
99§	Con	AC	7D	470	6D6, 6A7, 6B7S, 79, 2/42, 80	Y	12/1000	4	Y	N	N	Y	—	—	—	36 gns.
100	Con	AC	5B	446	AK2, 6D6, 75, 42 80	N	8/2000	3	Y	N	N	Y	—	—	—	21 gns.
101	Con	Uni	6D	470	6D6, 6A7, 6D6, 75, 43, 25Y5	Y	8/1250	4	Y	N	N	Y	—	—	—	34 gns.

*Available in Console at 22 guineas. †Available in Console at 24 guineas. ‡Available in Console at 29 guineas. §Has Variable Selectivity and H.F. Push-Pull output. ¶Dial lamp switched by tuning knob. All receivers in range, except mantels, are fitted with specially calibrated edgelit dial, 8in. diameter.

CALSTAN—Slade's Radio, Sydney.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
B4/5	Con	AC	5	458	6C6, 6D6, 75, 42, 80	N	8/2500	3	Y	Y	N	N	—	—	—	14/19/6

CALSTAN—Continued.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
B4/5 A.V.	Con	AC	5	458	6C6, 6D6, 75, 42, 80	N	8/2500	3	Y	N	Y*	Y	—	—	—	16/19/6
D5AV	Con	AC	5D	458	EK2, EF5, EBC3, EL2, EZ3, or 6A7 6D6, 75, 42, 80	N	8/2500	4	Y	N	Y*	Y	—	—	—	19 gns.
D5AV	Con	Uni	5D	458	CK1, CF2, CBC1 CL2, CY2	N	8/7500	4	Y	N	N	Y	—	—	—	19 gns.
D5AV	Con	Bat	5D	458	KK2, KF3, KBC1, KC3, KDD1	N	8/PM	4†	Y	N	N	Y	2/60	135	4.5	19 gns.
D6AV	Con	AC	6D	458	6D6, 6A7, 6D6, 75, 42, 80	Y	8/2500	4	Y	Y	N*	Y	—	—	—	29/10/-
D6AV	Con	Bat	6D	458	KF3, 1C6, KF3, 1B5, KC3, KDD1‡	Y	8/PM	4†	Y	N	N	Y	2/60	135	4.5	29/10/-
B4AV	Con	Bat	4B	458	1C6, 1C4, 1K6, 1D4	N	8/PM	3†	Y	N	N	Y	2/60	135	Auto	16/19/6

*Optional. †Provision made for switching off dial lights to economise A battery current. ‡Model D6AV for battery operation, is also available with "American" type valve equipment, as follows: 1C4, 1C6, 1C4, 1K6, 1K6, 19.

CONLON—S. M. Conlon Radio, Sydney.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
5DA	Con	AC	5D	465	6A7, 6D6, 75, 42, 80	N	8/2000	4	Y	Y	U	Y	—	—	—	27/10/-
6DA	Con	AC	6D	465	6D6, 6A7, 6D6, 6B7S, 42, 80	Y	8/2000	4	Y	Y	N	Y	—	—	—	32/10/-
5DB	Con	Bat	5D	465	1C4, KK2, 1C4, 1K6, 1D4	Y	8/PM	4	Y	N	N	Y	2/100	135	4.5	32/10/-

CROYDEN—Eclipse Radio Pty. Ltd., Melbourne.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
524/17	Con	AC	5B	465	6C6, 6D6, 6C6, 42, 80	N	11/2500	5	Y	Y	N	N	—	—	—	14 gns.*
539/17	Con	AC	5D	465	6A7, 6D6, 6C6, 42, 80	N	11/2500	5	Y	Y	N	N	—	—	—	17 gns.†
557/12	Con	AC	5D	465	6A7, 6D6, 6B7, 42, 80	N	11/2500	5‡	Y	N	Y	Y	—	—	—	19 gns.
562/8	Man	AC	5B	465	6A7, 6D6, 6C6, 42, 80	N	6/2500	3	Y	N	N	N	—	—	—	11/15/-
547/17	Con	AC	5D	465	6A7, 6D6, 6B7, 42, 80	N	11/2500	5	Y	Y	Y	Y	—	—	—	19 gns.§
552/12	Con	Bat	5B	465	1C4, 1C6, 1C4, 1B5, 1D4	Y	8/PM	4	Y	N	N	Y	6/—	Vib.	Auto	28/10/
563/8	Man	AC	5D	465	6A7, 6D6, 6B7, 42, 80	N	6/2500	4‡	Y	N	Y	Y	—	—	—	18 gns.
565/16	Con	AC	5D	465	6A7, 6D6, 6B7, 42, 80	N	11/2500	5‡	Y	N	Y	Y	—	—	—	22/10/-¶
569/13	Con	AC	5A	465	6A7, 6D6, 6C6, 42, 80	N	11/2500	5	Y	Y	N	N**	—	—	—	on appl.
615/12	Con	Bat	6D	465	1C4, 1C6, 2/1C4, 1B5, 1D4	Y	8/PM	4	Y	Y	N	Y	6/—	Vib.	Auto	35/-/-
614/12	Con	AC	6D	465	6D6, 6A7, 6D6, 75, 42, 80	Y	11/2500	5	Y	Y	N	Y	—	—	—	on appl.
706/12	Con	AC	7A	465	6K7, 6A8, 2/6K7, 6Q7, 6F6, 5Z4	Y	11/2500	5	Y	N	Y	Y	—	—	—	on appl.††

*Available in alternative cabinet at 16 guineas. Also with metal valve equipment as model 544/17.
†With metal valve equipment as Model 546/17.
‡These models incorporate "Automatic" pre-selected tuning for local stations.
§With metal valve equipment as Model 550/17.
¶Available in alternative cabinets at £23/15/- and £25/15/-. This model has a "band-spread' tuning indicator.
**Can be supplied with A.V.C. Also available with metal valve equipment as Model 570/13.
††Also available with glass valves as Model 705/12.

FISK RADIOLA—Amalgamated Wireless (A/sia) Ltd., Sydney.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
262	Con	AC	11A	465	6K7, 6L7, 6J7, 2/6H6, 6L7, 6N7, 2/6L6, 5Z3	Y	10/—	5†	Y	Y*	Y	Y	—	—	—	55 gns.

Continued on Page 254.)

FISK RADIOLA—Continued.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
257	Con	AC	9A	465	6K7, 6L7, 6J7, 2/6H6, 6L7, 6L6, 80	Y	10/—	5†	Y	Y*	Y	Y	—	—	—	45 gns.
256	Con	AC	6A	465	6D6, 6A7, 6D6, 6B7S, 42, 80	Y	10/—	5†	Y	Y	Y	Y	—	—	—	37 gns.
255	Con	AC	6D	465	6D6, 6A7, 6D6, 6B7S, 42, 80	Y	10/—	5†	Y	Y	N	Y	—	—	—	29 gns.
160	Con	AC	5B	465	6D6, 6A7, 6B7S, 42, 80	Y	10/—	4	Y	Y	N	Y	—	—	—	23 gns.
261	Con	DC	5A	465	6D6, 6A7, 6D6, 6B7S, 43	Y	10/—	5†	Y	Y	Y	Y	32V.	—	—	49 gns.
258	Con	DC	5A	465	6D6, 6A7, 6D6, 6B7S, 43	Y	10/—	5†	Y	Y	Y	Y	240V.	—	—	38 gns.
260	Con	Bat	7A	465	1C4, 1C6, 2/1C4, 1K6, 1K4, 19	Y	10/PM	5†	Y	N	N	Y	2/—	135	4.5	42 gns.‡
259	Con	Bat	5D	465	1C4, 1C6, 1C4, 1K6, 1D4	Y	8/PM	5†	Y	N	N	Y	2/—	135	4.5	34 gns.‡
161	Con	Bat	5B	465	1C4, 1C6, 1C4, 1K6, 1D4	Y	8/PM	4	Y	N	N	Y	2/—	135	4.5	23 gns.‡

*Automatic inter-station muting control. †Improved straight-line frequency tuning and revolving scale calibrations. ‡Available for, or readily convertible to "vibrator" operation at an extra cost of £4/15/-.
"All-wave" models provide coverage from 13-105 metres, in two bands, in addition to "broadcast" coverage.
"Dual-wave" models provide 16-50 metres coverage in addition to "broadcast." "Automatic" two-speed vernier tuning is provided on all "dual" and "all-wave" models.

FISK RADIOLETTE—Amalgamated Wireless (A/sia) Ltd., Sydney.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
41	Con	AC	5D	465	6A7, 6D6, 6B7S, 42 80	N	8/—	4	Y	Y	N	Y	—	—	—	23 gns.
38	Man	AC	5D	465	6A7, 6D6, 6B7S, 42 80	N	6½/—	4	Y	Y	N	Y	—	—	—	19 gns.*
37	Man	AC	5B	465	6D6, 6A7, 6B7S, 42 80	Y	5/—	2	N	Y	N	Y	—	—	—	15 gns.†
43	Con	DC	4D	465	6A7, 6D6, 6B7S, 43	N	6½/—	4	N	Y	N	Y	—	—	—	24 gns.
40	Man	DC	4D	465	6A7, 6D6, 6B7S, 43	N	6½/—	4	N	Y	N	Y	—	—	—	20 gns.§
39	Man	Bat	4B	465	1C6, 1C4, 1K6, 1D4	Y	6½/PM	4	Y	N	N	Y	2/—	120	4.5	19 gns.‡
42	Con	Bat	4B	465	1C6, 1C4, 1K6, 1D4	Y	8P/M	4	Y	N	N	Y	2/—	120	4.5	23 gns.¶

*For Brown moulded "Radelec" cabinet. Also available in Ivory or Jade Green at 20 guineas.
†For Black or Brown moulded "Radelec" cabinet. Also available in Ivory or Jade Green at 16 guineas.
§For Brown moulded "Radelec" cabinet. Also available in Ivory or Jade Green at 21 guineas.
‡For Brown moulded "Radelec" cabinet. Also available in Ivory or Jade Green at 20 guineas.
¶Available for, or readily convertible to six-volt "vibrator" operation at an extra cost of 5 guineas.
"Dual-wave" models provide coverage of the 19-50 metres band in addition to "broadcast."
"Automatic" two-speed vernier tuning on dual-wave models.

GENALEX—British General Electric Co. Ltd., Sydney.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
BC415	Con	Bat	7D	458	1C4, 1C6, 2/1C4, 1B5, 2/19	Y	10/PM	5	Y	N	N	Y	2/120	135	—	43 gns.
BC430	Con	AC	5B	458	EK2, 6D6, 75, EL3 80	N	8/1650	3	Y	Y	Y	Y	—	—	—	23 gns.*
BC435	Con	AC	5D	458	EK2, 6D6, 75, EL3 80	N	8/1650	5	Y	Y	Y	Y	—	—	—	28 gns.†
BC440	Con	AC	7A	458	6D6, EK2, 6B7S 6A6, 2/EL3, 80	Y	10/2500	5	Y	Y	Y	Y	—	—	—	40 gns.§
BC455	Con	Uni	6D	458	CF1, EK2, CF1, CBC1, CL2, CY2	Y	10/PM	5	Y	Y	Y	Y	—	—	—	36 gns.‡
BC460	Man	AC	5B	458	EK2, 6D6, 75, 42, 80	N	5/1650	3	Y	N	N	Y	—	—	—	15 gns.¶
BC465	Con	DC	6D	458	6D6, 6A7, 6D6, 75, CL4, 0Z4	Y	10/PM	5	Y	Y	Y	Y	32V.	Vib.	Auto	38 gns.
BC470	Con	Bat	4B	458	1C6, 1C4, 1K6, 1D4	N	8/PM	4	Y	N	N	Y	2/—	135	4.5	26 gns.[1]
BC475	Con	Bat.	5D	458	1C4, 1C6, 1C4, 1K6, 1D4	Y	8/PM	5	Y	N	N	Y	6/140	Vib.	Auto	38 gns.[2]
BC480	Con	Bat	5D	458	1C4, 1C6, 1C4, 1K6, 1D4	Y	8/PM	5	Y	N	N	Y	2/—	135	4.5	34 gns.[3]

GENALEX—Continued

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
BC485	Con	Bat	5B	458	1C4, 1C6, 1C4, 1K6, 1D4	Y	8/PM	5	Y	N	N	Y	6/140	Vib.	Auto	33 gns.[4]

*Table model, 19 guineas. †Table model, 22 guineas. §Alternative cabinet, 45 guineas, also as radiogram with auto. record changer, 75 guineas. ‡Alternative cabinets available, 38 and 43 guineas. ¶Alternative cabinet, 16 guineas. [1] Table model, 22 guineas. [2] Table model, 32 guineas. [3] Table model, 28 guineas. [4] Table model, 29 guineas.
All A.C. models are fitted with variable selectivity control.

HEALING GOLDEN-VOICED—A. G. Healing Ltd., Melbourne.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
47M	Mid	AC	5B	455	6A7, 6D6, 75, 42, 80	N	6½/2500	2	N	N	N	Y	—	—	—	15 gns.
447M	Mid	AC	5D	455	6A8, 6D6, 75, 42, 80	N	6½/2500	3	N	N	N	Y	—	—	—	19 gns.
47C	Mid	Uni	5B	455	6A8, 6K7, 6Q7, 25A6, 25Y5	N	6½/8000	2	N	N	N	Y	—	—	—	19 gns.
57A	Man	Bat	5B	180	1C4, 1C6, 1C4, 1K6, 1D4	Y	6½/PM	3	N	N	N	Y	6/150	Vib.	Auto	27 gns.
417E	Con	AC	5B	455	6A8, 6K7, 6J7, 6F6 80	N	8/2500	3	Y	N	N	N	—	—	—	20 gns.
4477E	Con	AC	5D	455	6A8, 6K7, 6Q7, 6F6, 80	N	8/2500	4	Y	N	N	Y	—	—	—	23 gns.
47E	Con	AC	5B	180	6A8, 6K7, 6Q7, 6F6, 80	N	10/2500	3	Y	N	N	Y	—	—	—	27 gns.
447E	Con	AC	5D	455	6A8, 6K7, 6Q7, 6F6, 80	N	12/2500	5	Y	N	N	Y	—	—	—	32 gns.
777E	Con	AC	8D	455	6K7, 6A8, 6K7, 6Q7, 6C5, 2/6L6, 5Z3	Y	12H.F*	5	Y	Y	N	Y	—	—	—	49 gns.
47B	Con	Bat	4B	455	1C6, 1C4, 1K6, 1D4	N	8/PM	3	N	N	N	Y	6/100	135	Auto	25 gns.
57B	Con	Bat	5B	180	1C4, 1C6, 1C4, 1K6, 1D4	Y	8/PM	5	Y	Y	N	Y	6/100	135	Auto	30 gns.
667B	Con	Bat	6D	455	1C4, 1C6, 1C4, 1K6, 1K4, 19.	Y	10/PM	5	Y	Y	N	Y	6/100	135	Auto	38 gns.
417A	Con	Bat	4B	455	1C6, 1C4, 1K6, 1D4	N	8/PM	3	N	N	N	Y	6/150	Vib.	Auto	28 gns.
517A	Con	Bat	5B	180	1C4, 1C6, 1C4, 1K6, 1D4	Y	8/PM	5	Y	Y	N	Y	6/150	Vib.	Auto	33 gns.
557A	Con	Bat	5D	455	1C4, 1C6, 1C4, 1K6, 1D4	Y	10/PM	5	Y	Y	N	Y	6/150	Vib.	Auto	39 gns.
447C	Con	Uni	5D	455	6A8, 6K7, 6Q7, 25A6, 25Y5	N	10/8000	5	Y	N	N	Y	—	—	—	28 gns.

*Rola G-12 High Fidelity auditorium type speaker used on this model.

HIS MASTER'S VOICE—The Gramophone Co. Ltd., Sydney.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
718	Man	AC	6A	460	6D6, 6A7, 6D6, 6B7, 42, 80	Y	6/1250	6	Y	Y	Y	Y	—	—	—	29 gns.
737	Con	AC	6A	460	6D6, 6A7, 6D6, 6B7, 42, 80	Y	8/1250	6*	Y	Y	Y	Y	—	—	—	37 gns.
721	Cmb‡	AC	6A	460	6D6, 6A7, 6D6, 6B7, 42, 80	Y	8/1250	6*	Y	Y	Y	Y	—	—	—	52 gns.
121	Con	AC	6B	460	6D6, 6A7, 6D6, 6B7, 42, 80	Y	6/1250	4	Y	N	N	Y	—	—	—	27 gns.
522	Con	AC	5B	460	6A7, 6D6, 6B7, 42, 80	N	8/1250	5*	Y	Y	N	Y	—	—	—	23 gns.
523	Con	AC	5D	460	6A7, 6D6, 6B7, 42, 80	N	8/1250	5*	Y	Y	Y	Y	—	—	—	28 gns.
345	Con	Bat	6B	460	1C4, 1C6, 1C4, 1B5, 30, 19	Y	8/PM	4	Y	N	N	Y	2/—	135	9	32 gns.
346	Con	Bat	6D	460	1C4, 1C6, 1C4, 1K6, 30, 19	Y	8/PM	5	Y	N	N	Y	6/140	Vib.	Auto	39 gns.†
347	Con	Bat	6D	460	1C4, 1C6, 1C4, 1K6, 30, 19	Y	8/PM	5	Y	N	N	Y	6/120	135	Auto	38 gns.†

*These models all fitted with large, rectangular edgelit dial. Dual and all-wave models are fitted with two-speed tuning controls. ‡Fitted with volume control on front of cabinet. †These two models are readily interchangeable; only difference is power supply system.

KRIESLER—Kriesler (A/sia) Ltd., Sydney.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
900	Man*	AC	5D	458	6A7, 6D6, 75, 42, 80	N	6½/2000	3	Y	N	N	Y	—	—	—	16 gns.

(Continued overleaf.)

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
KRIESLER—Continued.																
710A	Con	AC	5B	458	6A7, 6F7, 6B7S, 6A3, 80	N	8/2000	5	Y	Y	Y	Y	—	—	—	19 gns.†
720	Con	AC	5D	458	6A7, 6F7, 6B7S, 6A3, 80	N	8/2000	5	Y	Y	Y	Y	—	—	—	24 gns.§
730	Con	AC	6D	175	6D6, 6A7, 6D6, 6B7S, 6A3, 80	Y	8/2000	5	Y	Y	Y	Y	—	—	—	26 gns.‡
740	Con	AC	8D	175	6D6, 6A7, 6D6, 75, 76, 2/42, 5Y3	Y	10/—	5	Y	Y	Y	Y	—	—	—	31 gns.¶
810	Con	Bat	5D	458	1C6, 2/1C4, 25S, 1D4	N	8/PM	5	Y	N	N	Y	6/140	Vib.	Auto	35 gns.
820	Con	Bat	6D	458	1C6, 2/1C4, 25S, B217, 19	N	8/PM	5	Y	N	N	Y	6/140	Vib.	Auto	37 gns.
830	Con	Uni	5D	458	6A7, 6F7, 6B7S, 43, 25Y5	N	8/—	5	Y	Y	Y[1]	Y	—	—	—	28 gns.

*Housed in moulded cabinet with vertical slide-rule edgelit dial. †Available in alternative cabinet styles as models 711 and 712. Features large "slide-rule" dial, and triode audio amplification. §Available in alternative cabinet styles and with 10 inch speaker as models 721, 722 and 723. Features "Wonder Dial," "Timer Recorder," tone and volume indicators, "Turret top" shielding, "Tone Expander" and triode audio. ‡Available in alternative cabinet styles and with 10 inch speaker as models 731, 732 and 733. Same features as "720" series. ¶Available in alternative cabinet styles as models 741, 742 and 743. Same general features as "720" series but has push-pull output. Remaining models also available in range of cabinet styles. Same general features as A.C. models. [1]Tuning indicator optional on this model.

LEKMEK—Lekmek Radio Laboratories, Sydney.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
406	Mid	AC	4B	458	6A7, 6B7S, 6F6, 80	N	5/2500	2	N	N	N	N	—	—	—	11 gns.
529	Man	AC	5B	458	6A7, 6D6, 75, 42, 80	N	8/2500	3	Y	N	N	Y	—	—	—	15 gns.
528	Con	AC	5B	458	6A7, 6D6, 75, 42, 80	N	8/2500	3	Y	N	N	Y	—	—	—	19 gns.
528P	Con	AC	5B	458	6A7, 6D6, 75, 42, 80	N	10/2500	3*	Y	N	N	Y	—	—	—	24 gns.
633P	Con.	AC	6B	458	6D6, 6A7, 6D6, 75, 42, 80	Y	10/2500	3*	Y	N	N	Y	—	—	—	26 gns.
530	Man	AC	5D	458	6A7, 6D6, 75, 42, 80	N	8/2500	4	Y	N	N	Y	—	—	—	19 gns.
530	Con	AC	5D	458	6A7, 6D6, 75, 42, 80	N	8/2500	4	Y	N	N	Y	—	—	—	23 gns.
514P	Con	AC	5D	458	6A7, 6D6, 75, 42, 80	N	10/2500	5*	Y	Y	Y	Y	—	—	—	28 gns.
630	Con	AC	6D	458	6D6, 6A7, 6D6, 75, 42 80	Y	8/2500	5	Y	Y	N	Y	—	—	—	29 gns.
630P	Con	AC	6D	458	6D6, 6A7, 6D6, 75, 42 80	Y	10/2500	5*	Y	Y	Y	Y	—	—	—	35 gns.
805P	Con	AC	8D	458	6D6, 6A7, 6D6, 85, 76 2/6B5, 80	Y	12/850	5*	Y	Y	Y	Y	—	—	—	52 gns.
533	Man	Uni	5B	458	CK1, CF2, CBC1, CL4, CY2	N	8/1250	3	Y	N	N	Y	—	—	—	19 gns.
533	Con	Uni	5B	458	CK1, CF2, CBC1, CL4, CY2	N	8/1250	3	Y	N	N	Y	—	—	—	25 gns.
631	Con	Uni	6D	458	CF2, CK1, CF2, CBC1, CL4, CY2	Y	10/1250	5	Y	Y	N	Y	—	—	—	35 gns.
402	Mid	Bat	4B	458	1C6, 1C4, 1B5, 1D4	N	5/PM	2	N	N	N	Y	2/40	135	4.5	14 gns.
402	Port	Bat	4B	458	1C6, 1C4, 1B5, 1D4	N	5/PM	2	N	N	N	Y	2/40	135	4.5	16 gns.
403	Con	Bat	4B	458	1C6, 1C4, 1B5, 1D4	N	8/PM	3	Y	N	N	Y	2/100	135	4.5	25 gns.
534	Man	Bat	5B	458	1C4, 1C6, 1C4, 1K6, 1D4	Y	8/PM	4	Y	N	N	Y	2/100	135	6	26 gns.
534	Con	Bat	5B	458	1C4, 1C6, 1C4, 1K6, 1D4	Y	8/PM	5	Y	Y	N	Y	2/100	135	6	29 gns.
535	Con	Bat	5D	458	1C4, 1C6, 1C4, 1K6, 1D4	Y	8/PM	5	Y	Y	N	Y	2/100	135	6	32 gns.
632	Con	Bat	6D	458	1C4, 1C6, 2/1C4, 1K6, 1D4	Y	8/PM	5	Y	Y	N	Y	2/100	135	6	35 gns.

*Fitted with nine-inch diameter "Panoramic" dial.
Mantel models "529" and "530" are fitted with a special edgelit dial.

MULLARD—Mullard Radio Co. (Aust.) Ltd., Sydney.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
40	Man*	AC	4B	456	6A7, 6F7, 42, 80	N	6/1500	3	Y	N	N	N	—	—	—	£12/19/6
50	Man*	AC	5B	456	6A7, 6D6, 75, 42, 80	N	6/1500	3	Y	N	N	Y	—	—	—	15 gns.
60	Man*	AC	5D	456	6A7, 6D6, 75, 42, 80	N	6/1500	4	Y	N	N	Y	—	—	—	19 gns.
51	Man*	Uni	5B	456	EK2, CF2, CBC1, CL2, CY2	N	6/1500	3	Y	N	N	Y	—	—	—	19 gns.

(Continued on Page 258.)

MULLARD—Continoed.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
41	Man*	Bat	4B	456	1C6, 1C4, 1K6, 1D4	N	6/PM	4	Y	N	N	Y	2/110	135	Auto	19 gns.
70	Con	AC	5B	456	6A7, 6D6, 75, 42, 80	N	8/2000	4	Y	Y	N	Y	—	—	—	on app.
80	Con	AC	5D	456	6A7, 6D6, 75, 42, 80	N	10/2000	4	Y	N	N	Y	—	—	—	28 gns.
71	Con	Bat	5B	175	1C4, 1C6, 1C4, 1B5, 22A	Y	8/PM	4	Y	N	N	Y	2/110	135	4.5	on app.
72	Con	Bat	5B	175	1C4, 1C6, 1C4, 1B5, 1D4	Y	8/PM	4	Y	N	N	Y	6/150	Vib	Auto	on app.
91	Con	Bat	7D	456	1C4, 1C6, 2/1C4, 1B5, 30, 19	Y	10/PM	5	Y	Y	N	Y	2/150	135	9	on app.

*"Pegasus" cabinet of moulded bakelite. Available in al ternative colours, brown or black.

OPERATIC—Bland Radio, Adelaide.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
BV5DW	Con	Bat	5D	465	KK2, KF3, KB2, KF4, KL4	N	8/PM	5	Y	N	N	Y	6/135	Vib	Auto	on app.
BV5	Con	Bat	5B	465	KF3, KK2, KF3, KBC1, KL4	Y	8/PM	4	Y	N	N	Y	6/135	Vib	Auto	£31/10/-
BW5	Mid	AC	5B	465	EK2, EF5, EBC3, EL2, EZ3	N	4/2500	2	N	N	N	N	—	—	—	12 gns.
B5	Con	Bat	5B	465	KF2, KK2, KF2, KC1, C243N	Y	8/PM	4*	N	N	N	Y	2/100	120	Auto	£28/15/-
05DWA	Con	AC	5D	465	AK2, AF3, ABC1, AL2, AZ3	N	8/2500	5	Y	N	Y	Y	—	—	—	£26/10/-
ACDCDW	Con	Uni	6D	465	CK1, CF2, CB1, CF1, CL2, CY2	N	8/PM	5	Y	N	N	Y	—	—	—	£35/10/-
PR5DWA	Cmb	AC	5D	465	AK2, AF3, ABC1, AL2, AZ3	N	8/2500	4	Y	N	N	Y	—	—	—	on app.

*Fitted with dial lamp switch.

PHILCO—Philco Radio and Television Corporation (Aust.) Pty. Ltd., Sydney.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
654	Con	AC	5B	460	6F7, 6A7, 6F7, 42, 80	Y	8/2000	3	Y	N	N	Y	—	—	—	24 gns.
654D	Con	AC	5B	460	6F7, 6A7, 6F7, 42, 80	Y	10/2000	3	Y	N	Y	Y	—	—	—	26 gns.
655	Con	AC	5D	460	6A7, 78, 75, 42, 80	N	8/2000	4	Y	N	N	Y	—	—	—	26 gns.
667	Con	AC	6D	460	78, 6A7, 78, 75, 42, 80	Y	10/2000	4	Y	N	Y	Y	—	—	—	38 gns.
688	Con	AC	8D	460	78, 6A7, 78, 75, 42, 2/42, 5Z3	Y	12/1500	4	Y	N	Y	Y	—	—	—	42 gns.
609	Con	AC	10A	460	78, 2/77, 2/6F7, 75, 42, 2/42, 5Z3	Y	12/2000	4*	Y	Y	Y	Y	—	—	—	65 gns.
64B	Con	Bat	4B	460	1C6, 1A4, 1B5, 33	N	8/PM	3	N	N	N	Y	2/80	135	18	27 gns.
66B	Con	Bat	6B	175	34, 32, 34, 1B5, 30, 19	Y	8/PM	4	Y	Y	N	Y	2/100	180	Auto	37 gns.
66X	Con	Bat	6D	460	34, 1C6, 34, 1B5, 30, 19	Y	8/PM	4	N	Y	N	Y	2/100	180	Auto	38 gns.
68B	Con	Bat	8A	460	34, 2/15, 2/34, 1B5, 30, 19	Y	10/PM	4	N	N	N	Y	2/100	180	Auto	45 gns.
75VB	Con	Bat	5D	262.5	1C4, 1C6, 1C4, 1K6, 1D4	Y	8/PM	4†	N	N	N	Y	6/130	Vib	Auto	37 gns.
751	Man	AC	5B	462.5	6A7, 6D6, 75, 42, 80	N	8/2000	2	N	N	N	Y	—	—	—	15 gns.
752	Con	AC	5B	462.5	6A7, 6D6, 75, 42, 80	N	8/2000	3	Y	N	N	Y	—	—	—	21 gns.
753	Man	AC	5D	462.5	6A7, 6D6, 75, 42, 80	N	8/2000	4	Y	N	N	Y	—	—	—	19 gns.
754	Con	AC	5D	462.5	6A7, 6D6, 75, 42, 80	N	8/2000	4	Y	N	N	Y	—	—	—	23 gns.

*Fitted with inter-station noise suppression and variable selectivity controls.
†Special "band-spreading" device incorporated. Also ed.gelit dial and "floating" tuning unit.

PHILIPS RADIOPLAYER—Philips Lamps (A/sia) Ltd., Sydney.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
6723	Con	Uni	7D	472.5	CF2, CK1, CF2, CB1, CF1, CL4, CY2	Y	8/7500	4*	Y	N	Y	Y	—	—	—	on app.†

PHILIPS RADIOPLAYER—Continhed

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
6604	Con	AC	6D	472.5	AK2, AF3, AB2, ABC1, AL2, AZ3	N	8/1500	4*	Y	N	Y	Y	—	—	—	27 gns.
6702	Con	AC	7D	472.5	AF3, AK2, AF3, AB2, AF7, EL5, AZ3	Y	12/750	4*	Y	N	Y	Y	—	—	—	38 gns.†
6603	Con	AC	6D	472.5	AK2, AF3, AB2, AF7, AL3, AZ3	N	8/1500	4*	Y	N	Y	Y	—	—	—	31 gns.†
6506	Man	AC	5B	462.5	EK2, EF5, EBC3, EL2, AZ3	N	5/1000	2	N	N	N	Y	—	—	—	15 gns.
6620	Con	Uni	5B	462.5	CK1, CF2, CBC1, CL2, CY2	N	8/1000	3	Y	N	N	Y	—	—	—	27 gns.
6510	Con	Bat	5B	462.5	KF3, KK2, KF3, KBC1, KL4	Y	8/PM	3	N	N	N	Y	2/100	135	Auto	29 gns.
6713	Con	Bat	7D	472.5	KF3, KK2, 2/KF3, KBC1, 2/KL4	Y	8/PM	4*	Y	N	N	Y	2/100	135	Auto	39 gns.
6608	Con	AC	6D	462.5	AK2, AF3, AB2, ABC1, AL2, EZ3	N	8/1000	4*	Y	N	Y	Y	—	—	—	27 gns.
6709	Con	AC	7D	462.5	EF5, EK2, EF5, EB4, EBC3, EL2, EZ3	Y	10/1000	4*	Y	N	Y	Y	—	—	—	34 gns.
6501	Con	AC	5B	462.5	AK2, AF3, ABC1, AL2, AZ3	N	8/1000	2	N	N	N	Y	—	—	—	19 gns.
6500	Con	AC	5B	462.5	AK2, AF3, ABC1, AL2, AZ3	N	8/1000	3	Y	N	N	Y	—	—	—	23 gns.
6736	Cmb	AC	7D	472.5	AF3, AK2, AF3, AB2, AF7, EL5, AZ3	Y	12/750	4*	Y	N	Y	Y	—	—	—	52 gns.†
6505	Man	AC	5B	472.5	AK2, AF3, ABC1, AL2, AZ3	N	8/1500	2‡	N	N	N	Y	—	—	—	16 gns.

*Wave-change switch is concentric with tuning knob. †These models equipped with "Audioscopic" reproduction.
‡This model features a 6½ inch square, etched glass, edgelit dial.
Models 6723, 6702, 6603, 6713, and 6736 feature fully-floating R.F. Sub-chassis. Model 6603 uses pre-selector circuit instead of R.F. amplifying valve.

S.T.C.—Standard Telephones and Cables (A/sia) Ltd., Sydney.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
5017B	Man	AC	5B	450	6A7, 6D6, 6B7, 42, 80S	N	6/2000	2	N	N	N	Y	—	—	—	15 gns.*
5018C	Man	AC	6D	450	6D6, 6A7, 6D6, 6B7, 42, 80S	Y	8/2500	4	Y	Y	N	Y	—	—	—	30 gns.
5018E	Con	AC	6D	450	6D6, 6A7, 6D6, 6B7, 42, 80S	Y	8/2500	4	Y	Y	Y	Y	—	—	—	33 gns.†
5019C	Man	AC	5B	450	6A7, 6D6, 6B7, 42, 80S	N	8/2500	3	Y	N	N	Y	—	—	—	21 gns.
5019E	Con	AC	5B	450	6A7, 6D6, 6B7, 42, 80S	N	8/2500	3	Y	N	N	Y	—	—	—	£24/13/-‡
5020C	Man	Bat	5B	175	1C4, 1C6, 1C4, 1B5, 1D4	Y	8/PM	4	Y	N	N	Y	2/100	135	Auto	27 gns.
5020E	Con	Bat	5B	175	1C4, 1C6, 1C4, 1B5, 1D4	Y	8/PM	4	Y	N	N	Y	2/100	135	Auto	29 gns.§
5021C	Man	Bat	7D	450	1C4, 1C6, 2/1C4, 1B5, 30, 19	Y	10/PM	5	Y	Y	N	Y	2/140	135	6	37 gns.
5021E	Con	Bat	7D	450	1C4, 1C6, 2/1C4, 1B5, 30, 19	Y	10/PM	5	Y	Y	N	Y	2/140	135	6	39 gns.¶
5022C	Man	AC	5D	450	6A7, 6D6, 6B7, 42, 80S	N	8/2500	4	Y	Y	N	Y	—	—	—	24 gns.
5022E	Con	AC	5D	450	6A7, 6D6, 6B7, 42, 80S	N	8/2500	4	Y	Y	N	Y	—	—	—	27 gns.
5023C	Man	Bat	5D	450	1C6, 2/1C4, 1B5, 1D4	N	8/PM	5	Y	Y	N	Y	2/100	135	Auto	31 gns.
5023E	Con	Bat	5D	450	1C6, 2/1C4, 1B5, 1D4	N	8/PM	5	Y	Y	N	Y	2/100	135	Auto	33 gns.
5024C	Man	Uni	5B	450	6A7, 6D6, 6B7, 43, 12Z3	N	8/2500	3	Y	Y	N	Y	—	—	—	24 gns.
5024E	Con	Uni	5B	450	6A7, 6D6, 6B7, 43 12Z3	N	8/2500	3	Y	Y	N	Y	—	—	—	26 gns.
5025C	Man	Uni	6D	450	6D6, 6A7, 6D6, 6B7, 43, 12Z3	Y	8/2500	4	Y	Y	Y	Y	—	—	—	30 gns.

(Continued Overleaf.)

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
S.T.C.—Continued.																
5025E	Con	Uni	6D	450	6D6, 6A7, 6D6, 6B7, 43, 12Z3	Y	8/2500	4	Y	Y	Y	Y	—	—	—	33 gns.[4]
5026G	Con	AC	8A	450	6D6, 6A7, 6B7S, 76, 53, 2/6A3, 5Z3	Y	Spec.	4	Y	Y	Y	Y	—	—	—	on app.
5027B	Man	Bat	4B	450	1C6, 1C4, 1B5, 1D4	N	6/PM	2	N	N	N	Y	2/100	135	6	19 gns.
5027I	Con	Bat	4B	450	1C6, 1C4, 1B5, 1D4	N	8/PM	2	N	N	N	Y	2/100	135	6	24 gns.
5028H	Con	AC	5B	450	6A7, 6D6, 6B7, 42, 80	N	8/2000	3	Y	N	N	Y	—	—	—	20 gns.
5029B	Man	AC	5D	450	6A7, 6D6, 6B7, 42, 80	N	6/2000	4	Y	N	N	Y	—	—	—	18 gns.[5]
5030H	Con	AC	5D	450	6A7, 6D6, 6B7, 42, 80	N	8/2000	4	Y	N	N	Y	—	—	—	23 gns.
5032	Con	Bat	5B	175	1C4, 1C6, 1C4, 1K6, 1D4	Y	8/PM	5	Y	N	N	Y	6/140	Vib	Auto	on app.
5033	Con	Bat	7D	450	1C4, 1C6, 2/1C4, 1K6, 1K4, 19	Y	8/PM	6	Y	Y	N	Y	6/140	Vib	Auto	on app.
5034F	Con	Bat	6B	175	34, 6A7, 34, 2/30, 19	Y	8/PM	3	Y	N	N	Y	6/120	135	6	on app.

*Alternative cabinet as 5017A at £16/5/-. †With 10 inch speaker and different cabinet as 5018F at 36 gns.; with dual speakers and different cabinet as 5018G at 42 gns.; also alternative cabinet as 5018J at 33 gns. ‡Alternative cabinet as 5019J at same price; different cabinet as 5019F at 26 gns. §Alternative cabinet as 5020J at same price; different cabinet as 5020F at 32 gns. ¶Alternative cabinet as 5021J at same price; different cabinet as 5021F at 42 gns. [1] Alternative cabinet as 5022J at same price; different cabinet as 5022F at 30 gns. [2] Alternative cabinet as 5023J at same price; different cabinet as 5023F at 36 gns. [3] Alternative cabinet as 5024J at same price; different cabinet as 5024F at 29 gns. [4] Alternative cabinet as 5025J at same price; different cabinet as 5025F at 36 gns. [5] Alternative cabinet as 5029A at £19/10/-.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
STROMBERG-CARLSON—Stromberg-Carlson (A/sia) Ltd., Sydney.																
937	Con	AC	9D	268	6D6, 6A7, 2/6B7S, 6C6, 6A6, 2/2A3, EZ3	Y	8/1000†	4	Y*	N	Y	Y‡	—	—	—	47 gns.
937PR	Cmb	AC	9D	268	6D6, 6A7, 2/6B7S, 6C6, 6A6, 2/2A3, EZ3	Y	8/1000†	4	Y*	N	Y	Y‡	—	—	—	68 gns.
837U	Con	AC	8D	268	6D6, 6A7, 2/6B7S, 79, 2/42, EZ3	Y	8/1000†	4	Y*	N	Y	Y‡	—	—	—	40 gns.§
837PR	Cmb	AC	8D	268	6D6, 6A7, 2/6B7S, 79, 2/42, EZ3	Y	8/1000†	4	Y*	N	Y	Y‡	—	—	—	61 gns.
777	Con	Bat	7D	392	1C4, KK2, 2/1C4, 1K6, 30, KDD1	Y	8/PM	5	Y	Y	N	Y	2/120	135	Auto	41 gns.
778	Con	Bat	7D	392	1C4, KK2, 2/1C4, 1K6, 30, KDD1	Y	10/PM	5	Y	Y	N	Y	2/120	135	Auto	44 gns.
677	Con	Uni	6D	392	CF2, CK1, CF2, CBC1, CL2, CY2	Y	10/1000	4	Y	N	N	Y	—	—	—	33 gns.
667	Con	AC	6B	465	6A7, 6D6, EB4, 75, 42, EZ3	N	10/1000	4	Y	Y	Y	Y	—	—	—	26 gns.
637U	Con	AC	6D	392	6D6, 6A7, 6D6, 75, 42. EZ3	Y	10/1000	4	Y	N	N	Y	—	—	—	33 gns.¶
6237	Con	AC	6D	465	6A7, 6D6, EB4, 75, 42, EZ3	N	8/1000	4	Y	Y	Y	Y	—	—	—	29 gns.
6237PR	Cmb	AC	6D	465	6A7, 6D6, EB4, 75, 42, EZ3	N	8/1000	4	Y	Y	Y	Y	—	—	—	49 gns.
617	Con	Bat	6D	392	1C4, KK2, 2/1C4, 1B5, 1D4	Y	10/PM	4	Y	N	N	Y	6/140	Vib	Auto	43 gns.
607	Con	Bat	6D	392	1C4, KK2, 2/1C4, 1B5, 1D4	Y	10/PM	4	Y	N	N	Y	2/120	135	Auto	35 gns.
567	Con	Uni	5B	465	CK1, CF2, CBC1, CL2, CY2	N	8/1000	4	Y	Y	N	Y	—	—	—	25 gns.
537	Con	AC	5D	465	6A7, 6D6, 75, 42, 80	N	8/1000	4	Y	Y	Y	Y	—	—	—	26 gns.
507	Con	Bat	5B	175	1C4, KK2, 1C4, 1B5, 1D4	Y	8/PM	4	Y	N	N	Y	2/120	135	Auto	29 gns.[1]
407	Con	Bat	4B	465	KK2, KF4, 1B5, 1D4	N	8/PM	4	N	Y	N	Y	2/120	135	Auto	£27/16/6[1]
D7	Man[2]	AC	5D	465	6A7, 6D6, 75, 42, EZ3	N	4/2500	4	Y	Y	N	Y	—	—	—	19 gns.
67	Man[2]	Uni	5B	465	CK1, CF2, CBC1, CL2, CY2	N	4/PM	4	Y	Y	N	Y	—	—	—	19 gns.

(Continued on Page 262.)

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
STROMBERG-CARLSON—Continued.																
57	Man[2]	AC	5B	465	6A7, 6D6, 75, 42, EZ3	N	4/2500	4	Y	Y	N	Y	—	—	—	16 gns.
46	Man	Bat	4B	465	KK2, KF4, 1B5, 1D4	N	8/PM	3	N	N	N	Y	2/120	135	Auto	19 gns.

*Tone control is combined with selectivity variation control. †Special speaker fitted to the "Acoustical Labyrinth." ‡Special A.V.C. system using separate amplifier. §Upright Grand cabinet. Also available in Console Grand cabinet at 42 gns. as model "837G." ¶Upright Grand cabinet. Also available in Console Grand cabinet at 35 gns. as model "637G." Both of these models incorporate a "degenerated" output stage. [1] Similar models to these, suitable for "Air-Cell" operation, are available to order. [2] These three models are housed in horizontal mantel type cabinets moulded of "Duperite." Four alternative colours are available at no extra cost.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
TASMA—Thom and Smith, Ltd., Sydney.																
415	Con	Bat	7D	458	1C4, 1C6, 2/1C4, 1B5, 2/19	Y	10/PM	5	Y	N	N	Y	2/120	135	—	43 gns.
430	Con	AC	5B	458	EK2, 6D6, 75, EL3, 80	N	8/1650	3	Y	Y	Y	Y	—	—	—	23 gns.*
435	Con	AC	5D	458	EK2, 6D6, 75, EL3, 80	N	8/1650	5	Y	Y	Y	Y	—	—	—	28 gns.†
440	Con	AC	7A	458	6D6, EK2, 6B7S, 6A6, 2/EL3, 80	Y	12,2500	5	Y	N	Y	Y	—	—	—	40 gns.‡
445	Con	Uni	5B	458	EK2, CF2, CBC1, CL4, CY2	N	8/1650	3	Y	Y	Y	Y	—	—	—	25 gns.§
450	Con	Uni	5D	458	EK2, CF2, CBC1, CL4, CY2	N	10/PM	5	Y	Y	Y	Y	—	—	—	33 gns.¶
455	Con	Uni	6D	458	CF2, EK2, CF2, CBC1, CL4, CY2	Y	10/PM	5	Y	N	Y	Y	—	—	—	38 gns.[1]
460	Man	AC	5B	458	EK2, 6D6, 75, 42, 80	N	6/1650	3	Y	Y	N	Y	—	—	—	15 gns.
460	Con	AC	5B	458	EK2, 6D6, 75, 42, 80	N	8/1650	3	Y	Y	N	Y	—	—	—	19 gns.
465	Con	DC	6D	458	6D6, EK2, 6D6, 75, CL4, 0Z4	Y	10/PM	5	Y	N	Y	Y	32V.	Vib	Auto	38 gns.[2]
470	Con	Bat	4B	458	1C6, 1C4, 1K6, 1D4	N	8/PM	4	Y	Y	N	Y	2/120	135	4.5	26 gns.[3]
475	Con	Bat	5D	458	1C4, 1C6, 1C4, 1K6, 1D4	Y	10/PM	5	Y	N	N	Y	6/120	Vib	Auto	38 gns.[4]
480	Con	Bat	5D	458	1C4, 1C6, 1C4, 1K6, 1D4	Y	8/PM	5	Y	N	N	Y	2/120	135	4.5	34 gns.[5]
485	Con	Bat	5B	458	1C4, 1C6, 1C4, 1K6, 1D4	Y	8/PM	4	Y	N	N	Y	6/120	Vib	Auto	33 gns.[6]

*Also available as mantel at 19 gns. and combination at 43 gns. †Also available as mantel at 22 gns. and comb. at 46 gns. ‡Available as comb. at 56 gns. §Available as mantel at 22 gns. and comb. at 48 gns. ¶Available as mantel at 27 gns. and comb. at 52 gns. [1]Available as comb.at 56 gns. [2]Available as comb. at 52 gns. [3]Available as mantel at 22 gns. [4]Available as mantel at 32 gns. [5]Available as mantel at 28 gns. [6]Available as mantel at 29 gns. All "Tasma" power-operated models are fitted with a counterbalanced tuning drive and variable selectivity control as standard. All battery models are fitted with a special automatic dial lamp switch.

Model	Cabinet	Power Source	No. Valves & Coverage	Int. Freq.	Valve Types Used	R.F. Stage?	Size Spkr. & Field R.	Controls	Tone Con?	Sen. Con?	Tun. Indic?	A.V.C.?	A Volts & A/H Cap.	B Volts	C Bias	Price
VELCO—A. J. Veall Pty., Ltd., Melbourne.																
365B	Con	Bat	5B	175	1C4, 1A6, 1C4, 1B5, 1D4	Y	8/PM	3	Y	N	N	Y	2/110	135	Auto	£25/10/-
ZENITH—Zenith Radio Co. Ltd., Sydney.																
1*	Con	AC	5D	465	AK2, AF3, ABC1, AL3, AZ3	N	8/2000	3	N	N	N	Y	—	—	—	20 gns.
2*	Con	AC	5D	465	6A7, 6D6, 75, 42, 80	N	8/2000	4	Y	N	N	Y	—	—	—	£24/15/-
2†	Con	AC	5D	465	6A7, 6D6, 75, 42, 80	N	8/2000	4	Y	N	Y	Y	—	—	—	£27/15/-
3*	Con	AC	7A	465	6D6, 6A7, 6D6, 75, 42, 80	Y	10/2000	4	Y	N	Y	Y	—	—	—	£34/10/-
4*	Con	Uni	6D	465	CF2, CK1, CF2, CBC1, CL2, CY2	Y	8/7500	4	Y	N	N	Y	—	—	—	£29/10/-
5*	Con	Bat	7D	465	1C4, 1C6, 2/1C4, 1B5, B217, B240	Y	8/PM	4	Y	N	N	Y	2/100	135	4.5	£37/10/-
6*	Man	AC	5D	465	AK2, AF3, ABC1, AL3, AZ3	N	8/2000	3	N	N	Y	Y	—	—	—	19 gns.

*Zenith Radio Company's models are designated by names instead of a numeral—letter combination. The corresponding names for the numeral designations used above are as follows: 1—"Explorer." 2—"Adventurer." 3—"Ranger." 4—"Traveller." 5—"Roamer," and 6—"Magic Star."
†This model is a de-luxe version of the "Adventurer" model.

WORLD TIME CHART

Samoa	New Zealand	Sydney, Melbourne, Eastern Aust.	Adelaide, South Aust.	Tokyo	P.I., China, Western Australia	Borneo, Java, Dutch E.I.	India	Bagdad, Persia	Petrograd, Constantinople, Capetown	Sweden, Germany, Switzerland, Italy	G.M.T. or G.C.T.	London, Paris, Madrid	Rio de Janeiro, Brazil	Halifax, Buenos Aires	U.S.A. New York, Washington E.S.T.	U.S.A. Central S.T.	U.S.A. Mountain S.T.	U.S.A. Pacific S.T.	Hawaiian Islands
Noon	11.30	10.00	9.30	9.00	8.00	6.00	5.00	3.00	2.00	1.00	0000	Midn.	9.00	8.00	7.00	6.00	5.00	4.00	1.30
1.00	12.30	11.00	10.30	10.00	9.00	7.00	6.00	4.00	3.00	2.00	0100	1.00	10.00	9.00	8.00	7.00	6.00	5.00	2.30
2.00	1.30	Noon	11.30	11.00	10.00	8.00	7.00	5.00	4.00	3.00	0200	2.00	11.00	10.00	9.00	8.00	7.00	6.00	3.30
3.00	2.30	1.00	12.30	Noon	11.00	9.00	8.00	6.00	5.00	4.00	0300	3.00	Midn.	11.00	10.00	9.00	8.00	7.00	4.30
4.00	3.30	2.00	1.30	1.00	Noon	10.00	9.00	7.00	6.00	5.00	0400	4.00	1.00	Midn.	11.00	10.00	9.00	8.00	5.30
5.00	4.30	3.00	2.30	2.00	1.00	11.00	10.00	8.00	7.00	6.00	0500	5.00	2.00	1.00	Midn.	11.00	10.00	9.00	6.30
6.00	5.30	4.00	3.30	3.00	2.00	Noon	11.00	9.00	8.00	7.00	0600	6.00	3.00	2.00	1.00	Midn.	11.00	10.00	7.30
7.00	6.30	5.00	4.30	4.00	3.00	1.00	Noon	10.00	9.00	8.00	0700	7.00	4.00	3.00	2.00	1.00	Midn.	11.00	8.30
8.00	7.30	6.00	5.30	5.00	4.00	2.00	1.00	11.00	10.00	9.00	0800	8.00	5.00	4.00	3.00	2.00	1.00	Midn.	9.30
9.00	8.30	7.00	6.30	6.00	5.00	3.00	2.00	Noon	11.00	10.00	0900	9.00	6.00	5.00	4.00	3.00	2.00	1.00	10.30
10.00	9.30	8.00	7.30	7.00	6.00	4.00	3.00	1.00	Noon	11.00	1000	10.00	7.00	6.00	5.00	4.00	3.00	2.00	11.30
11.00	10.30	9.00	8.30	8.00	7.00	5.00	4.00	2.00	1.00	Noon	1100	11.00	8.00	7.00	6.00	5.00	4.00	3.00	12.30
Midn	11.30	10.00	9.30	9.00	8.00	6.00	5.00	3.00	2.00	1.00	1200	Noon	9.00	8.00	7.00	6.00	5.00	4.00	1.30
1.00	12.30	11.00	10.30	10.00	9.00	7.00	6.00	4.00	3.00	2.00	1300	1.00	10.00	9.00	8.00	7.00	6.00	5.00	2.30
2.00	1.30	Midn.	11.30	11.00	10.00	8.00	7.00	5.00	4.00	3.00	1400	2.00	11.00	10.00	9.00	8.00	7.00	6.00	3.30
3.00	2.30	1.00	12.30	Midn.	11.00	9.00	8.00	6.00	5.00	4.00	1500	3.00	Noon	11.00	10.00	9.00	8.00	7.00	4.30
4.00	3.30	2.00	1.30	1.00	Midn.	10.00	9.00	7.00	6.00	5.00	1600	4.00	1.00	Noon	11.00	10.00	9.00	8.00	5.30
5.00	4.30	3.00	2.30	2.00	1.00	11.00	10.00	8.00	7.00	6.00	1700	5.00	2.00	1.00	Noon	11.00	10.00	9.00	6.30
6.00	5.30	4.00	3.30	3.00	2.00	Midn.	11.00	9.00	8.00	7.00	1800	6.00	3.00	2.00	1.00	Noon	11.00	10.00	7.30
7.00	6.30	5.00	4.30	4.00	3.00	1.00	Midn.	10.00	9.00	8.00	1900	7.00	4.00	3.00	2.00	1.00	Noon	11.00	8.30
8.00	7.30	6.00	5.30	5.00	4.00	2.00	1.00	11.00	10.00	9.00	2000	8.00	5.00	4.00	3.00	2.00	1.00	Noon	9.30
9.00	8.30	7.00	6.30	6.00	5.00	3.00	2.00	Midn.	11.00	10.00	2100	9.00	6.00	5.00	4.00	3.00	2.00	1.00	10.30
10.00	9.30	8.00	7.30	7.00	6.00	4.00	3.00	1.00	Midn.	11.00	2200	10.00	7.00	6.00	5.00	4.00	3.00	2.00	11.30
11.00	10.30	9.00	8.30	8.00	7.00	5.00	4.00	2.00	1.00	Midn.	2300	11.00	8.00	7.00	6.00	5.00	4.00	3.00	12.30

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.

VALVE CHARACTERISTICS

IN the following pages will be found complete tabulations of the characteristics of the valve types in common use during 1936-1937:—

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.

Brands.

The manufacturers of each type are designated by their initials as follows:—

S.A. . . . . . . Standard American types; which are produced by Radiotron, Ken-Rad, National Union, 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.

Thus, a valve manufactured by National Union and Ken-Rad only is designated as "K.N." "Raytheon" is an exception to this, and is designated by the letter "Y."

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 American R.M.A. socket index number. No corresponding illustrations are given; the information being presented for classification purposes only. This applies to "American type" valves only, except in the case of European types which are available with an American base. Where both "Base Type" and "Symbol" headings are provided, the "Symbol" column is left blank for European valves; sufficient information being provided by the "Base Type" column.

Where a "Symbol" column only is provided, the space will be filled by the "Base Type" abbreviation as given above.

These changes have been made possible by the adoption of a new system of base contact identification. Instead of the symbolic representation of the valve presented in previous years, with a key to be followed out from the data tables, the base connection of information is now complete in itself, and no cross-referencing is necessary.

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 abbreviation 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 of 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 **"millamperes per volt"** expression may obtain it by shifting the decimal point three places to the left (e.g. 200 micromhos is equal to mA/V.).

Plate resistance (or impedance) is given in ohms except where specified as being in megohms.

The **load resistance** figures given for power valves 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 valves 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 valve. In the case of intermediate amplifier stage valves 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 valves, however, the position is somewhat different and the maximum permissible value of resistance us 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 valves. 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 valves 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 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 valve itself) are really "semi-fixed" biassing systems, and,

(Continued on Page 266.)

VALVE CHARACTERISTICS (Continued.)

under these circumstances, a grid resistance value about mid-way between the limits tabulated may be used with safety.

Variable-mu valves 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 valve types where a separate supressor 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.

"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 22.5	600 15	0.6	360
,,	1A4	R.F. tetrode " short-base "	UX	4-K	2.0	0.06	dir.	180	67.5	2.3	0.7	3.0 15.0	700 15	0.75	525
K.N.	1D5G	Sim. to 1A4	oct.	5-R	2.0	0.06	dir.	180	67.5	2.3	0.7	3.0	700	0.75	525
K.R.-M.O.	1C4	R.F. pentode " short-base "	UX	4-M	2.0	0.12	dir.	135	67.5	2.5	0.9	zero 16.0	1000 4	0.8	800
,,	1C4	" Economy " rating	—		2.0	0.12	—	135	30.0*	0.65	0.25	zero 16.0	600 4	2.54	1525
Mul.	VP2	R.F. pentode	6	—	2.0	0.2†	dir.	150	150	3.7	1.0	0.5 16.0	1700 5	0.5	900
Phil.	KF2	,, ,,	6	—	2.0	0.2†	dir.	150	150	3.7	1.0	0.5 16.0	1700 5	0.5	900
P.M.	KF3	,, ,, "short-base "	P	—	2.0	0.05	dir.	135	135	2.0	0.6	zero 15.0	650 2	1.3	850
Osr.	VS24	,, ,,	UX	—	2.0	0.15	dir.	150	75	4.4	0.3	zero 9.0	1500 16	—	—
S.A.	58	,, ,,	6	6-F	2.5	1.0	ind.	250	100	8.2	2.0	3.0 40.0	1600 10	0.8	1280
Mul.	VP4	,, ,,	7 (L)	—	4.0	1.1	ind.	200	100	4.5	1.8	2.0 35.0	2000 10	1.0	2000
Phil.	E447	,, ,, " long-base "	7 (L)	—	4.0	1.1	ind.	250	100	4.5	1.8	2.0 35.0	2000 5	1.0	2000
P.M.	AF2	,, ,, " short-base "	7 (L)	—	4.0	1.1	ind.	250	100	4.25	1.5	2.0 20.0	2500 5	1.4	3500
,,	AF3	,, ,,	P	—	4.0	0.65	ind.	250	100	8.0	2.6	3.0 45.0	1800 2	1.2	2200
Osr.	VMP4G	Catkin R.F. pent. " short-base "	Eng.	—	4.0	1.0	ind.	250	100	8.0	5.0	2.0 20.0	2700 10	—	—
,,	VMS4	Catkin R.F. pent.	UY	—	4.0	1.0	ind.	200	80	10.0	2.0	1.0 30.0	2600 30	—	—
P.M.	EF5	R.F. pentode	P	—	6.3	0.2	ind.	250	100	8.0	2.5	3.0 50.0	1700 2	1.2	2000
S.A.	78	,, ,,	6	6-F	6.3	0.3	ind.	250	100	7.0	1.7	3.0 42.5	1450 2	0.8	1160
,,	6D6	,, ,,	6	6-F	6.3	0.3	ind.	250	100	8.2	2.0	3.0 40.0	1600 10	0.8	1280
,,	6K7	Metal R.F. pent. **	oct.	7-R	6.3	0.3	ind.	250	100	7.0	1.7	3.0 42.5	1450 2	0.8	1160
,,	6L7	Pentagrid Mixer** as amplifier ††	oct.	7-T	6.3	0.3	ind.	250	100	5.3	5.5	3.0 15.0	1100 5	0.8	880
,,	6F7	Pentode section as R.F. amplifier	7(S)	7-E	6.3	0.3	ind.	250	100	6.5	1.5	3.0 35.0	1100 10	0.85	900
K.N.R.	6S7G	Sim. to 6D6	oct.	7-R	6.3	0.15	ind.	250	100	8.0	2.2	3.0	1600	0.8	1280
P.M.	CF2	Univ. R.F. pentode " short base "	P	—	13.0	0.2	ind.	250	100	4.5	1.5	2.0 20.0	2200 5	1.0	2200
Osr.	VDS	Univ. R.F. pentode	UY	—	16.0	0.25	ind.	200	80	10.0	1.0	1.0 30.0	2400 13	—	—

* 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.

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	—
K.N.	1C7G	Sim. to 1C6	7-Z	2.0	0.12	dir.	135	67.5	135†	2.6	3.0	300	0.55	5.9	50,000	13.0
K.N.	1D7G	Sim. to 1A6	7-Z	2.0	0.06	dir.	135	67.5	135	2.3	3.0	275	0.4	5.9	50,000	13.0
P.M.	KK2	Oct. B/C.	M7	2.0	0.13	dir.	135	45	135	2.1	zero	270	2.5	3.5	50,000	8.5
			P	—	—	—	—	—	—	—	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. A/W.	—	4.0	1.2	ind.	250	70	100	—	1.5	550	2.0	7.6	50,000	10.0
				—	—	—	—	—	—	—	—	—	—	—	0.15	—
Phil.	AK1	Oct. A/W.	M7	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	—
P.M.	AK2	Oct. A/W.	P	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	—
Phil.	EK1	Oct. A/W.	P	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	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.	8-A	6.3	0.3	ind.	250	100	250†	4.0	3.0	500	0.36	10.5	50,000	35.0
		see note (A)		—	—	—	—	—	—	—	45.0	2	—	—	0.5	—
,,	6L7	Pen. mixer	7-T	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	—	—	—	—	—
K.N.R.	6D8G	Sim. to 6A8	8-A	6.3	0.15	ind.	250	100	250†	4.5	3.0	500	0.32	11.0	50,000	13.0
P.M.	CK1	Oct. A/W.	P	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.

INDEPENDANT DIODE DETECTORS

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	—	2.0	0.95	ind.	125 (P)	0.5 mA	0.5
P.M.	AB2	,,	V	—	4.0	0.65	ind.	200 (P)	0.8 mA	0.5
,,	EB4	,,	P	—	6.3	0.2	ind.	200 (P)	0.8 mA	0.5
,,	CB1	Universal D.D.	V	—	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	7-Q	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 V.	Filament A.	Cath. type	Va	Vsg	Ia mA	Isg mA	Vcg neg	Mutual Cond. μ mhos	Plate resist. ohms	Amp. factor
S.A.	1B5/25S	Duo-diode-triode †	6	6-M	2.0	0.06	dir.	135	—	0.8	—	3.0	575	35,000	20
K.N.	1H6G	Sim. to 1B5	oct.	7-AA	2.0	0.06	dir.	135	—	0.8	—	3.0	575	35,000	20
K.N.	1F6	D.D. Pentode	6	6-W	2.0	0.06	dir.	180	67.5	2.0	0.6	1.5	650	1MΩ	650
K	1F7G	Sim. to 1F6	oct.	7-AD	2.0	0.06	dir.	180	67.5	2.0	0.6	1.5	650	1MΩ	650
K.R.-M.O.	1K6	D.D. Pentode †	6	—	2.0	0.12	dir.	135	67.5	1.8	0.7	0	800	1.25MΩ	1000
P.M.	KBC1	,, ,, †	P	—	2.0	0.1	dir.	135	—	2.5	—	4.5	1000	16,000	16
Mul.	TDD2	Also old KBC1 †	6	—	2.0	0.1	dir.	150	—	2.5	—	5.5	1400	12,000	16.5
Mul.	TDD4	Duo-diode triode	7 (L)	—	4.0	1.2	ind.	200	—	3.5	—	3.5	2000	15,000	30
Phil.	E454	,, ,, ,,	7 (L)	—	4.0	1.2	ind.	250	—	3.5	—	3.5	1600	19,000	30
,,	E444N	Single D.-tetrode	6	—	4.0	1.1	ind.	250	110	4.8	1.5	2.3	3000	2.5MΩ	1000
P.M.	ABC1	Duo-diode-triode	P	—	4.0	0.65	ind.	250	—	4.0	—	7.0	2000	13,500	27
Osr.	MHD4	Duo-diode-triode	7	—	4.0	1.0	ind.	200	—	3.0	—	3.0	2200	18,200	40
P.M.	EBC3	,, ,, ,,	P	—	6.3	0.2	ind.	250	—	5.0	—	5.5	2000	15,000	30
,,	EBF1	D.D.-pentode	P	—	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
K.R.O.	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.	7-V	6.3	0.3	ind.	250	—	9.5	—	9.0	1900	8,500	16
,,	6Q7	Metal D.D.-triode *	oct.	7-V	6.3	0.3	ind.	250	—	1.1	—	3.0	1200	58,000	70
K.R.	6B8	Sim. to 6B7 *	oct.	8-E	6.3	0.3	ind.	250	125	10.0	2.3	3.0	1325	0.6MΩ	800
,,	6T7G	Sim. to 6Q7	oct.	7-V	6.3	0.15	ind.	250	—	0.9	—	3.0	1000	65,000	65
K.	6V7G	Sim. to 85	oct.	7-V	6.3	0.3	ind.	250	—	8.0	—	20.0	1100	7,500	8.3
P.M.	CBC1	Univ. D.D.-triode	P	—	13.0	0.2	ind.	200	—	4.0	—	5.0	2000	15,000	30

* 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.

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
K.N.	1H4G	Sim. to 30	oct.	5-S	2.0	0.06	dir.	180	13.5	3.1	900	10,300	9.3
Rad.	1K4	as triode driver	UX	—	2.0	0.12	dir.	135	4.5	3.5	1400	10,700	15
,,	1K6	,, ,, ,,	UX	—	2.0	0.12	dir.	135	4.5	2.0	900	16,500	15
Mul.	PM1HL	gen. purpose	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	special driver	P	P	2.0	0.21	dir.	135	2.8	3.0	2500	12,000	30
Osram	HL2	gen. purpose	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	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
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	6-Q	6.3	0.3	ind.	250	8.0	8.0	2000	10,000	20
,,	6F5	metal hi-mu **	octal	5-M	6.3	0.3	ind.	250	2.0	0.9	1500	66,000	100
,,	6C6	as triode	6	6-F	6.3	0.3	ind.	250	8.0	6.5	1900	10,500	20
K.N.R.	6L5G	gen. purpose	oct.	6-Q	6.3	0.15	ind.	250	9.0	8.0	1900	9,000	17
Ken.	6C8G	twin-triode	oct.	8-G	6.3	0.3	ind.	250	4.5	3.1	1450	26,000	38†
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
P.M.	CC1	,,	P	P	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.
† One section only. This valve is designed especially for use as a phase-inverter,

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	12.5	7000	0.15	—	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.	PX4	Class "A"	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.	ACO44	" "	4-D	4.0	1.0	dir.	200	30.0	32.0	S	3500	6.0	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.	E406N	" "	P	4.0	1.0	dir.	250	48.0	22.0	S	3500	6.0	3500	1.6	5.0	0.6
		" "	—	—	—	—	—	—	—	F	—	—	—	—	—	0.2
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*	7-S	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)
K.N.Y.	6A3	Class "A" (5)	4-D	6.3	1.0	dir.	250	60.0	45.0	S	5250	4.2	2500	3.2	—	0.5
K	6B4G	Sim. to 6A3	5-S	6.3	1.0	dir.	250	60.0	45.0	S	5250	4.2	2500	3.2	—	0.5
K.N.	6N6G	Sim. to 6B5	7-W	6.3	0.8	ind.	(6B5)	—	—	—	—	—	—	—	—	—
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.N.Y.	6B5	Twin Triode (int.	6-D	6.3	0.8	ind.	325	51.0	—	—	2400	58.0	7000	5.2	—	—
		direct coupled) (6)	—	—	—	—	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) 6.3 volt version of 2A3 and push-pull data are same. (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.

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-K	2.0	0.26	dir.	135	135	14.5	3.0	13.5	F.	1450	70	7,000	0.7	7.0	0.5
K.R.-M.O.	1D4	" "	5-K	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
K.N.R.	1F4	" "	5-K	2.0	0.12	dir.	135	135	8.0	2.6	4.5	F	1700	340	16,000	0.34	5.0	0.5
K.N.	1F5G	Sim. to 1F4	6-X	2.0	0.12	dir.	135	135	8.0	2.6	4.5	F	1700	340	16,000	0.34	5.0	0.5
K.	1E7G	twin-pentode	8-C	2.0	0.24	dir.	135	135	6.5	2.0	7.5	F	1600	350	24,000	0.65	5.0	0.5
Osr.	PT2	Class "A"	5-K	2.0	0.2	dir.	150	150	6.5	1.9	4.5	F	—	—	17,000	0.5	—	0.5
Mul.	PM22A	" "	5-K	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-K	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	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	" "	—	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	" "	—	4.0	1.35	ind.	250	250	36.0	3.2	22.0	S	2700	100	8,000	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
P.M.	AL2	Class "A"	P	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	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
P.M.	EL2	Class "A"	P	6.3	0.2	ind.	250	250	32.0	5.0	18.0	S	2800	—	8,000	3.6	10.0	1.0
"	EL3	High-mu	P	6.3	1.2	ind.	250	250	36.0	4.0	6.0	S	9500	—	7,000	4.4	10.0	1.0
"	EL5	High-power	P	6.3	1.3	ind.	250	250	72.0	7.5	16.0	S	7000	—	3,500	7.7	10.0	0.5
P.M.	EBL1	diode-pen. *	P	6.3	1.4	ind.	250	250	36.0	5.0	6.0	S	9500	—	7,000	4.3	10.0	1.0
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	7-S	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"	—	—	—	—	**	**	**	**	**	**	**	**	**	**	**	**
K.N.	6K6G	Class "A"	7-S	6.3	0.4	ind.	180	180	18.5	3.0	13.5	S	1850	150	9,000	1.5	10.0	1.0
K.N.R.	6V6G	"Beam"	7-AC	6.3	0.45	ind.	250	250	45.0	4.5	12.5	S	4100	218	5,000	4.25	7.5	1.0
"	6V6G	two in P.P.	—	—	—	—	300	300	78.0	5.0	20.0	S	—	—	8,000	13.5	4.0	0.5
"	6L6G	"Beam"	7-AC	6.3	0.9	ind.	250	250	72.0	5.0	14.0	S	6000	135	2,500	6.5	10.0	1.0
"	6L6G	1 tube (max.)	—	—	—	—	375	250	57.0	2.5	17.5	F	—	—	4,000	11.5	14.5	0.05
"	6L6G	1 tube (avge.)	—	—	—	—	300	200	51.0	3.0	12.0	S	—	—	4,500	6.5	11.0	0.5
"	6L6G	2 tubes (A)	—	—	—	—	250	250	120	10.0	16.0	S	—	—	5,000	14.0	2.0	0.5
"	6L6G	2 tubes (AB1)	—	—	—	—	400	300	112	6.0	23.5	S	—	—	6,600	30.0	2.0	0.5
"	6L6G	2 tubes (AB2)	—	—	—	—	400	300	102	6.0	25.0	F	—	—	3,800	60.0	2.0	(C)
P.M.	CL2	"	P	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	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	33.0	0.2	ind.	200	200	45.0	6.0	8.5	S	8000		4,500	4.0	10.0	1.0
K N.Y.	12A5	Class "A"	7-F	12.3	0.3	ind.	100	100	17.0	3.0	15.0	S	1900	70	4,500	0.85	10.0	1.0
"	12A5	(alt. rating)	—	6.3	0.6	ind.	180	180	36.0	6.0	27.0	S	2500	80	3,800	3.5	10.0	1.0
K.N.	12A7	rect.-pentode	7-K	12.6	0.3	ind.	135	135	9.0	2.5	13.5	S	975	100	13,500	0.55	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.	7-S	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 EBL1 is a pentode of the EL3 type fitted with two diodes for detection and A.V.C. Diodes are similar to type EB4.

† 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.

(C) This rating requires 350 milliwatts of grid driving power. Good plate, screen and grid supply regulation and transformer coupling essential.

"STRAIGHT" R.F. TETRODES AND PENTODES

Make	Type	Description	Base	Symb.	Filament V.	Filament A.	Cath. type	Va	Vsg	Ia mA	Isg mA	Vcg neg	Mutual Cond. μ mhos	Plate resist. megohms	Amp. factor
K.N.	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.Y.	1B4	,, ,,	UX	4-K	2.0	0.06	dir.	180	67.5	1.7	0.4	3.0	650	1.0	650
N.	1E5G	Sim. to 1B4T	oct.	5-R	2.0	0.06	dir.	180	67.5	1.7	0.4	3.0	650	1.0	650
K.R.	1K4	R.F. Pentode	UX	4-K	2.0	0.12	dir.	135	67.5	2.5	0.9	0	1050	1.0	1050
Mul.	SP2	R.F. pentode	6	—	2.0	0.2*	dir.	150	150	2.6	0.7	0.5	1700	0.75	1300
Phil.	KF1	,, ,,	6	—	2.0	0.2*	dir.	150	150	2.6	0.7	0.5	1700	0.75	1300
P.M.	KF4	,, ,,	P	—	2.0	0.05	dir.	135	135	2.6	1.0	zero	800	1.0	800
Osr.	S23	,, ,,	UX	—	2.0	0.1	dir.	150	70	1.4	0.8	2.0	1100	0.25	275
Mul.	SP4	,, ,,	7 (L)	—	4.0	1.1	ind.	200	100	3.0	1.1	2.0	2500	2.0	5000
Phil.	E446	,, ,,	7 (L)	—	4.0	1.1	ind.	200	100	3.0	1.1	2.0	2500	2.0	5000
,,	AF7	,, ,,	P	—	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
P.M.	EF6	,, ,,	P	—	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.	7-R	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
P.M.	CF1	,, ,, ,,	P	—	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.

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
Ray.	0Z4	F.W. gaseous	—	No	No	No	—	—	250	300	75	Condenser input
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.	DW4	,, ,, ,,	4-C	4.0	2.0	dir.	—	—	500	500	120	,, ,,
Phil.	1561	,, ,, ,,	4-C	4.0	2.0	dir.	—	—	500	500	120	,, ,,
Mul.	IW3	,, ,, ,,	4-L	4.0	2.4	ind.	—*	—	350	350	120	,, ,,
Phil.	1867	,, ,, ,,	4-L	4.0	2.4	ind.	—*	—	350	350	120	,, ,,
P.M.	AZ3	,, ,, ,,	P	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
,,	5Z3	,, ,, ,,	4-C	5.0	3.0	dir.	—	—	500	475	250	Condenser input
,,	,,	,, ,, ,,	,,	,,	,,	,,	,,	,,	500	360	250	10 H. Choke input
,,	5Y3G	F.W.V. "G" series	5-T	5.0	2.0	dir.	—	—	(80)	(80)	(80)	(80)
,,	5Z4	F.W.V. metal	5-L	5.0	2.0	ind.	—*	1100	400	470	125	8 mfd. max. cond.
K.R.	5W4	F.W.V. Metal	5-T	5.0	1.5	dir.	—	1000	350	370	110	4 mfd. condenser
K.N.	5V4G	F.W.V., "G" series	5-L	5.0	1.75	ind.	—*	—	400	470	200	8 mfd. condenser
K.N.	5X4G	F.W.V., "G" series	5-Q	5.0	3.0	dir.	—	—	500	475	250	Condenser input
Phil.	EZ2	Full-wave vacuum	P	6.3	0.25	ind.	—*	—	350	350	60	condenser input
P.M.	EZ3	,, ,, ,,	P	6.3	0.65	ind.	—*	—	350	350	100	,, ,,
P.M.	EZ4	,, ,, ,,	P	6.3	0.9	ind.	—*	—	350	350	175	,, ,,
S.A.	1V	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	6-S	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†	7-Q	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
P.M.	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.

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 (Note 2)	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
P.M.	KDD1	,, ,,	—	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 (Note 3)	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.

Note 2.—Also available in "G" series as type 1J6G, with identical characteristics except for filament current, which is 0.24 ampere. R.M.A. symbol is "7-AB."

Note 3.—Also available in "metal" and "G" types, as 6N7 and 6N7G, with identical characteristics. R.M.A. symbol is "8-B."

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
Phil.	4060	,, ,,	—	0.6	1.0	dir.	4.0	—	—	—	2.5	28	Low grid current
Rad.	956	Var. mu "954"	—	6.3	0.15	ind.	250	100	5.5	1.8	3.0	1800	Rp—0.8M Ω., A.F. 1440
			—	—	—	—	—	—	—	—	45.0	2	
,,	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
S.A.	6Q7	as A.F. amp. (R.C.)	7-V	6.3	0.3	ind.	250	—	0.35	—	1.9	—	Stage gain 45. Note (1)
,,	75	or 2A6, as A.F. amp (R.C.)	6-G	—	—	—	250	—	0.41	—	1.3	—	,, ,, 50. Note (2)
,,	1B5	as A.F. amp. (R.C.)	6-M	—	—	—	135	—	0.23	—	1.5	—	,, ,, 16.5. Note (3)
Rad.	1K6	as A.F. amp. (R.C.)	—	2.0	0.12	dir.	135	45	0.25	0.09	1.5	—	Stage gain 60, Note (4)
,,	1K4	,, ,, ,,	—	2.0	0.12	dir.	135	45	0.34	0.12	1.5	—	,, ,, 65, Note (5)

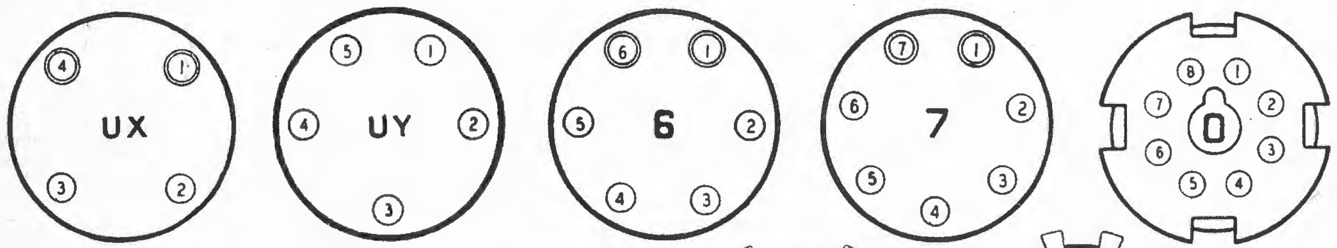
(1) Plate supply of 250 volts applied through 0.25 meg. load resistance. Bias resistance, 5000 ohms. 0.5 meg. grid res. on following valve.

(2) Plate supply, 250 volts, applied through load resistance of 0.25 meg. Bias resistance, 3000 ohms. 0.25 grid res. on following valve.

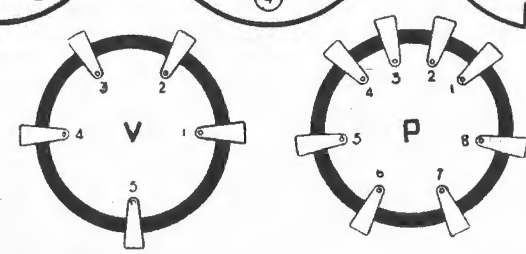
(3) Plate supply, 135 volts, applied through load resistance of 0.25 meg. 1 megohm grid resistance on following valve.

(4) Plate supply of 135 volts applied through 0.25 meg. load resistance. Screen supply from 135 volts through 1.0 meg. dropping resistor.

(5) Plate supply of 135 volts applied through 0.25 meg. load resistance. Screen supply from 135 volts through 0.75 meg. dropping resistor.



Valve Socket Connections



THE following tabulation, together with the outline drawings given above, provides complete socket connection information for all of the valve types listed on the preceding pages. To simplify reference, the socket connections data are grouped in the same manner and the same order as the characteristics data. No cross-referencing is necessary, as in previous editions of this Annual, and the following matter is complete in itself.

The outline drawings shown opposite are representative of the valve base when looking at the pins (usual under-socket view). The pin numberings in each case are standard American or Continental practice, as the case may be. Note carefully that American numbering increases clockwise, whilst the Continental system operates in the opposite direction. The base designations are standard.

On reference to the tabulated matter, it will be seen that eleven columns are provided. The first of these contains the valve type number; the second the base type designation; and the remainder the abbreviations for the particular electrode connected to the base connection numbered in accordance with the column.

The abbreviations are in each case the initial letters of the electrodes in question, but to avoid confusion, they are as follows:—

F—Filament. Polarity is given on battery valves only.

C—Cathode. A number is suffixed where there is more than one.

G—Grid. A number is suffixed where there is more than one, and in some cases another initial is prefixed where the grid serves a particular function such as "OG" for the oscillator grid of a pentagrid or octode, or "TG" for the triode grid of a 6F7.

P—Plate. The same remarks apply here as for grid classifications.

S—Shield or Shell. Metal or internally shielded valves only.

M—Metallization. Spray-shielded Continental-type valves only. In one or two instances a small "M" is shown after a "C." This indicates that the metallization is connected, and is common to, the cathode connection.

Sc—Screen Grid. To avoid confusion with the "shell" designation, the first two letters of "screen" are given.

Su—Suppressor Grid. The same remarks as for "screen grid" apply here.

D—Diode Plate. A polarity sign is suffixed in the case of battery diodes and indicates which leg of the filament the diode is located on.

"Variable-Mu" R.F. Tetrodes and Pentodes

Type	Base	1	2	3	4	5	6	7	8	Cap
34	UX	F+	P	Sc	F—	—	—	—	—	G
1A4	UX	F+	P	Sc	F—	—	—	—	—	G
1D5G	O	S	F+	P	Sc	—	—	F—	—	G
1C4	UX	F+	P	Sc	F—	—	—	—	—	G
VP2	6	F	Sc	M	G	Su	F	—	—	P
KF2	6	F	Sc	M	G	Su	F	—	—	P
KF3	P	M	F	F	—	Su	—	Sc	P	G
VS24	UX	F+	Sc	G	F—	—	—	—	—	P
58	6	F	P	Sc	Su	C	F	—	—	G
E447	7	F	C	Sc	M	G	—	F	—	P
VP4	7	F	C	Sc	M	G	—	F	—	P
AF2	7	F	C	Sc	M	G	—	F	—	P
AF3	P	M	F	F	C	Su	—	Sc	P	G
VMS4	UY	F	Sc	G	C	F	—	—	—	P
EF5	P	M	F	F	C	Su	—	Sc	P	G
78	6	F	P	Sc	Su	C	F	—	—	G
6D6	6	F	P	Sc	Su	C	F	—	—	G
6K7	O	S	F	P	Sc	Su	—	F	C	G
6L7	O	S	F	P	Sc	OG	—	F	C	G
6F7	7	F	P	Sc	TP	TG	C	F	—	G
6S7G	O	S	F	P	Sc	Su	—	F	C	G
CF2	P	M	F	F	C	Su	—	Sc	P	G
VDS	UY	F	Sc	G	C	F	—	—	—	P

Converter and Mixer Valves

Type	Base	1	2	3	4	5	6	7	8	Cap
1A6	6	F+	P	OA	OG	Sc	F—	—	—	G
1C6	6	F+	P	OA	OG	Sc	F—	—	—	G
1C7G	O	S	F+	P	Sc	OG	OA	F—	—	G
1D7G	O	S	F+	P	Sc	OG	OA	F—	—	G
KK2	P	M	F—	F+	—	OA	OG	Sc	P	G
2A7	7	F	P	Sc	OA	OG	C	F	—	G
AKI	7	F	Cm	P	OA	OG	Sc	F	—	G
AK2	P	M	F	F	C	OA	OG	Sc	P	G
EKI	P	M	F	F	C	OA	OG	Sc	P	G
EK2	P	M	F	F	C	OA	OG	Sc	P	G
6A7	7	F	P	Sc	OA	OG	C	F	—	G
6A8	O	S	F	P	Sc	OG	OA	F	C	G
6D8G	O	S	F	P	Sc	OG	OA	F	C	G
6L7	O	S	F	P	Sc	OG	—	F	C	G
6F7	7	F	PP	PSc	TP	TG	C	F	—	PG
6D6	6	F	P	Sc	Su	C	F	—	—	G
CK1	P	M	F	F	C	OA	OG	Sc	P	G

Diode Detectors

Type	Base	1	2	3	4	5	6	7	8	Cap
KB2	V	D2	F	F	Cm	D1	—	—	—	—
AB2	V	D2	F	F	Cm	D1	—	—	—	—

DIODE DETECTORS (Continued.)

Type	Base	1	2	3	4	5	6	7	8	Cap
EB4	P	M	F	F	C1	D1	S	D2	C2	—
CBI	V	M	F	F	C	D1	—	—	—	D2
6H6	O	S	F	D2	C2	D1	—	F	C1	—

Diode - Triodes and Pentodes

Type	Base	1	2	3	4	5	6	7	8	Cap
1B5	6	F+	P	D+	D—	G	F—	—	—	—
1H6G	O	S	F+	P	D	D	G	F—	—	—
1F6	6	F+	P	Sc	D	D	F—	—	—	G
1F7G	O	S	F+	P	D	D	Sc	F—	—	G
1K6	6	F+	P	D+	D—	Sc	F—	—	—	G
KBC1	P	M	F—	F+	—	D+	D—	—	P	G
TDD2	6	F+	P	D—	D+	M	F—	—	—	G
TDD4	7	F	C	P	D	M	D	F	—	G
E454	7	F	C	P	D	M	D	F	—	G
E444N	6	F	Sc	D	G	C	F	—	—	P
ABC1	P	M	F	F	C	D	D	—	P	G
EBC3	P	M	F	F	C	D	D	—	P	G
EBF1	P	M	F	F	C	D	D	Sc	P	G
85	6	F	P	D	D	C	F	—	—	G
75	6	F	P	D	D	C	F	—	—	G
6B7(S)	7	F	P	Sc	D	D	C	F	—	G
6R7	O	S	F	P	D	D	—	F	C	G
6Q7	O	S	F	P	D	D	—	F	C	G
6B8(G)	O	S	F	P	D	D	Sc	F	C	G
CBC1	P	M	F	F	C	D	D	—	P	G

Amplifier Triodes

Type	Base	1	2	3	4	5	6	7	8	Cap
30	UX	F+	P	G	F—	—	—	—	—	—
1H4G	O	S	F	P	—	G	—	F	—	—
1K4	UX	F+	P	Sc	F—	—	—	—	—	G
1K6	6	F+	P	D+	D—	Sc	F—	—	—	G
PM1HL	UX	F	P	G	F	—	—	—	—	—
PM2DX	UX	F	P	G	F	—	—	—	—	—
B217	UX	F	P	G	F	—	—	—	—	—
KC3	P	—	F	F	—	—	G	—	P	—
HL2	UX	F	P	G	F	—	—	—	—	—
L21	UX	F	P	G	F	—	—	—	—	—
56	UY	F	P	G	C	F	—	—	—	—
53	7	F	P1	G1	C	G2	P2	F	—	—
E424	UY	F	P	G	C	F	—	—	—	—
AC2	P	M	F	F	C	—	—	—	P	G
164V	UY	F	P	G	C	F	—	—	—	—
354V	UY	F	P	G	C	F	—	—	—	—
MH4	UY	F	P	G	C	F	—	—	—	—
MHL4	UY	F	P	G	C	F	—	—	—	—
76	UY	F	P	G	C	F	—	—	—	—
6A6	7	F	P1	G1	C	G2	P2	F	—	—
6C6	6	F	P	Sc	Su	C	F	—	—	G
6C5	O	S	F	P	—	G	—	F	C	—
6L5G	O	S	F	P	—	G	—	F	C	—
6F5	O	S	F	—	P	—	—	F	C	G
6C8G	O	S	F	P1	C1	G2	P2	F	C2	G1
DH	UY	F	P	G	C	F	—	—	—	—
H30	UY	F	P	G	C	F	—	—	—	—
CC1	P	M	F	F	C	—	—	—	P	G

Output Triodes

Type	Base	1	2	3	4	5	6	7	8	Cap
31	UX	F+	P	G	F—	—	—	—	—	—
PM2A	UX	F+	P	G	F—	—	—	—	—	—
45	UX	F	P	G	F	—	—	—	—	—
46	UY	F	P	G1	G2	F	—	—	—	—
49	UY	F+	P	G1	G2	F—	—	—	—	—
2A3	UX	F	P	G	F	—	—	—	—	—
PX4	UX	F	P	G	F	—	—	—	—	—
PX25	UX	F	P	G	F	—	—	—	—	—
PX25A	UX	F	P	G	F	—	—	—	—	—
DA30	UX	F	P	G	F	—	—	—	—	—
AC/044	UX	F	P	G	F	—	—	—	—	—
DO/26	UX	F	P	G	F	—	—	—	—	—
E406N	P	—	F	F	—	—	G	—	—	—
42	6	F	P	Sc	G	C	F	—	—	—
6F6	O	S	F	P	Sc	G	—	F	C	—
6A3	UX	F	P	G	F	—	—	—	—	—
6B4G	O	—	F	P	—	G	—	F	—	—
6E6	7	F	P1	G1	C	G2	P2	F	—	—
6B5	6	F	P2	P1	G	C	F	—	—	—
6N6G	O	—	F	P2	P1	G	—	F	C	—

Output Pentodes

Type	Base	1	2	3	4	5	6	7	8	Cap
33	UY	F+	P	G	Sc	F—	—	—	—	—
1D4	UY	F+	P	G	Sc	F—	—	—	—	—
1F4	UY	F+	P	G	Sc	F—	—	—	—	—
1F5G	O	S	F+	P	Sc	G	—	F—	—	—
1E7G	O	S	F+	P1	G1	G2	P2	F—	Sc	—
PT2	UY	F+	P	G	Sc	F—	—	—	—	—
PM22A	UY	F+	P	G	Sc	F—	—	—	—	—
C243N	UY	F+	P	G	Sc	F—	—	—	—	—
KL4	P	—	F—	F+	—	—	G	Sc	P	—
2A5	6	F	P	Sc	G	C	F	—	—	—
E463	7	F	C	P	—	G	Sc	F	—	—
P.4VA	7	F	C	P	—	G	Sc	F	—	—
F443N	UY	F	P	G	Sc	F	—	—	—	—
AL2	P	—	F	F	C	—	—	Sc	P	G
AL3	P	—	F	F	C	—	G	Sc	P	—
MPT4	UY	F	P	G	Sc	F	—	—	—	—
PT16	UY	F	P	G	Sc	F	—	—	—	—
PT25H	UY	F	P	G	Sc	F	—	—	—	—
EL2	P	—	F	F	C	—	—	Sc	P	G
EL3	P	—	F	F	C	—	G	Sc	P	—
EL5	P	—	F	F	C	—	G	Sc	P	—
EBL1	P	—	F	F	C	D	D	Sc	P	G
41	6	F	P	Sc	G	C	F	—	—	—
42	6	F	P	Sc	G	C	F	—	—	—
6A4/LA	UY	F	P	G	Sc	F	—	—	—	—
6F6	O	S	F	P	Sc	G	—	F	C	—
6K6G	O	S	F	P	Sc	G	—	F	C	—
6V6G	O	S	F	P	Sc	G	—	F	C	—
6L6G	O	S	F	P	Sc	G	—	F	C	—
CL2	P	—	F	F	C	—	—	Sc	P	G
CL4	P	—	F	F	C	—	—	Sc	P	G
12A5	7	F	P	Sc	G	C	Fc	F	—	—
12A7	7	F	P	Sc	RC	RP	C	F	—	G
43	6	F	P	Sc	G	C	F	—	—	—
25A6	O	S	F	P	Sc	G	—	F	C	—

(Balance of Valve Socket Connections on Page 322.)

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

ACE AMPLIFIERS LTD., 10 Grosvenor Street, Neutral Bay, N.S.W. X3312. Telegrams or Cables: "Udisco." Chief Engineer, E. G. Beard. Manager, R. B. Durant. Manufacturers of Radio Telegraphy/Telephony Equipment, Sound Equipment. Distributors: A. R. Harris and Co. Ltd.; Christchurch, N.Z.

ACORN PRESSED METAL PTY. LTD., 66-72 Shepherd Street, Chippendale, N.S.W. MJ4681 (3 lines). Governing Director, E. A. Parmiter. Acting Secretary, F. G. Barnaby. Telegrams/Cables, "Acornmetal," Sydney. Manufacturing Engineers, Metal Stampers, Metal Spinners, Electroplaters, Electric Welders. Manufactures of Chassis in all metals (unassembled), square and round I.F. and Coil Cans, Dies, Tools, etc.

ADAMS, WM. & CO. LTD., 175 Clarence Street, Sydney, New South Wales. BW 4051 (10 lines); 521-3 Collins Street, Melbourne (Central 4561); 157 Waymouth Street, Adelaide, S.A. (Central 6197, 2 lines); 432-6 Murray Street, Perth, W.A. (B 9393, 5 lines); and Crn. Albert and Margaret Street, Brisbane, Q. (B 8097). Distributors for Philips Lamps (A/sia) Ltd.

AIRZONE (1931) LTD., 16-22 Australia Street, Camperdown, Sydney, N.S.W. L2851 (6 lines). Managing Director, Claude Plowman. Walter B. Homewood, Sales Manager; Phillip S. Parker, Works Manager; Geoffry J. Menon, Chief Engineer; W. Max Valentine, 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, B6206. (William O. Barber, Manager), Rundle Chambers, Rundle Street, Adelaide, Central 5223. (W. E. Gill, Manager), 886 Hay Street, Perth, B5726, B5808. (R. Plowman, Manager), N.Z., Wakefield Chambers, Wakefield Street, Wellington, No. 53-980. P.O. Box 1000. (Peter Scott Ramsay, Managing Director).

AMALGAMATED WIRELESS A/SIA LTD., 47 York Street, Sydney, N.S.W. BW 2211. G.P.O. Box 2516BB Sydney. 167-9 Queen Street, Melbourne, Vic. (F 4161). 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. Interstate and Overseas Distributors: J. B. Chandler and Co., Brisbane, Q.; Newton McLaren Ltd., Leigh Street, Adelaide, S.A.; Wyper Howard Ltd., 671 Hay Street, Perth, W.A.; Nicholson's Ltd., Barrack Street, Perth, W.A.; Findlay's Pty. Ltd., 67 Brisbane Street, Launceston and Elizabeth Street, Hobart, Tas.; Noyes Bros. (Melb.) Ltd., 36 Argyle Street, Hobart, Tas.; The National Electrical and Engineering Co. Ltd., Wellington, N.Z.; British New Guinea Trading Co., Port Moresby, Papua; Burns Philip and Co. Ltd., Rabaul, New Guinea; Fiji Broadcasting Co. Ltd., Victoria Parade, Suva, Fiji; Burns Philp and Co. Ltd., at Faisi, Gizo, Makambo, and Tulagi in Solomon Islands.

AMALGAMATED WIRELESS VALVE CO., 47 York Street, Sydney, N.S.W. BW 5059. P.O. Box 2516 B.B., G.P.O., Sydney. Telegrams/Cables, Valves, Sydney. Director and General Manager, L. A. Hooke; Secretary, J. F. Wilson; Sales Manager, A. P. Hosking. Manufacturers and Wholesalers Wireless Valves. Representatives for RCA Radiotron Valves.

AMPLION (AUSTRALASIA) LTD., 66 Clarence Street, Sydney, B6694 (3 lines). Telegrams/Cables, "Amplion," Sydney. Managing Director, P. J. Manley; Sales Manager, E. S. Cox. Manufacturers of Amplion Dynamic Speakers, Lion Microphone Combinations, Amplion Tubular Condensers, Amplion Microphones. Wholesalers of Amplion Condensers, Amplion Dynamic Speakers, Amplion Microphones, Carbon (Air) Cells, Emicol Radio Meters, Hammond Electric Frequency Clocks, Lionel Model Electric Trains and Model Electric Aeroplanes, Westinghouse Copper Oxide Rectifiers, Lion Microphone Combinations, Webster Crystal Pick-ups, Block Plate-less Accumulators, Metrec Copper Oxide Battery Chargers, McK. and-H. Chargers, Electro-Voice Microphones. Representatives of Hammond Electric Clocks, Lionel Electric Trains, Webster Crystal Pick-ups, Electro-voice Microphones. Interstate Distributors: Edgar V. Hudson Pty. Ltd., Brisbane, Queensland; Australasian Engineering Equipment Co. Ltd., Melbourne, Vic.; Newton McLaren Ltd., Leigh Street, Adelaide, S.A.; Carlyle and Co., 915 Hay Street, Perth, W.A.; W. and G. Genders Pty. Ltd., Launceston and Hobart.

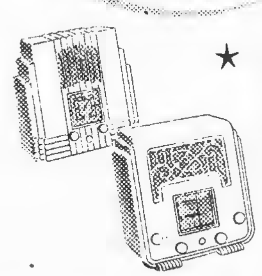
ANDERSON, H. C. & FRANTZEN, Johnson Street, Alexandria. Mascot 284. Manufacturers of Wireless Cabinets.

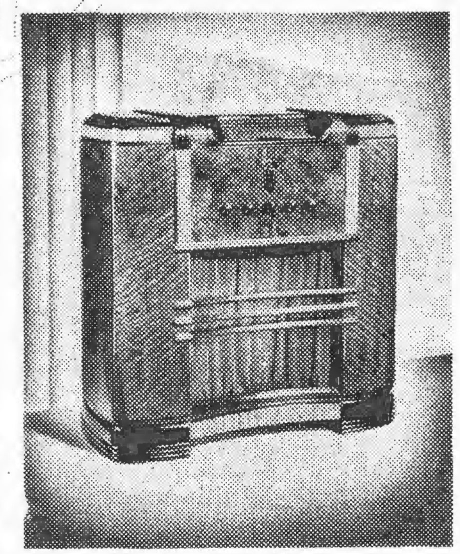
APEX METAL PRODUCTS PTY. LTD., 3 Edward Street, Toorak, Vic. Wind. 3478. Pressed Metal Workers, specialising in Wireless Chassis.

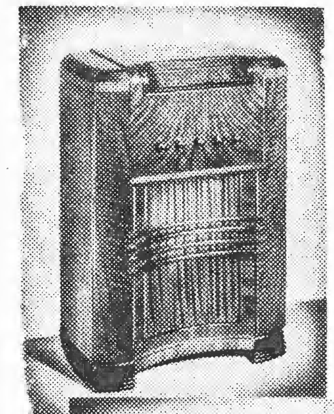
ARNOLD & BEARD LTD., 632 Botany Road, Alexandria, N.S.W. Mascot (M7) 1094/5/6/7. P.O. Box, 23 Mascot P.O. Managing Director, J. Arnold; Director and Secretary, E. H. Beard; Factory Manager, A. R. Garvan; Assistant Factory Manager, S. Smithson. General Engineering, Spinning and Stamping in all Metals, etc. Specialists in modern light fittings to order.

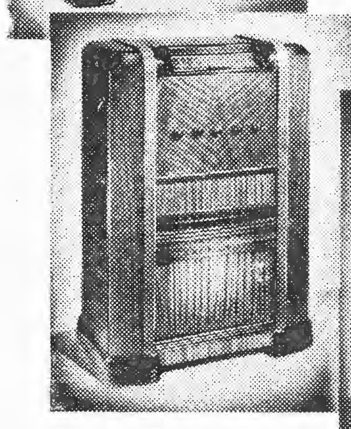
ATKINS (W.A.) LTD., 894 Hay Street, Perth, W.A. B3151, B1901; G.P.O., D147. Telegrams: "Calcolim," Perth. Managing Director, M. M. Nathan. Sales Manager, J. J. Nathan. Branches, Fremantle and Kalgoorlie. Wholesalers and Distributors. N.S.W. Rep.: Atkins McLean Ltd., 301 Castlereagh Street, Sydney.

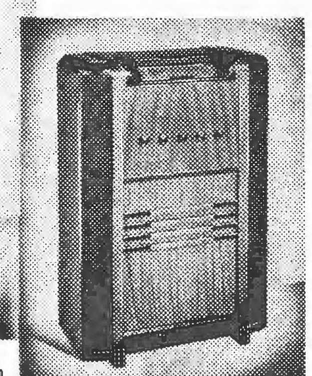
AUSTRALASIAN ENGINEERING EQUIPMENT CO. PTY. LTD., 415-419 Bourke Street, Melbourne, Vic. MU2315. Telegrams: "Eniquip," Melbourne. Managing Director, D. Doughton. Director, W. M. Hipgrave. Australasian Distributors for T.C.C. Condensers, Durham I.R.C. Resistors, Harley Microphones and Pick-ups. Interstate Reps.: N.S.W., W. J. McLellan; Qld., Trackson Bros.; West Australia, Carlyle & Co.; South Australia, South Australian Radio Co.











MANUFACTURERS AND WHOLESALERS DIRECTORY (Continued)

AUSTRALIAN GENERAL ELECTRIC LTD., 95 Clarence Street, Sydney, N.S.W. BW2261. Box No. 2517BB, G.P.O. Telegrams/Cables, "Ingenetric." Chairman and Managing Director, F. B. Clapp; Deputy Chairman, A. Maling; Director and Australian Sales Manager, S. B. Cox.; Director and Manager for New South Wales, L. F. Burgess; Secretary, W. A. Dean. Manufacturers and Wholesalers. Manufacturers of Radio Receivers, Transformers, etc. Wholesalers of all electrical products. Representatives for "B.T.H.," "Hotpoint," "B-I" Cables and Winding Wires: "M.I.C." Insulating Material. Pick-ups. Phonograph Motors, Tungar Bulbs, "Hotpoint" Appliances. "General Electric" (U.S.A.) Tungars. Clocks. "Telechron" Clocks. Branches: Australian General Electric Ltd., Queen and Little Collins Street, G.P.O. Box 538-F, Melbourne (H. C. Van Valzah, Manager for Victoria); Kelvin House, 252 Adelaide Street, G.P.O. Box 1445-T, Brisbane (L. G. Hinwood, Manager for Queensland); 73 Pirie Street, G.P.O. Box 1324-F, Adelaide (C. F. Sharpe, Manager for South Australia); 33 Elizabeth Street, Box 1-D, Hobart (J. A. Smith, Manager); 9-11 Darby Street, Box 447-E Newcastle, N.S.W.; Keen Street, Box 282 Lismore, N.S.W.; 57 William Street, Box 358 Rockhampton, Q.; Flinders Street East, Box 29-Section 2, Townsville, Q.; 15 The Quadrant, Box 227 P.O. Launceston, Tas.; Factories, Percy Street, Auburn, N.S.W.; 198 Burnley Street, Richmond, Vic. Agent in West Australia, Atkins (W.A.) Ltd., 894 Hay Street, Box D-147 Perth, W.A.

AUSTRALIAN RADIO COLLEGE PTY. LTD., corner Broadway and City Road, Sydney, N.S.W. MA2419. Managing Director, L. B. Graham.. Superintendent, F. W. Freeman. Chief Instructor, R. Lackey, A.M. Inst., R.E. Aust. Resident and Correspondence tuition in radio, television and refrigeration.

AUSTRALIAN SCHOOL OF RADIO ENGINEERING, 1st Floor, Wembley House, Railway Square, Sydney. MA4642. Principal, R. T. Andrew. Business Manager, E. Minnis. Chief Examiner, V. G. Beard, M. Inst. R.E. Correspondence tuition in all branches of radio engineering. Interstate Reps.: Brisbane, E. G. Roper, c/- Yal, Union Bank Chambers, Queen and Creek Streets, Brisbane; 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.

AUSTRALIAN VALVE MERCHANTS ASSOCIATION, 1 Jamieson Street, Sydney. B.1046. Chairman, A. P. Hosking. Secretary, S. G. Dwyer. Advisory Committees in all States.

A.Z. RADIO PTY. LTD., 52 Buckhurst Street, South Melbourne, SC5: M3169. 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, B9346. Branch, 119 High Street, Fremantle (FM2630).

B

B.R. (RADIO) LTD., 59-65 Elizabeth Street, Melbourne, C.1. Central 4480 (3 lines). Central 4485 (2 lines). Manager, C. A. Morris; Sales Manager, J. I. Carew; J. S. Jenkins, Accountant. Wholesalers, Radio, Electrical Appliances and Accessories.

BATEMAN, L. L., Pastoral House, St. George's Terrace, Perth, W.A. B 7941. Distributor for Lekmek Receivers.

BATEMAN, M. J. LTD., 12 Milligan Street, Perth, W.A. B 9346 (2 lines). Distributors for Standard Telephones and Cables (A/sia) Ltd.

BATY, C. S. & CO., 782 Hay Street, Perth, W.A. B5219. P.O. Box F345. Telegrams/Cables, Batycoy. Manufacturers of Radio Receivers.

BEALE & COMPANY LTD., 41-47 Trafalgar Street, Annandale, N.S.W. Showrooms, 177 Pitt Street, Sydney. Tel. L2791 (6 lines), B7545.. 1621 BB, G.P.O., Sydney. Telegrams/Cables, Beale, Sydney. Directors: Sir Kelso King, K.B. (Chairman); Sir George Mason Allard, Kt.; Ronald M. Beale (Managing); Rupert O. Beale and H. Russell Crane; Secretary ,H. Adair; Sales Manager, J. M. Davis. Manufacturers Pianos, Radio and Sewing Machine Cabinets, etc. Wholesalers Pianos, Radios, Radio and Sewing Machine Cabinets, etc. Interstate Representatives: G. J. Grice Ltd., 90-92 Queen Street, Brisbane, Q.; Romcke Pty. Ltd., McCracken Building, Church Lane, Melbourne, Vic.; Savery's Pianos Ltd., 29 Rundle Street, Adelaide, S.A.; Thomsons Ltd., Hay Street, Perth, W.A.

BEAUCHAMP, F. S. Pty. Ltd., 37 Elizabeth Street, Hobart, Tas. 'Phone 6109. Distributors for Philips Radioplayers.

BEGG, WILLIAM & SONS, 343 Little Collins Street, Melbourne, C.1. MU2656. Telegrams/Cables, Begansons. Factory representatives for "Minstrel"—Radio Goods. Branch: William Begg and Sons, 15 Austin Street, Adelaide, S.A.

BELL, NORMAN & CO. PTY. LTD., 403 Adelaide Street, Brisbane, Q. B3561 (4 lines). 28OD G.P.O., Brisbane. Telegrams/Cables, Norman Bell, Brisbane. Wholesalers of all electrical goods. Representatives for General Electric Co. Ltd.

BENJAMIN, R. D., 231b Murray Street, Perth, W.A. B7088. Distributor for Meltran Engineering Pty. Ltd.

BENNETT & WOOD PTY. LTD., 284 Pitt Street, Sydney. M-4405 (100 extensions). Box 55 CC, G.P.O., Sydney. Telegrams/Cables, "Speedwell," Sydney. "Bentwood" Sydney. Governing Director, Charles W. Bennett; Managing Director, Kenneth A. Bennett. Wholesaler Radio Sets, etc. Branches at Goulburn, Inverell, Lismore, Newcastle, Parramatta, Wagga, Wollongong.

BESTON, D., Kent Street, Sydney, N.S.W. M 3526. Distributor for J. J. Hoelle and Co.

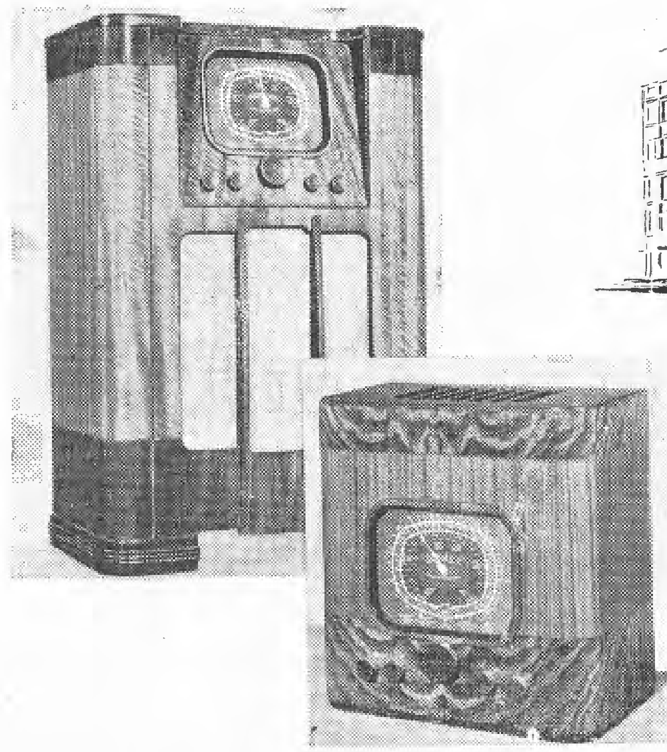
BIRKS, CHAS. & CO. LTD., 44 Rundle Street, Adelaide, S.A. (Cent.: 7130). Distributors for Tasma Receivers.

BLACKMAN & LAW LTD., 843 Hay Street, Perth, W.A. B 8694-5. Distributors of Electrice Refrigerators.

BLAND RADIO, Coromandel Place, Adelaide, S.A. C5581. Telegrams/Cables, Blandradio. Proprietor, W. J. Bland; Sales Manager, J. E. Vard; Accountant, L. H. Lindsay. Manufacturers and Wholesalers Radio Parts and Sets (Operatic Radio Sets), and Radio Gramophones. Interstate Rep.: Charles Harper and Co., Perth, W.A.

BLOCH & GERBER PTY. LTD. (with which is associated The Weldon Electric Supply Co.), 46-48 York Street, Sydney, N.S.W. MA6291 (9 lines). P.O. Box, 2282M, G.P.O. Code address, Lesab. Chairman of Directors, Eugene Gerber; Managing Director, Otto Raz; Mail Order Manager, P. E. Gerber; Assistant Manager (Refrigerators, Washing Machines, Bicycles), C. E. Eckert; Radio Distribution Manager, A. Chapman. Manufacturers of Weldon Radio, Welkold Refrigerators, Metropolitan Distributors for Radiola and Airzone Receivers. Wholesale Merchants in all radio components and electrical fittings and appliances.

BORTHWICK EVERITT & CO., 33 Mountain Street, Broadway, Sydney. MA1235. Joint Managers, A. R. Everitt and K. B. Borthwick. Manufacturers of Radio Chassis and Parts.



Magnet House
104 Clarence St., Sydney.,
Head Office.

BGE

The Name Behind the Product . . .

SINCE the commencement of Broadcasting in Australia the name British General Electric Co. Ltd., has been linked with the marketing of Radio Receivers of consistent high quality, performance and workmanship.

To-day, B.G.E. "GENALEX" Receivers maintain this reputation, and occupy a position of distinction in the Radio trade throughout Australia.

All "GENALEX" Dealers are backed by the reputation of the B.G.E., which is their guarantee and assurance of a product of the highest grade of design and manufacture.

British General Electric Co. Ltd. are sole Australian representatives of The General Electric Co. Ltd., of England, the largest British controlled Electrical organisation in the World.

The British General

GENALEX

(REG. TRADE MARK)

Marketed in Australia by:

BRITISH GENERAL ELECTRIC CO. LTD.

SYDNEY NEWCASTLE MELBOURNE PERTH HOBART LAUNCESTON

SOLE AGENTS AT BRISBANE AND ADELAIDE.

MANUFACTURERS AND WHOLESALERS DIRECTORY (Continued)

BOSS MANUFACTURING CO., 11 Yabsley Avenue, Ashfield, Sydney. UA1895. Manager, E. W. O'Sullivan. Manufacturers and Wholesalers of Battery Chargers, Testers, Soldering Irons, Transformers. Interstate representatives: Johnson Gaston, 359 Queen Street, Brisbane; Worando Buildings, Grenfell Street, Adelaide; Bank Chambers, Elizabeth Street, Melbourne.

BRAME, V. MACDONALD. Box 545F, G.P.O., Hobart, Tas. Distributor for Commonwealth Moulding Pty. Ltd.

BRASH, M. & CO. PTY. LTD., 108-110 Elizabeth St., Melbourne. Vic. CI3729. Cables, "Brashpiano," Melbourne. Managing Director, A. G. Brash. Sales Manager, J. E. Rowson. Radio Department Manager, C. R. Graham. Radio Foreman, J. Jackson. Distributors for Stromberg-Carlson and Radiola. Australian distributors for Linconola and Studeberg.

BREVILLE RADIO PTY. LTD. 486 Elizabeth Street, Sydney, N.S.W. M6391/2. Telegrams/Cables, "Breville." Managing Director, W J O'Brien. Manufacturers and Wholesalers of Radio Parts and Receivers. Wholesalers, Radio Receivers and Accessories. Lehmann Washing Machines. Representatives for Beach Refrigerators. Branch Offices, Breville Radio Pty. Ltd. (Vic.), 191 Queen Street, Melbourne, Vic. (E. Beal, Manager); Breville Radio Pty. Ltd., King House, Queen Street, Brisbane, Q. (O. Thomas, Manager). Interstate Reps.: Wyper Bros. Ltd., Bundaberg, Q.; Williams' Pty. Ltd., Rockhampton, Q.; Stott and Hoare (S.A.) Ltd., 21 Grenfell Street, Adelaide, S.A.; Stott and Hoare Typewriters Ltd., 55 William Street, Perth, W.A.; Stanley B. Davys and Co., G.P.O. Box 801, Wellington, N.Z.; Wills and Co. Pty. Ltd., 7 Quadrant, Launceston, Tas; Findlay and Wills (D'port), Devonport, Tas; F. S. Beauchamp Pty. Ltd., 37 Elizabeth Street, Hobart, Tas.; O. Smedley, 22 Roe Street, Mayfield, N.S.W.

BRITISH GENERAL ELECTRIC CO. LTD., Magnet House, 104-114 Clarence Street, Sydney, N.S.W. B3011 (after 5.30 B4075—B4339—B5073) G.P.O. 1594BB. Managing Director, E. E. Hirst, Melbourne Manager, T. E. Morgan, 388 Bourke Street, Melbourne (CI.9940). Perth Manager, T. W. John, 370 Murray Street (B5141); Newcastle Manager, K. W. Bullough, 141 Scott Street (1259); Hobart Manager, K. B. Hayes, 55, Elizabeth Street ('phone 3789); 167 Charles Street, Launceston (K. B. Hayes, Manager). Agents, Brisbane, Norman Bell & Co. (Pty.) Ltd., 403 Adelaide Street (B3561); Adelaide: A. G. Healing Ltd., 171 Pirie Street.

BRITON ELECTRICAL & RADIO PTY. LTD., 152 Parramatta Rd., Petersham, N.S.W. L3621 (3 lines). Telegrams/Cables, Berco, Sydney. General Manager, G. Hunt; Chief Engineer, J. Briton. Manufacturers and Wholesalers, Radio Receivers.

BROOKS ROBINSON PTY. LTD., 59-65 Elizabeth Street, Melbourne, Vic. Central 8800. Distributors for Philips Lamps (A/sia) Ltd.

BRYCE, R. J. S., London Stores Buildings, Elizabeth Street, Melbourne, Vic. Representative for Tasma Radio.

BUCKLAND, WM. L. PTY. LTD., 139 Franklin Street, Melbourne. F6644. Telegrams/Cables. "Willbuck," Melbourne. Managing Director, Wm. L. Buckland. Tasmanian Distributors for Emmco. Wholesale Distributors for Diamond and Ever Ready Batteries, U.S.L. Car and Radio Batteries, Philips and Radiotron Valves. Distributors for Airmaster Radio Receivers—Essanay, Astor and Celebrity Mastermade Radio Receivers. Branches: Charles and Cameron Streets, Launceston, Tas.; 59 Liverpool Street, Hobart, Tas.

BURROWS AND MEEK PTY. LTD., 93 Elizabeth Street, Hobart, Tas. 3250. P.O. Box 161C. Directors: A. P. Burrows and A. O. Burrows. Manager, Radio Department, R.E.M. Newton. Chief Engineer, R. H. Drake. Wholesaler and Retailer. Radiola, Astor, and Howard Radio Receivers.

C

CARLYLE & CO., 915-7 Hay Street, Perth, W.A. B9371 (3 lines). J716, G.P.O. Telegrams/Cables, "Lylecar," Perth. Wholesalers of Radio Goods. Representatives for Ken-Rad Valves. Solar Condensers, Mullard Valves, Allen Bradley Products, Lionel Trains, Liverpool Cables, Astor Radio Sets.

CARR, JOHN & CO. PTY. LTD., 661 George Street, Sydney, N.S.W. MA 5698 and 4252. Sydney representative of General Mica Supplies (Aust.) Pty. Ltd., Melbourne.

CHANDLER, J. B. LTD., Australia House, Carrington Street, Sydney, N.S.W. B6401/2. P.O. Box. 3699SS. Telegrams/Cables, Chandlerco. Managing Director, J. B. Chandler. Wholesalers of Electrical Appliances and Radio Equipment. Representatives for Sunbeam Electrical Appliances, Wincharger. Branch: Brisbane. Interstate Representatives: Gloria Light Co. Pty. Ltd., Melbourne, Vic.

CHANDLER, J. B. & CO., 43 Adelaide Street, Brisbane, Q. B2041. P.O. Box. 833L, Brisbane. Telegrams/Cables, "Chandleyco." Managing Director, J. B. Chandler; General Manager, W. G. Duncan; V. F. Mitchell, Sales Manager. Branch: J. B. Chandler Ltd., Australia House, Carrington Street, Sydney, N.S.W. Wholesalers of all Electrical and Radio goods.

CLUBB, A. M. & Co., 76 Clarence St., Sydney, N.S.W. B3908. Managing Director, Alexander Murrison Clubb. Manager Radio Electric Dept., A. M. Clubb. Manager Merchandise Department, 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. UW8881-5. Sales Department, 61-65 Wentworth Avenue, Sydney. (M6738). Cables "Phoenix," Sydney. Telegrams; "Clydebatry" Sydney. Directors: G. Weymouth, A. B. F. Rofe, C. G. Hudson, Wm. Sinclair. General Manager, H. P. Weymouth. Sales Manager, A. G. Evennett. Battery Manager, F. Cavin Young. Branches: Queensland—115 C.E.H. Buildings, Albert and Charlotte Streets, Brisbane (Manager, C. A. Hammand); Victoria, 194-6 Latrobe Street, Melbourne (Manager, C. M. Nightingall); S.A., 155-7, Grenfell Street, Adelaide (Acting Manager, L. A. Brokensha). Manufacturers of Clyde Batteries, Electric Power Plants, and General Engineering, etc.

COLTON, PALMER & PRESTON, LTD., Currie Street, Adelaide, S.A. CI3580 (10 lines). Joint Managing Directors, E. F. Hamilton and Roy H. Palmer. Distributors of Masterpiece Radio and Astor Radio.

COLVILLE WIRELESS EQUIPMENT CO. PTY. LTD., 8 Smail Street, Broadway, Sydney, N.S.W. MA3172. Governing Director, S. V. Colville. Designers and Manufacturers of Broadcast Transmission Equipment (under license from Philips Radio) Communication Transmitters and Receivers, Ultra High Frequency Apparatus, Aircraft and Portable Transmitters and Receivers, Custombuilt Broadcast Receivers and Amplifiers, Colvilleco Transmitting Condensers, H. F. Inductors, Power and Audio Transformers, Studio and Control Apparatus. Australian agents for National Coy. Inc., Malden, Mass., U.S.A., and E. F. Johnson Coy., Waseco, Minn., U.S.A.

COMMONWEALTH MOULDING PTY. LTD., 242 Prince's Highway, Arncliffe, N.S.W. LX1237-8-9 (3 lines). Telegrams/Cables, "Commould." Managing Director, A. W. Baker; Sales Manager, J. P. Taylor. Manufacturers of Plastic Mouldings. Interstate Agents and Representatives: S.A., A. M. Ralph, 68 Flinders Street, Adelaide; Vic., G. P. Embelton & Co. Ltd., 208 Lonsdale Place, Melbourne; Queensland, P. H. Phillips, Box 597J, G.P.O., Brisbane; Tas., V. Macdonald Brame, Box 545F, G.P.O., Hobart; New Zealand, H. C. Urlwin Ltd., Manchester and Gloucester Streets, Christchurch.

MANUFACTURERS AND WHOLESALERS DIRECTORY (Continued)

CONDENSER SPECIALTY CO. LTD., 112 Rothchild Avenue, Rosebery, N.S.W. Mascot (M-7) 700. Telegrams/Cables, "Conspeco," Sydney. Managing Director, Keith D. Davison. Manufacturers of "C.S.C." Condensers. Interstate Representatives: Radio Wholesalers Ltd., Adelaide; William Begg & Sons, Melbourne; C. F. Willers, Brisbane, Q.; H. P. Davey, Launceston, Tas.

CONLON, S.M. RADIO CO., 26 Kippax Street, Sydney. FL1935. Manager, S. M. Conlon, B.Sc.; Works Manager, W. P. Lynch. Manufacturers of Radio Receivers.

CONTINENTAL CARBON CO. PTY. LTD., Corner Abbotsford and Miller Streets, Melbourne. F3647. Telegrams/Cables, "Resis" Melbourne. Trade name "Aerovox." Managing Director: F. W. Clark. Interstate Reps.: Simplex Products Pty. Ltd. 716 Parramatta Road, Petersham. S.A. National Radio Ltd., Pirie Street; A. G. Healing, Pirie Street, Adelaide. Queensland, A. E. Harrold, Charlotte Street, Brisbane. Manufacturers and distributors of Electrolytic Condensers, Carbon Resistors, Auto Radio Suppressors and Resistors.

CRAMMOND RADIO MFG. COY., 8 Queen Street, North Quay, Brisbane. Proprietors: A. Crammond Snr.; Mrs. Crammond, and A. Crammond Jnr. Manufacturers of Crammond Receivers and a full range of Receivers covering some 22 models. No dealers or representatives. Telephone B6431.

CROWN RADIO MANUFACTURING CO. PTY. LTD., 51 Murray Street, Pyrmont, N.S.W. Telegrams/Cables, "Crownradio." Managing Director, J. B. Phillips. Manufacturers and Wholesalers of Radio Components, Kit Sets, Coil Kits. Interstate representatives: A. E. Harrold, Charlotte Street, Brisbane, Q.; G. P. Embelton and Co., 208 Lonsdale Place, Melbourne, Vic.

D

DALTON, H. & CO., 85 Eveleigh Street, Redfern, N.S.W. MA5580. 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.

DAVEY, H. P., Launceston, Tas. Distributor for "C.S.C." Condensers.

DAVIS, A. G. & CO., Wembley House, Railway Square, Sydney, N.S.W. MA2866. Proprietor A. G. Davis (Also Proprietor, Wembley Radio). General Wholesaler.

DICKIN, F. Ltd., 18-34 Lords Road, Leichhardt, N.S.W. P.O. Box 18 Leichhardt. Products: "Dickin" Cabinets. Managing Director, A. J. Dickin. Sales Manager, T. H. Dickin. LM4431-2.

DOBBIE, A.W. & COMPANY, 53-55, Gawler Place, Adelaide, S.A. Central 6170. Managing Director, H. R. Pinkerton. Manager, J. T. Altass. Distributors of Radiophone Radio Receivers, Stanmor Dry Batteries. Wholesale and Retail Distributors Radio and Electrical goods.

DON ELECTRICAL CO. PTY. 17, Gibbon Street, Camperdown, N.S.W. L2839. Proprietor, F. G. S. O'Donnell. Manager, E. O. Howe. Sales Manager, T. S. Godden. Manufacturers of Transformers, Rectifiers, Battery Chargers. Interstate Reps.: Vic., Salmon Bros. Pty. Ltd.; Queensland, Electric Agencies, Brisbane; W. A. Atkins, (W.A.), Ltd., Perth; N.Z., John Chambers & Son Ltd.

DONNELLY, C. R., 144 Zadoc Street, Lismore, N.S.W. Representative for Tasma Radio.

DUCON CONDENSER PTY. LTD., 73-83 Bourke Street, Waterloo, Sydney, N.S.W. MA6104 (3 lines). Box 32 P.O. Waterloo. Telegrams "Hecht," Sydney. Cables "Esoxur," Sydney. Managing Director, A. R. Persson. Sales Manager, C. S. Gittoes. Manufacturers, Paper and Mica Dielectric Electric Condensers. Semi-dry and Liquid Electrolytic Condensers. Wirewound and Metallized Resistors. Representatives for Sirufer Iron Dust Cores, "Calit" High Frequency Ceramic. Interstate Reps.: H. Hecht & Co., 450 Collins Street, Melbourne, Vic. (517 Central, 3 lines. Cables, "Esoxur." Telegrams: "Hecht"); P. H. Phillip, 123-5 Charlotte Street, Brisbane, Q. ('Phone B5774. Telegrams: "Philectric"); Arnold & Wright, "Levy Buildings," Manners Street, Wellington, C.3. N.Z. ('Phone 51-323, Cables, "Arnrite"); Carlyle & Co., 917 Hay Street, Perth, W.A. ('Phone B9371-2-3. Cables/Telegrams, "Lylecar"); W. T. Matthew, 95 Grenfell Street, Adelaide, S.A. (Central 2260, 2 lines, Cables/Telegrams "Adorwhoop").

DUKE, ALAN, PTY. LTD., 486 Bourke Street, Melbourne, Vic. CI.1255. Representatives of: D. Falshaw & Sons, Gerard Electric Manufacturers Ltd., Australian Westinghouse Electric Co., Mackenzie and Holland (Aust.) Pty. Ltd., Jensen (Aust.) Raytheon Valves.

DUNCAN & CO. LTD., 107-109 Pirie Street, Adelaide, S.A. C3344 (5 lines). Managing Director, H. F. Peake. Branch Office: 110 Commercial Street, Mount Gambier. (Mount Gambier 587). Manager, C. E. Hill. Manufacturers and distributors of Vasco Radio Receivers.

MANUFACTURERS AND WHOLESALERS DIRECTORY (Continued)

E

EASTERN TRADING CO. LTD., 470/480 Elizabeth Street, Sydney, N.S.W. MX1121. 42 P.O. Haymarket. Telegrams/Cables, Quietando. Managing Director, A. C. Millingen; Director, C. B. Meyer; Secretary, R. V. Bridekirk; Manager Radio Dept., H. I. Hobden; Factory Manager, C. W. Vaughan. Manufacturers, Radio Components. Wholesalers, Broadcast Receiving Valves and Radio Components. Branch: Peacock House, 486 Bourke Street, Melbourne, Vic. M5693. Box 1771 G.P.O., Melbourne. Interstate Reps.: Edgar V. Hudson Pty. Ltd., Charlotte Street, Brisbane, Q.; Newton McLaren Ltd., Leigh Street, Adelaide, S.A.; Carlyle and Co., Hay Street, Perth, W.A.; W. and G. Genders Pty. Ltd., Cameron Street, Launceston and Liverpool Street, Hobart, Tas.

ECLIPSE RADIO PTY. LTD., 216-22 City Road, South Melbourne. M4681 (9 lines). P.O. Box 2322 G.P.O., Melbourne. Telegrams/Cables. Eclipse. Melbourne. Directors. C. O. Welsh, Albert Aarons, Saul Aarons. Manufacturers and Wholesalers, Radio Receivers (53 models), Radio Accessories. Representatives: Empire Pickups and Motors, Plessey Switches, Condensers. Branches: 137 Clarence Street, Sydney; 43 Austin Street, Adelaide; 156 Creek Street, Brisbane.

EFCO MANUFACTURING CO. LTD., 108 Princes Highway, Arncliffe, N.S.W. LX1231 (4 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. PTY. LTD., 100 Clarence Street, Sydney, N.S.W. B5090. Box 2541E, G.P.O. Telegrams/Cables, RACCENNATO, Sydney. Representatives for Tungsram Valves, Dubilier Condensers, British N.S.F. Resistors and Volume Controls.

ELECTRICAL AGENCIES, 193 Elizabeth Street, Brisbane. Q. B 4287. Distributors for J. J. Hoelle and Co., and W. A. Syme and Co.

ELECTRICAL SERVICE CO., 6 Pacific St., Newcastle, N.S.W. 'Phone Newcastle 299. Wholesalers of Radio Receivers and Component Parts, etc.

ELECTRICAL SPECIALTY MANUFACTURING CO. Ltd., 17-19 Glebe Street, Glebe, N.S.W. MW2608-09-00. Telegrams, Essemco. General Manager, J. T Dunn. Manufacturers and Wholesalers of Radio Receivers ("Aristocrat" Radio Receivers"). Interstate Reps.: Trackson Bros. Pty. Ltd., Brisbane, McCann Bros., Hobart.

ELECTRIC SHOP LIMITED, 43 Russell Str., Toowoomba, Q'ld. Telephone: 844, 842. P.O. Box 224. Telegrams/Cables, ELECTRICSHOP. Directors, A. E. Squelch, J. F. Fulcher, G. F. Alke, J. Hill, H. T. Anderson. Wholesalers of Stromberg-Carlson Receivers.

ELECTRICITY METER MANUFACTURING CO. PTY. LTD., Joynton Avenue, Waterloo, N.S.W. MA6043 P.O. Box 4, Waterloo. Telegrams/Cable, 'Electromet," Sydney. Commercial Manager, D. E. Williams; Works Manager, F. Layer; Radio Engineer, H. K. James. Manufacturers Radio Sets and Rerigerators (Emmco Radio and ElectrICE Refrigerators). Interstate Reps.: (Radio) Radio Industries Ltd., Joynton Avenue, Waterloo, N.S.W.; William Begg and Sons, 343 Little Collins Street, Melbourne. Vic.; J. G. Pritchard Ltd., 18 William Street, Perth, W.A.; Wm. L. Buckland Pty. Ltd., 57 Liverpool Street, Hobart, and Charles and Cameron Streets, Launceston, Tas. (Refrigerators) New System Telephones Pty. Ltd., 276 Castlereagh Street, Sydney, N.S.W.; New System Telephones Pty. Ltd., 276 Flinders Street, Melbourne, Vic.; Howards Ltd., 317/327 Adelaide Street, Brisbane, Q.; Myer Emporium (S.A.) Ltd., Grenfell Street, Adelaide, S.A.; Blackman and Law, Perth, W.A.

ELPHINSTONES PTY. LTD., 342-350 Adelaide Street, Brisbane, Q. B 2141 (5 lines). P.O. Box 512H. Telegrams/Cables, "Elphinstones." Managing Director, A. C. Elphinstone; General Manager and Director, H. L. Elphinstone. Secretary, H. C. R. Murray, F.I.C.A. Wholesalers of Lighting Plants, Motor Accessories, etc. Representatives for Jos. Lucas Ltd. products, Stromberg, Marvel, Schebler, Johnson and Solex Carburettors, etc.

EMBELTON, G. P. & CO., 208 Londsdale Place, Melbourne, C.1 Central 9132. Telegrams and Cables, "Notlebme." Proprietor, G. P. Embelton; Sales Manager, J. H. Magrath; Accountant and Secretary, R. J. Gibson. Manufacturers of Coil Kits, etc. Wholesaler of Radio Components. Sole agents in Victoria for Crown Radio Products and Marquis Moulded Products. Representatives of Electro-Dynamic Construction Co. Interstate representatives: H. P. Standen, Hindmarsh Buildings, Hindmarsh Square, Adelaide, and Bostock, Brisbane, Queensland.

MANUFACTURERS AND WHOLESALERS DIRECTORY (Continued)

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.

THE EVER-READY COMPANY (AUSTRALIA) LTD., Harcourt Parade, Rosebery, N.S.W. Mascot 1180 (5 lines). P.O. Box Mascot 37. Telegrams/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, C14417, Manager, John Leeman. Brisbane, Perry House, Elizabeth Street, B9811, Manager, Chas. H. Hart. Manufacturers of Dry Batteries. Representatives for "Eveready" Air Cells, Ever Ready Torch Cases and Electrical Specialties.

EXIDE BATTERIES OF AUSTRALIA PTY. LTD., Grace Building, 77 York Street, Sydney, N.S.W. MA6751-2-3, 3344P.P., G.P.O., Sydney. Telegrams/Cables, Chloridic. Wholesalers of Batteries.

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 St., Windsor, Vic. Windsor 7084-5. Telegrams and cables, "Eyelets" Melbourne. Interstate Reps.: C. H. R. Johnston, corner Cleveland and Buckingham Streets, Sydney; P. G. Lavers, 125 Adelaide Street, Brisbane, Q.; F. L. Runge, Edments' Buildings, Rundle Street, Adelaide, S.A.; C. R. Palmer, 75 King Street, Perth, W.A. Makers of Metal Parts.

F

FALLSHAW, D. & SONS, 1 Boundary Road, North Melbourne, Vic. F4636. Director, F. Fallshaw. Manufacturers of Radio Cabinets.

FERROCART (A/SIA) LTD., corner Abbotsford and Miller Streets, Melbourne. F3647. Telegrams and Cables "Ferrocart." Sydney Rep., Simplex Products Pty. Ltd., 716 Parramatta Road, Petersham. S.A. Rep., National Radio Ltd., Pirie Street, Adelaide, A. G. Healing, Pirie Street, Adelaide; Queensland Rep.; A. E. Harrold, Charlotte Street, Brisbane. N.Z. Rep., Swan Electric Co. Ltd., High Street, Auckland.

FINDLAYS PTY. LTD., 80-82 Elizabeth Street, Hobart. Tel.: 3718. P.O. Box, 284C. Telegrams and Cables: Findlays Ltd., Hobart. Manager, S. H. Findlay. Branch at Apollo House, Launceston. Tel.: 482. P.O. Box 39. Telegrams and Cables: "Findlays," Launceston. Directors, P. A. Findlay, A. P. Findlay, S. H. Findlay. Wholesalers and Retailers, Pianos, Musical Instruments, Gramophones, Radios, Records. Branch offices: Findlays, Hobart, Findlays and Wills, Devonport.

FINDLAY & WILLS (D'PORT) PTY. LTD., 95 Rooke Street, Devonport, Tas. 'Phone 193. Distributors for Breville Radio Pty. Ltd. and The Gramophone Co. Ltd., H.M.V., and Stromberg-Carlson (A/sia) Ltd.

FORBES, ROBERT C. & CO., 30a Currie Street, Adelaide, S.A. Central 4746. P.O. Box, 256D, Adelaide. Cables, "Sebrof." Proprietor, Robert C. Forbes. Wholesalers, Electric and Radio Goods. Representatives for Liverpool Electric Cables, Lewcos Wires, Weston Meters.

FOX AND MACGILLYCUDDY LTD., 57 York Street, Sydney, N.S.W. B 2409, B 2410. P.O. Box 2144LL. Telegrams/Cables, Fox Radio. Director, A. R. Fox; Manager, C. H. Vaughan; Sales Manager, J. Richmond. Wholesalers of Radio Parts and Sets.

G

GAGE H., Tempany Street, North Fitzroy, Vic. JW1138. Manufacturers of Radio Cabinets.

GARDAM, J. R. W. & CO., 138 Murray Street, Perth, W.A. B9241-2. P.O. Box L903. Telegrams/Cables, "Gardam," Perth. Managing Partner, J. R. W. Gardam. Wholesalers of Electrical and Engineering Plant, etc.

GENDERS, W. & G. PTY. LTD., 53 Cameron Street, Launceston, and Liverpool Street, Hobart, Tas. 1140 (3 lines) and 3001 (3 lines). Directors: E. B. Geners (Managing Director), Claude James, M.H.A., F.F.I.A. Secretary: P. C. Thompson. Distributors for Eastern Trading Co. Ltd., Siemens (Aust.) Pty. Ltd., Standard Telephones and Cables (A/sia) Ltd., Vesta Batteries.

GENERAL MICA SUPPLIES (AUSTRALIA) PTY. LTD. 496 Church St., Richmond, E. I. Vic. J2774. Telegrams/Cables "Supermicas." General Manager, Miss A. T. Coggan. Mine Manager, Mr. S. F. Weller. Miners and manufacturers of Mica for Electrical and Radio trade. Sydney Rep.: John Carr & Co. Pty. Ltd., 661 George Street, Sydney.

GENERAL RADIO CO., 4th Floor, State Shopping Block, Market Street, Sydney, N.S.W. M3531. Proprietor, Hayward C. Parish. Telegrams/Cables "Calpa" Sydney.

MANUFACTURERS AND WHOLESALERS DIRECTORY (Continued)

GERARD & GOODMAN TL., Synagogue Place, Adelaide, Central 5040 (4 lines). P.O. Box X2. Telegrams: Gerard-Goodman, Adelaide. Cables, "Gandg," Adelaide. Managing Director, A. E. Gerard; Director and Manager, A. Hubert Gerard; Director and Works Manager, L. D. Sobels; Sales Manager, R. L. Culley. Branch Office, 132 Rundle Street, Adelaide. Electrical Engineers and Merchants.

GIBSON, A. H. (ELECTRICAL) CO. PTY. LTD., 23 Hardware Street, Melbourne, C.1, Vic. F3123 (5 lines). P.O. Box, 711F. Telegrams/Cables, "Gibeloc." Managing Director, A. H. Gibson; Directors, F. J. Yourelle, C. W. Bryant. Wholesalers for Elex Radio and Elex Electrical Appliances, and all requirements of Radio and Electrical Trade. Representatives in Victoria, Derby Cable and Telefunken. Interstate Reps.: J. Thompson, Box 28A, G.P.O., Adelaide, S.A.; C. F. Willers, Perry House, Elizabeth Street, Brisbane, Q.; Parkinson and Co., Economic Chambers, William Street, Perth, W.A.

THE GRAMOPHONE CO. LTD., H.M.V. (Australian Branch of British Company at Hayes, Middlesex), 2 Parramatta Road, Homebush, N.S.W. UM6671. General Manager, W. A. Donner. Sales Manager, W. G. Simpson. Manufacturers of "His Master's Voice" Radio Receivers. Distributors: Melbourne, Columbia Graphophone (Aust.) Ltd., 347 Flinders Lane, C.1 (M5675); Brisbane, A. E. Harrold, 123 Charlotte Street, Adelaide, S. Hoffnung & Co. Ltd., 83 Grenfell Street (C1.4170); Perth, Household Appliances Ltd., St. George's Terrace, (B6667). Tas., Findlay & Wills Pty. Ltd. Devonport (Tel. 193). Findlay's Pty. Ltd., Hobart (Tel. 4505). Wills & Co. Pty. Ltd., (Tel. 501), Findlays Pty. Ltd., Launceston (Tel. 482).

GRICE, G. J. LTD., 90-92 Queen Street, Brisbane, Q. B1674. P.O. Box, 231D. Telegrams/Cables, Symphony. Managing Director, Arthur Baynes; Sales Manager, W. T. Knight. Wholesalers, Beale and Tasma Radio, Kelvinator Refrigerators, Columbia Batteries. Branches: Mr. L. Shaw, Rockhampton, Q.; R. Musgrave, Townsville, Q.; A. J. Fleetwood, Mackay, Q.; P. J. Bodkin, Toowoomba, Q.; J. Wylie, Cairns.

H

HALLT, E. J., Elizabeth Street, Brisbane, Q. B 9502. Distributor for Mica and Insulating Supplies Co.

HANTKE, T. F., St. George's Terrace, Perth, W. A. Agent for National Radio Corporation Ltd.

HARRIS D. & CO., 140 Rundle Street, Adelaide. S.A. C6122 (2 lines). Partners, D. T. Harris and S. D. Harris. Manufacturers of "Radion" Radio Receivers. Distributors for "Rola" Speakers, "Simplex" Condensers, "Hygrade" Radio Cabinets, and all Radio Accessories.

HARRIS, SCARFE LTD., Grenfell Street, Adelaide, S.A. Central 3300 (31 lines). Box 385A, G.P.O. Telegrams/Cables, Harriscarf. Directors, P. J. A. Lawrence (Chairman), Harold Law-Smith, C. C. Deeley, F. E. Robertson, F. W. Trowse; Secretary, L. B. Daymond; Sales Manager, A. F. Baggott. Wholesalers, Airzone, Serenader, Prelude, Astor, General Electric and Emmco Radio Receivers. Branch: Blende Street, Broken Hill, N.S.W.

HARRISON, A.S. & CO. PTY. LTD., 85 Clarence Street, Sydney, N.S.W. B6541 (3 lines). Managing Director, A. S. Harrison. Distributors of "Nesforite" Moulding Powders. Overseas Reps.: London House, 11 Dowgate Hill, Cannon Street, London, E.C.4.

HARROLD, A. E., 123-125 Charlotte Street, Brisbane, Q. B2729 (2 lines). Box 593J. Telegrams and Cables "Harrold" Brisbane. Sole Queensland Distributor for H.M.V. Radio, Rola Speakers, Crown Radio Manufacturing Co., Simplex Products Pty. Ltd., Continental Carbon Co. Pty. Ltd., Ferrocarte (A/sia) Pty. Ltd. Wholesaler of all standard makes of Radio Components.

HARTLEYS PTY. LTD., 270 Flinders Street, Melbourne. Vic. Central 4970 (10 lines). Telegrams/Cables, Hartsport. Managing Director, H .W. Joseph. Wholesalers of Radio Receivers, Radio Accessories and appliances.

HEALING, A. G. LTD., 167-173 Franklin Street, Melbourne, C.1, Vic. F5171 (10 lines). P.O. Box 870J. Telegrams/Cables, Healing, Melbourne. Directors, A. G. Healing (Governing), N. Broomhall (Managing), C. Forbes, W. W. Devling, V. R. Powell, E. M. Dumbrell. Manufacturers and Wholesalers, Batteries, Radio Receivers, Refrigerators ("Healing Golden Voiced Radio"), etc. Branches: 164/170 Goulburn Street, Sydney, N.S.W. (E. M. Dumbrell, Manager); corner Pirie and Pulteney Streets, Adelaide, S.A. (W. W. Devling, Manager).

HECHT, H. and CO., 450 Collins Street, Melbourne, Vic. 517 (3 lines). Cables: "Esoxur"; Telegrams: "Hecht." Distributors for Ducon Condensers.

HEIRON & SMITH (Salonola), 91 Hunter Street, Newcastle. N.S.W. Newcastle 1094. Box 32 Newcastle. Manager, G. B. Parry. Wholesalers and Retailers. Wholesalers of Radios.

HENDERSON, P.A. & CO., Berry Road, St. Leonards, N.S.W. X1214 & X1087. Products, Henderson Power Equipment. Manager, P. A. Henderson.

HILCO TRANSFORMERS PTY. LTD., 97-111 Berkeley St., Carlton. N.3, Vic. F1661-1662. Box 44a, G.P.O. Melbourne, C.1. Telegrams/Cables, Hilcoy Melbourne. Manufacturers and Wholesalers of Transformers, Chokes and Allied Power Equipment.

HOELLE, J. J. & CO., 47 Alma Street, Darlington, N.S.W. MA5762. 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 (M3526).

HOLLWAY, JOHN & SONS, 40 Armstrong Street North, Ballarat, Vic. (Tel. 89.) Distributors of Tasma Receivers.

HOMECRAFTS PTY. LTD., 211 Swanston Street, Melbourne. Central 8200 (2 lines), (Direct Trunk Line TL202). Telegrams/Cables, Homecrafts, Melbourne. Victorian Distributors, Astor Radio. Wholesalers, Radio, Electrical and Cycle lines.

HORDERN, G. P., 499 Little Collins Street, Melbourne, Vic. Distributors for J. J. Hoelle and Co.

HOWARD RADIO PTY. LTD., Vere Street, Richmond, E.1, Vic. J5148 (3 lines). Telegrams/Cables, "Howrad," Richmond. Managing Director, W. H. Carnegie; Manager and Director, F. J. Henderson; Manager Merchandising Division, A. J. Phillips. General Wholesalers of Radio and Electrical Goods. Manufacturers of Radio Receivers and Radio Cabinets. Sole agents for: Mullard Radio Receivers and Valves, "Garrard" Motors and Clocks, Graham Farish products, Hasag Bulbs, Erpees Headphones, Meltran Transformers, Zeiss Ikon Industrial and Commercial Lighting Equipment, S.B. Wire and Cable. Distributors of: Condor Lamps, "Hecla" Products, Diamond Batteries, Ever Ready Batteries, Greengate (C.M.A.) Wire and Cable. Interstate Reps.: E. V. Hudson Pty. Ltd., 284-286 Edward Street, Brisbane, Q.; Reg. Rose and Co. Ltd., Kembla Building, Margaret Street, Sydney, N.S.W.; South Australian Radio Pty. Ltd., 71 Hindmarsh Square, Adelaide, S.A.; Howard Radio and Co., 33 Argyle Street, Hobart, Tas.

MANUFACTURERS AND WHOLESALERS DIRECTORY (Continued)

HOWARD RADIO & CO., 33 Argyle Street, Hobart, Tas. Distributors for Howard Radio, Meltran Engineering Pty. Ltd., Mullard Radio.

HOWARDS LTD., 317-327 Adelaide Street, Brisbane, Q. B 1951 (9 lines). Distributors for Electricity Meter Mfg. Co. Pty. Ltd. (Electric Refrigerators) and Philco Receivers.

HUDSON, EDGAR V. PTY. LTD., 284-6 Edward Street, Brisbane, Q. B3733-4. P.O. 522H. Telegrams/Cables, "Qupee." Director, Fred. Hoe; Secretary, W. A. Hubner. Radio Wholesalers. Representatives: C. W. Thompson, Townsville, Q.; A. O. Raymond, Warwick, Q.; Arthur Keers, Cairns, Q.

I

IMPEX LIMITED (late New Herberholds), 431 Hoddle Street, Abbotsford, N. 9, Vic. J5231 (2 lines). Telegrams/Cables, Parwin, Melbourne. Managing Director, W. F. Winter; Secretary, N. P. Womersley. Manufacturers, Dry Batteries, Torch Units, Condensers. Branch: 181 Clarence Street, Sydney, N.S.W. (W. Taylor, Manager. MA3602). Distributors: V. J. Griffiths, Exton House, Queen Street, Brisbane, Q.; R. C. Woolard, 18 Chessar Street, Adelaide, S.A.; S. W. Green, 164 St. George's Terrace, Perth, W.A.

INTERNATIONAL RADIO CO. PTY. LIMITED, 254 Castlereagh Street, Sydney, N.S.W. M4893 (3 lines). Telegrams/Cables, Radiophon. Managing Director, Charles E. Forrest; Sales Manager, Clifford G. Salmon; Acting Secretary, Leslie D. Goodsall, Norman Biden, Sydney Manager. Manufacturers and Manufacturers representatives (JENSEN Speakers, GOAT Valve Shields, AMPHENOL Valve Sockets and Plugs, OHIOHM Resistors). Wholesalers of NATIONAL UNION Valves, Cathode Ray Tubes, Pilot Lamps and Photo-Electric Cells, "SHURE" Microphones, INTERNATIONAL Gen-E-Motors and Farm Lighting Plants. GENERAL INDUSTRIES Electric Motors and Record Changers, Magicores, JENSEN Speakers, AMPERITE Microphones, LENZ Hook-up Wire, SPRAGUE Condensers. OHIOHM Suppressors and Volume Controls. Subsidiary Companies: International Radio Co. Pty. Ltd., 403 Bourke Street, Melbourne, Vic. ('Phone F2858); 178 Rundle Street, Adelaide, S.A. ('Phone Cent. 2425); C.T.A. Buildings, Elizabeth Street, Brisbane, Q. ('Phone B9411); International Radio Co. Ltd., Courthouse Lane, Auckland, New Zealand, ('Phone 40-400).

INTERNATIONAL RESISTANCE CO. (A/SIA) LTD., 55 Addison Road, Marrickville, N.S.W. BW 2385-6. Telegrams, "Ircal." Directors, Wm. J. McLellan and Maxwell Walker. Secretary, G. E. Lucas. Distributors: Wm. J. McLellan and Co., 55 York Street, Sydney. Manufacturers of I.R.C. Ceramic Metallised Resistors, Insulated Metallised Resistors, Wire Wound Resistors.

IRVINE RADIO & ELECTRICAL CO., Perry House, Elizabeth Street, Brisbane. B8395. Telegrams and Cables, Irvine Radio. Wholesalers Radio Receivers and Radio Components.

MANUFACTURERS AND WHOLESALERS DIRECTORY (Continued)

J

JACKSON & MACDONALD, 360-362 Kent Street, Sydney. M2226 (3 lines). P.O. Box, 848G. Telegrams/Cables, Jayandem. Manufacturers of Radio Cabinets.

JAMES & VAUTIN, 661 George Street, Sydney, N.S.W. MA2437. Cable address, "Tokalon," Sydney. Wholesalers of Insulating Materials and Wire, Valves, Washing Machines, Refrigerators, etc. Interstate Rep.: Invine Radio and Electrical Co., Perry House, Elizabeth Street, Brisbane.

JOHNSON & GASTON (Qld.) PTY. LTD., 359 Queen Street, Brisbane, Q. B 6495, and at Worando Buildings, Grenfell Street, Adelaide: Bank Chambers, Elizabeth Street, Melbourne, Vic. Distributors for Boss Manufacturing Co.

K

KEEP BROS. & WOOD PTY. LTD., 200 Latrobe Street, Melbourne, Vic. F1155. Distributors "Astor" radio receivers.

KIRBY, A. W. & CO. PTY. LTD., East Street, Rockhampton, Q. Distributors for Radio Corporation Pty. Ltd.

KLOSTER, J. A. C., Stegga's Chambers, Market Street, Newcastle, N.S.W. (Tel. 1966.) Representative for Tasma Radio.

KOHN BROS. PTY. LTD., 118 York Street, Launceston, Tas. Tel. 1192. Telegrams/Cables, Kohn Bros., Launceston. Managing Director, G. B. Kohn; Technical Adviser, E. H. Kohn. Wholesalers. Representatives for Radio Products.

KRIESLER A/SIA LTD., Cnr. Pine and Myrtle Streets, Chippendale, N.S.W. M 4391 (2 lines). 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.

L

LAWRENCE AND HANSON ELECTRICAL CO. LTD., 33 York Street, Sydney, N.S.W. B 6476. Box 2551. Telegrams and Cables: "Lawhanson" (all States). Branches: 172-6 William Street, Melbourne, C1., 10394; 87 Elizabeth Street, Brisbane, B 1407; 120 Collins Street, Hobart; 20 Leigh Street, Adelaide, C1., 2106; 26 Hunter Street, Newcastle. Managing Director, A. J. Hanson. Directors, A. E. Kaleski and A. R. Hanson. Wholesalers and distributors Glovers' C.M.A. wires and cables, Philips electric lamps. Distributors Philips valves.

LEKMEK RADIO LABORATORIES, 75 William Street, Sydney, N.S.W. FL 2626 (3 lines). Telegrams/Cables, Lekmek, Sydney. Proprietor, N. S. Gilmour; Chief Engineer, J. Paton; Factory Superintendent, A. V. Bates. Manufacturers of Radio Receivers, Superfine Kits and Components, Special High Fidelity Transformers and Broadcast Equipment, Intercommunication Speaker Systems, etc. Receivers distributed by: Lawrence and Hanson Electrical Pty. Ltd., Sydney, Melbourne, Adelaide, Hobart, Launceston and Brisbane; S. McCrum, 352 Hunter Street West, Newcastle; L. L. Bateman, Pastoral House, St. George's Terrace, Perth. "Superfine" Kits and Components distributed by: Fox & MacGillycuddy Ltd., 57 York Street, Sydney; Bloch and Gerber Ltd., 46-48 York Street, Sydney; Lawrence and Hanson Electrical Pty. Ltd., 33 York Street, Sydney; John Martin Ltd., 116 Clarence Street, Sydney; United Radio Distributors, 234 Clarence Street, Sydney; S. McCrum, 352 Hunter Street West, Newcastle; Edgar V. Hudson Pty. Ltd., 284-286 Edward Street, Brisbane; Australian Engineering and Equipment Co. Pty. Ltd., 415 Bourke Street, Melbourne, Vic.; Lawrence and Hanson Electrical Pty. Ltd., 172-176 William Street, Melbourne; The Electric Lamp House Ltd., 27 Manners Street, Wellington; Newton McLaren Ltd., Leigh Street, Adelaide, S.A. Speaker Systems, Telephone Rentals (J. T. Campbell), Cranbrook Chambers, Bentham Street, Adelaide. High Fidelity Equipment, Stannage Radio, Queen's Arcade, Auckland, N.Z.

LENROC LTD., 211-5, Pulteney Street, Adelaide. C8770 (4 lines). P.O. Box, No. 1119K. Telegrams and Cables. Lenroc. Managing Director, P. Moody; Works Director, W. G. H. Davey. Radio Wholesalers.

LITTLE, H. C. & CO., 402 Murray Street, Perth, W.A. Distributors for Siemens (Aust.) Pty. Ltd.

LIVERPOOL ELECTRIC CABLE CO. LTD. (in conjunction with its associated company, London Electric Wire Co. and Smith Ltd.) (Incorporated in England), Lewcos House, 233 Clarence Street, Sydney, N.S.W. MA 6001 (3 lines). Australian Manager, A. Maughan. Interstate Reps.— Vic.: 586 Bourke Street, Melbourne (M5989, Manager, T. E. Dukes); W.A.: Carlyle and Co., 915 Hay Street, Perth; Queensland (industrial): Intercolonial Boring Co. Ltd., Ann Street, Brisbane; (radio), J. B. Chandler and Co., 43 Adelaide Street, Brisbane; S.A.: Robert C. Forbes and Co., 30a Currie Street, Adelaide; Tasmania, W. L. Buckland Pty., Ltd., 57 Liverpool Street, Hobart, and Charles Street and Cameron Street, Launceston. Wholesalers for all kinds of electric wires.

M

McCANN BROS., 180-184 Elizabeth St. and 51 Murray St., Hobart, Tas. Tel., 4183. Telegrams/Cables, McCann Bros., Hobart. Directors, B. and L. C. McCann. Wholesalers and Retailers.

McCOLL ELECTRICAL WORKS PTY. LTD., 104-112 Moor Street, Fitzroy, Vic. J 3197-8, 3515. Telegrams/Cables, Makelworks, Melbourne. Managing Director, E. H. W. Westwood; Works Director, N. B. MacDonald; Sales Engineer, L. D. Kemp. Manufacturers and Wholesalers in Victoria. Wholesalers interstate. Manufacturers of small transformers, converter sets, generators and electric motors.

MacCRUM, A. & S., 352 Hunter Street West, Newcastle, N.S.W. Newcastle 1020. Distributors for Lekmek Products.

MANUFACTURERS AND WHOLESALERS DIRECTORY (Continued)

McKENZIE & HOLLAND (Aust.) PTY. LTD., Electrical and Mechanical Engineers, Newport, W.15, Vic., Williamstown 429. Telegrams: "Holland-Spotsword," Vic. Cables: "Schwirren." Branch office, McKenzie and Holland, Northgate, Brisbane, Q., M 6001. Telegraphic address, "Nundah," Brisbane. Managing Director, J. B. Jacobson; Manager, A. W. Beachamp. Distributors: Norman Bell and Co. Ltd., Adelaide Street, Brisbane, Q.; Amplion (A/sia) Ltd., Sydney, N.S.W.; Westinghouse Sales and Roseberry Ltd., 13 Market Street, Sydney, N.S.W.; Westinghouse Sales and Roseberry Ltd., Temple Court, Collins Street, Melbourne, Vic.; Newton McLaren Ltd., Adelaide, S.A.; Carlyle and Co., Perth, W.A. Manufacturers of "Westinghouse" metal rectifiers, "Holanite" plastic moulding, "Westric" battery chargers, etc.

McLELLAN, WM. J. & 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 and Co., Brisbane; Tasmania, W. and 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. and Co. Ltd., Baldwin Instrument Co., London, Rubicon Instrument Co., Philadelphia.

MAGNAVOX (Aust.) LTD., 61 Dowling Street, East Sydney, N.S.W. FL 4174. Managing Director, D. T. Hinchen. Manufacturers of dynamic speakers.

MANTLE, JOHN & CO., 804 Hay Street, Perth, W.A. B4000. Telegrams/Cables, Mantle, Perth, W.A. Distributor, Healing Radio.

MARTIN, B., Wilson House, Charlotte Street, Brisbane. B1744-5. Box 1708V, G.P.O., Brisbane. Telegrams/-Cables, BeeMartin, Brisbane. Proprietor and Sales Manager, Bert Martin; General Manager, A. E. Cooper; Accountant, S. A. Martin; Electrical Manager, V. R. Castle; Manager Advertising and Novelties Department, H. C. Spratt. Wholesaler and Factory Representative.

MARTIN DE LAUNAY LTD., 287-9 Clarence Street, Sydney. M4268 (4 lines). Telegrams/Cables, "Martindel." Managing Director, E. P. Logan; Manager, Radio Department, G. Mitchell. Wholesalers of all standard branded lines and specialising on products of E.T.C. Branches: Newcastle (F. P. Heskett, Manager), Wollongong (H. G. Russell, Manager).

MARTIN, G. G., 26 King Street, Perth, W.A. B 2012. Distributor for Mica and Insulating Supplies Co.

MARTIN, JOHN LTD., 116-118 Clarence Street, Sydney. BW3109 (2 lines). Telegrams/Cables, "Jonmar," Managing Director, John Martin; Technical Manager, J. R. Lamplough.. Wholesalers of Radio Components and Electrical Appliances.

MATHEW, W. T., 95 Grenfell Street, Adelaide, S.A. Central 2260 (2 lines). Telegrames/Cables: "Adorwhoop." Distributors for Ducon Condensers.

MELTRAN ENGINEERING PTY. LTD., 8-10 Scotia Street, North Melbourne, N.1., Vic. F1490/F5709. Telegrams/Cables, Meltran, Melbourne. Manufacturers of Transformers, etc., and Sheet Metal goods. Interstate Representatives: Howard Radio. Tasmania; Robenjamin, Perth, W.A.

MICA INSULATING SUPPLIES CO., 562-4 Bourke Street, Melbourne, Vic. Central 3669, F 5307. Telegrams/Cables, Mandisco. Partners: J. W. Griffiths, G. W. Griffiths, W. C. Pitcher. Manufacturers and wholesalers of insulating materials. Branch: 168 Clarence Street, Sydney, N.S.W. MA 4241. Representatives: A. M. Ralph, Flinders Street, Adelaide, S.A., Cent. 4803; G. G. Martin, 26 King Street, Perth, W.A., B 2012; E. J. Hallt, Elizabeth Street, Brisbane, Q., B 9502.

MICHELMORE, J. & CO. PTY. LTD., Mackay, Queensland. Distributors for Radio Corporation Pty. Ltd.

MICK SIMMONS LTD., 720 George Street, Haymarket, Sydney, N.S.W. M6311. Managing Director, R. M. Simmons. Distributors of Radiola, Airzone, Astor, Oceanic, Kriesler, Emmco radio sets.

MILLS, W. J., 187 Catherine Street, Leichhardt, N.S.W. Petersham 2191. Carbon resistor manufacturer. Trade mark, "Bifrost."

MORSE, R. N., Temple Court, Collins Street, Melbourne, Vic. Victorian representative for Westinghouse Sales and Roseberry Ltd.

MOTORS LTD., 145 Gawler Place, Adelaide, S.A. Distributors for Vesta Batteries.

MOULDED PRODUCTS (A/sia) PTY. LTD., 37-41 Scotchmere Street, North Fitzroy, N.7, Vic. JW 1144-5. Telegrams and Cables: "Vocal-Gramo." Bentley's Code. General Manager, John W. Derham. Sydney representative: Products Pty. Ltd., 73 York Street, Sydney. Branches all States. Manufacturers of all types of synthetic resin mouldings.

THE MULLARD RADIO COMPANY (AUST.) LTD., Sydney. Box 2118L, G.P.O. B 7446-7. Cables/Telegrams: "Mulvalve," Sydney. General Manager, Eric Dare. Sub-Distributors.—Victoria and Tasmania: Howard Radio Pty. Ltd., "Osborne House," Little Collins Street, Melbourne, Vic., 33 Argyle Street, Hobart, Tas.; S.A.: R. C. Woollard, 18 Chesser Street, Adelaide; Queensland: Elphinstones Pty. Ltd., 342 Adelaide Street, Brisbane, also at Rockhampton, Townsville, Cairns, and Toowoomba; W.A.: Carlyle and Co., 915 Hay Street, Perth.

MUSGROVE'S LTD., Lyric House, 223 Murray Street, Perth, W.A. B 1971. G.P.O. Box 195. Telegrams: "Pianoforte," Perth. Director and Manager Radio and Electrical Dept., F. C. Kingstone. W.A. distributor of Stromberg-Carlson receivers.

MYER EMPORIUM (S.A.) LTD., Grenfell Street, Adelaide, S.A. Central 9040. Distributors for Electrice Refrigerators and Philco Receivers.

N

NALLY LIMITED, 5 Queen Street, Glebe, Sydney, N.S.W. MW1370/MW1870. Managing Director, Arthur A. Kelly, Manufacturers of Nally Ware and Plastic Mouldings. Branch: 10 Princess Street, Kew, Vic. Interstate Reps.: L. E. Summerson, King House, Queen Street, Brisbane, Q.; Alex. Stephen, 14 Worando Buildings, Grenfell Street, Adelaide, S.A.; George Wills and Co. Ltd., 133 St. George's Terrace, Perth, W.A.

NATIONAL RADIO CORPORATION LTD., 96 Pirie Street, Adelaide, S.A. 'Phone C 1780 (2 lines). Directors: E. R. Smith, Oswald Smith, G. J. Smith, W. Smith. Manager, E. R. Lindberg. Sales Manager, K. Wadham. Secretary, John A. Shird. Manufacturers of National Radio Receivers, broadcast and dual wave. Branch offices: Victoria House, Hay Street, Perth, W.A.; 238 Elizabeth Street, Melbourne, Vic.; Distributing Agents, Radio and Television Ltd., Perry House, Elizabeth Street, Brisbane, 'Phone 61780,

MANUFACTURERS AND WHOLESALERS DIRECTORY (Continued)

NEW SYSTEMS TELEPHONES PTY. LTD., 276 Castlereagh Street, Sydney, N.S.W., and 276 Flinders Street, Melbourne, Vic. M 6425 (7 lines), Sydney; M 3191 Melbourne. Telegrams/Cables, "Newsysaust." General Manager, J. I. Carroll. Assistant General Manager, R. M. Davies. Radio Wholesalers. Representatives for Siemens and Halske, Berlin (Electrical Equipment). Branch: 22 Currie Street, Adelaide, S.A.

NEWTON, McLAREN LIMITED, 17 Leigh Street, Adelaide, S.A. C8341 (6 lines). P.O. Box, 1339H, G.P.O., Adelaide. Telegrams, "Newton, McLaren," Adelaide. Cables, "Generator," Adelaide. General Manager, John P. Hales, M. Inst. R.E. (Aust.); Secretary, H. E. Morgan, A.F.I.A.; Engineering Manager, A. R. Altmann, B.E., F.S.A.S.M.; Electrical Warehouse Manager, J. F. Pettersen, A.I.I.S.; Radio Manager, L. H. Ferrar, A.M. Inst. R.E. (Aust.) Radio, Electrical and Mechanical Engineers. Manufacturers of Special Switch Gear and Automatic Control Equipment. Wholesalers of Radio, Electrical and Engineering requirements generally. Representatives: W. T. Henley's Wire and Cables, Winding and Resistance Wires; Hoover Limited, Electric Cleaners; The Record Electrical Co. Ltd., Record Instruments.. Interstate representatives: H. Rowe and Co. Pty. Ltd., Melbourne and Sydney; C. F. Willers, Brisbane; Geo. Wills and Co. Ltd., Perth.

NICHOLSON'S LTD., 86 Barrack Street, Perth, W.A. B 6131 (5 lines). Distributors for Amalgamated Wireless (A/sia) Ltd., and Amalgamated Wireless Valve Co. Ltd.

NILSON, O. J. & CO. LTD., 49 King William Street, Adelaide, S.A. Central 4881. Distributors of Tasma Receivers.

NOYES BROS. (Melb.) LTD. 597-603 Lonsdale Street, Melbourne, C.1., Vic., C1.10105. G.P.O. 779H. Telegrams/Cables: "Noyes," Melbourne. Manager Electrical Department, F. A. Gordon. Interstate branches: 89 Grenfell Street, Adelaide (C1.2357); A. E. Keegan, 138 Murray Street, Perth (B 9241); 36 Argyle Street, Hobart, Tas.; 59 George Street, Launceston. Sole Victorian distributors for S.T.C.

NOYES BROS. (SYDNEY) LTD., 115 Clarence Street, Sydney, N.S.W. B7581 (10 lines). Box 1587B, G.P.O., Sydney. Telegrams and Cables, "Noyes," Sydney. Managing Director, T. Malcolm Ritchie; Merchandise Manager, A. W. L. Ellis; Electrical Supplies Section, J. A. Bull. Makers and Designers of "Seyon" Receivers. Sole Agents for Ferranti Receivers and Instruments, Radio Transformers, Carbon Potentiometers, etc. Distributors for "Microhm" Wire Wound Potentiometers, Goldring Pickups, Du Bois and "Fluxite-Kord" Solders, Gladstone Transformers and Transmitting Equipment, Simpson Turntables. General Wholesalers of practically all lines. Branch Offices: 11 Watt Street, Newcastle, 'Phone Newcastle 525, P.O. Box No. 446E. Manager, R. W. Glazebrook; 197 Elizabeth Street, Brisbane, 'Phone B3186 (3 lines), Box 148C, G.P.O., Brisbane. Manager, N. B. Harper.

O

O'BRIEN, O. H. (Sydney), 37-39 Pitt Street, Sydney, BW 1305 (6 lines). Telegrams/Cables, "Beldas," all States. Proprietor, O. H. O'Brien. Manager, E. R. Tidswell. Branch: 654-64 Bourke Street, Melbourne, Vic. (C1.2178, 2 lines). Interstate Reps.: W. E. Peterman, 160 Edward Street, Brisbane, Q. (B 5704); T. G. Butement, 29 Tavistock Street, Adelaide, S.A. (C1.3736). Suppliers of all raw material 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" metallised carbon resistors.

OSBORNE, ALEX. PTY. LTD., Cr. Wilmot and Mount Streets, Burnie, Tas. 'Phone 130. P.O. Box 42. Managing Director, Alex. Osborne. Wholesalers and Retailers of Radio Sets and parts.

P

PARAMOUNT RADIO MANUFACTURING CO., 301 Castlereagh Street, Sydney, N.S.W. MA 3875. Manufacturers of resistors, coils, coil kits, dials, etc. Manager, D. Maskall. Victorian distributors, Henry G. Small.

PARSONS & ROBERTSON LTD., 172-4 Pulteney Street, Adelaide, S.A. C6696 (5 lines). G.P.O., 1397G. Telegrames and Cables, Parob, Adelaide. Managing Director, F. Lancelot Parsons, A.M.I.E. (Aust.); Secretary, A. L. De Laine; Technical Engineer, J. H. Klicke; Sales Manager, R. J. Pain; Accountant, Henley Thomas. Distributors for Delio-Light Electric Light and Power Plants, etr.

THE PATON ELECTRICAL INSTRUMENT CO., 90 Victoria Street, Ashfield, N.S.W. UA 1960. Proprietor, Frederick H. Paton. Chief Engineer, Eric Packer. Manufacturers of cathode ray oscillographs and d'Arsonval type moving coil meters. Distributors: Bloch and Gerber Ltd., and Fox and MacGillycuddy Ltd., Sydney, N.S.W.; A. H. Gibson (Electrical), Melbourne, Vic.; Lawrence and 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, etc.

PETERMAN, W. E., 160 Howard Street, Brisbane, Q. B2088/2089. P.O. Box 194C. Telegrams/Cables, Petan. Chief Assistant, C. Watson-Will. Wholesalers, Potentiometers, Resistors, Hook-up Wires, Testing Equipment.

PHILCO RADIO & TELEVISION CORPN. (AUST.) PTY. LTD., Joynton Avenue, Waterloo, N.S.W. MA6043. P.O. Box 4, Waterloo P.O. Telegrams/Cables, Electromet, Sydney. Superintendent, J. Duncan Bain. Manufacturers, Philco Radio Receivers, Testing Equipment and Valves. Interstate Distributors: New System Telepnones Pty. Ltd., 276 Castlereagh Street, Sydney, N.S.W. (Country Distributors); Wescott, Hazell and Co. Ltd., 225 Castlereagh Street, Sydney, N.S.W. (City and Metropolitan); Mick Simmons Ltd., Haymarket, Sydney. Victoria: New Systems Telephones Pty. Ltd., 276 Flinders Street, Melbourne; B.R. (Radio) Ltd., 59 Elizabeth Street, Melbourne.. Queensland: Howards Ltd., 317-327, Adelaide Street, Brisbane. S.A.: Myer Emporium (S.A.), Ltd., Grenfell Street, Adelaide. Tasmania: McCannan Bros., Elizabeth Street, Hobart; Kohn Bros. Pty., Ltd., Launceston.

MANUFACTURERS AND WHOLESALERS DIRECTORY (Continued)

PHILIPS LAMPS (A/SIA) LTD., Philips House, 69-73 Clarence Street, Sydney. N.S.W. BW2121-6, B1469. P.O. Box 2703C. Telegrams/Cables, "Argenta," Sydney. A. den Hertog, Managing Director; J. A. Overdiep, General Manager; L. Lord, Manager Lighting Division; J. Van Dyk, Manager "Philora" Division; D. G. Wyles, Manager, Technical and Commercial Department; G. R. Davidson, Sales Manager, Radio Division; V. H. Dudman, Manager Transmitting and Rectifier Department. Manufacturers and Agents for Philips Lamps, Valves, Radioplayers, Rectifiers, Transmitting Equipment, X-RAY Apparatus ("Metalix," "Centralix"), Vapour Discharge Lamps ("Philora"). Branches: 590 Bourke Street, Melbourne, Vic. (F3191 —Manager, Keith Nicholls); Perry House, Elizabeth Street, Brisbane, Queensland (B7462—Manager, A. H. Hills); 65 Scott Street, Newcastle, N.S.W. (N'cl. 1150 —Manager, E. Beames); Hayward Building, Charles Place, Adelaide, S.A. (Central 6843—Manager, A. Thomas); 381-385 Murray Street, Perth, W.A. (B4696—Manager, Alec. Dening). Distributors: Sydney, Lawrence and Hanson, Electrical Co., Ltd., 33 York Street; William Adams and Co., Ltd., 175 Clarence Street; Warburton Franki Ltd., 307 Kent Street.. Melbourne: Brooks Robinson Pty. Ltd., 59-65 Elizabeth Street; Warburton Franki Ltd., 380-2 Bourke Street; Lawrence and Hanson Elec. Co. Ltd., 172-6 William Street; William Adams and Co. Ltd., 521-3 Collin Street.. Adelaide: Unbehaun and Johnston Ltd., 58 Gawler Place; Newton McLaren Ltd., Leigh Street; William Adams and Co. Ltd., 157 Waymouth Street; Wm. Adams and Co. Ltd., 432-6 Murray Street. Brisbane: Lawrence and Hanson Elec. Co. (Q'ld.) Ltdr, 85-7 Elizabeth Street; Warburton Franki Ltd., 233-5 Elizabeth Street; William Adams and Co. Ltd., cnr. Albert and Margaret Streets. Hobart: Lawrence and Hanson Elec. Co. Ltd., 120 Collins Street. Launceston: Lawrence and Honson Elec. Co. Ltd., 20 Patterson Street.

PHILLIPS, P. H., 123-5, Charlotte Street, Brisbane, Q. B 5774. P.O. Box 597J. Telegrams: Philectric. Manufacturers' representatives for Ducon Condenser Pty. Ltd. ("Ducon" and "Chanex"), Commonwealth Moulding Co. Pty. Ltd. ("Marquis"), Radiokes Ltd. ("Radiokes").

PIDGEON, ARTHUR, 818 Hay Street, Perth, W.A. B 2576. Telegrams, "Wirebird, Perth." Proprietor, Arthur P. Pidgeon. Wholesaler and Retailer, Kriesler Radio, Milne's Units and Windchargers.

PITTARD DIACK & CO. PTY. LTD., Lake Street, Cairns, Q.. 2521. Distributors for Radio Corporation Pty. Ltd.

PRECISION ENGINEERING CO. PTY. LTD., 25 Little Collins Street, Melbourne, Vic. C. A. O'Halloran and A. H. Lane. C1.4930. Telegrams, "Peco," Melbourne. Manufacturers of general radio apparatus and special gear for transmitting stations.

PRITCHARD, J. G. LTD., 18 William Street, Perth, W.A. B4710, B4711. Managing Director, James G. Pritchard; Sales Manager, H. U. Kendall. Distributors Alpha Engineering Co. Ltd., Crown Radio Mfg. Co. Ltd., Electricity Meter Manufacturing Co. Ltd., Radio Industries Ltd.

PROCTOR, G., 40 Pirie Street, Adelaide, S.A. C 5715. G.P.O. Box 150. Representatives, A. J. Veall Pty. Ltd.

PYROX PTY. LTD., 264 Latrobe Street, Melbourne, Vic. F 4157. Telegrams, "Pyrox." Managing Director, A. Hoette. Manager, N. Taylor. Sydney office, 97 Palmer Street, East Sydney (FL 4960). Manager, P. Meyer. Proprietor of "Pyrox" car radio.

R

RADIO AND TELEVISION PTY. LTD., Perry House, Elizabeth Street, Brisbane, Q. Distributors for National Radio Corporation Ltd.

RADIO CORPORATION PTY. LTD., 21 Sturt Street, South Melbourne, Vic. M4711 (10 lines). Joint Managing Directors, L. Abrahms and A. G. Warner; Secretary, N. D. Gray; Sales Manager, C. V. Eutrope. Manufacturers Astor Radio, Astor Mickey Mouse Radio, Specialists in Car Radio. Importers, Financing Hire Purchase for Radio, Refrigerators, Automobiles, etc. Branch Offices: 160 Goulburn Street, Surrey Hills, N.S.W., F1363 (L. Solomons, Manager); 173 Pirie Street, Adelaide, S.A., Cent. 2769 (W. Whitley, Manager); Car Radio Service (H. T. M. Lyne, Sales Rep|); 905 Hay Street, Perth, W., B8459 (H. E. Pead, Factory Representative); 104 Collins Street, Hobart, Tas. (L. Lucke, Factory Representative); 107 John Street, Launceston, Tas., L'ton 371 (L. Lucke, Factory Repre-stnative); 802 Ann Street, Valley, N.1, Brisbane, Q., B6658 (A. P. Taylor, Factory Representative). Distributors: Smith Sons and Rees Ltd., 30 Wentworth Avenue, Sydney, N.S.W.; A. W. Kirby and Co. Pty. Ltd., East Street, Rockhampton, Q.; G. J. Grice Ltd., 90 Queen Street, Brisbane, Q.; Trackson Bros. Ltd., 157 Elizabeth Street, Brisbane, Q.; J. Michelmore and Co. Pty. Ltd., Mackay, Q.; Pittard Diack and Co. Pty. Ltd., Lake Street, Cairns, Q.; F. Heatley and Sons, Pty. Ltd., Flinders Street, Townsville, Q.; Carlyle and Co., 915-917 Hay Street, Perth, W.A.; Colton Palmer and Preston Ltd., Currie Street, Adelaide, S.A.; Harris Scarfe Ltd., Rundle Street, Adelaide, S.A.; Burrows and Meek Pty. Ltd., Elizabeth Street, Hobart, Tas.; A. Osborne Pty. Ltd., Universal Corner, Burnie, Tas.; M. Rava and Co., Bayliss Street, Wagga, N.S.W.; Homecrafts Pty. Ltd., 211 Swanston Street, Melbourne, Vic.; Keep Bros. and Wood Pty. Ltd., 200 Latrobe Street, Melbourne, Vic. Overseas Representatives, Buyers etc., Ajax Radio Corporation, 37 Rue Deguingard, Lavallois-Perret, France; Louis Coen Wireless Pty. Ltd., 113 University Place, New York City; A. Warner and Son Ltd., 201 Forrest Road, Walthamstow, England.

RADIO INDUSTRIES LTD., Joynton Avenue, Waterloo, N.S.W. MA 6043. Distributors of Emmco radio products.

RADIOKES LTD., Cnr. George and Cleveland Street, Redfern, N.S.W. MA 6771. Cables/Telegrams: "Radiokes" Sydney. Codes, "Bentleys." Managing Director, R. K. Stokes. Manufacturers of Radiokes components, distributed through all trade wholesalers.

RADIO MERCHANTS LTD., 6th Floor, Australia House, Carrington Street, Sydney, N.S.W. BW6673. Telegrams/Cables, Radmer. Managing Director, R. C. Wright. Wholesalers, Electrical and Radio Supplies.

RADIO PRODUCTS, 27 Pine Street, Chippendale, N.S.W. MA 7856. Importers of Columbus Radio Receivers. Representing Radio Corporation of New Zealand Ltd.

RADIO WHOLESALERS LTD., James Place, Adelaide, S.A. C.8000 (3 lines). P.O. Box 660F. Managing Director, H. R. Pinkerton. Manager, A. E. Stephen. Secretary, A. J. Carvosso. Wholesalers of Radio Receivers, Appliances, Accessories, etc., South Australian Distributors for Stromberg-Carlson Radio Receivers. Calstan Testing Equipment. C.S.C. Condensers, Diamond and Ever Ready Batteries.

MANUFACTURERS AND WHOLESALERS DIRECTORY (Continued)

RADIX POWER SUPPLIES, 64 Lawler Street, Subiaco, W.A. B4812. Manufacturers Radio Parts. Proprietor, A. Albert Dix.

RALPH, ARTHUR M., 68 Flinder Street, Adelaide. Central 4803. P.O. Box 1148K, Adelaide. Wholesalers for Electrical Insulating Materials of all kinds. Factory rep. for Mica and Insulating Supplies, Co., Melbourne; "Marquis" Products, Sydney; "Crown" Radio Products, Sydney.

RAVA, M. & CO., Baylis Street, Wagga, N.S.W. Distributors for Radio Corporation Pty. Ltd.

RAYCOPHONE LTD., Booth and Trafalgar Street, Annandale, N.S.W. MW 1834-1874. Telegrams, "Raycophone," Sydney. Managing Director, G. D. Cree. Director and Chief Technical Engineer, Ray Allsopp. Manufacturers of talking picture equipment, etc.

REGENT RADIO PTY. LTD., 975 Burke Road, Camberwell, E.6, Vic. Hawthorn 905. Managing Director, Geoff. D. Searle. Director, George Searle. Manufacturers of all types of radio receivers, public address amplifiers, low-power transmitters.

R. C. S. RADIO, 26 Ivy Street, Darlington, N.S.W. MA 6041-2. Proprietor, Ronald A. Bell. Interstate Reps.—Vic.: Henry G. Small Pty. Ltd., 374 P.O. Place, Melbourne; S.A.: A. G. Healing Ltd., Pirie Street, Adelaide; Queensland: Trackson Bros., Elizabeth Street, Brisbane; W.A.: Carlyle & Co., 915 Hay Street, Perth. Products, wire wound components.

RICKETTS & THORP PTY. LTD., Hattersley Street, Rockdale, N.S.W. LX1241/2/3/4. Directors, G. S. Ricketts, F. Thorp. Manufacturers and Wholesalers, Wireless Cabinets and Furniture.

ROLA CO. (AUSTRALIA) PTY. LTD., 77-83 City Road, South Melbourne, S.C.4., Vic. M1278 (3 lines). Telegrams/Cables, Rola, Melbourne. Managing Director, A. Leonard C. Webb; Manager, Raymond H. Yeend. Manufacturers of Rola Loudspeakers.

ROMCKE PTY. LTD., McCracken Building, Church Lane, Melbourne, Vic. F 5017 (2 lines). Distributors for Beale and Co. Ltd.

ROSE, REG. & CO. LTD., Kembla Buildings, Margaret Street, Sydney. BW 2114. 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.)

ROSENTENGELS PTY. LTD., Ruthven Street, Toowoomba, Q. Tel. 45 and 245. P.O. Box 74. Governing Director, E. M. Rosenstengel; Accountant and Secretary, J. McMaster. Manufacturers, Quality Furniture. Sole Distributors of Tasma Radio for Darling Downs and South Western Queensland.

S

SAVEREY'S PIANOS LTD., 29 Rundle Street, Adelaide, S.A. C.8000 (3 lines). P.O. Box 660F. Telegrams/Cables, "Saverys," Adelaide. Managing Director, H. R. Pinkerton. Secretary, A. J. Carvosso. Country Radio Manager, A. E. Stephen. City Manager, D. R. Whitburn. Wholesalers of Stromberg-Carlson and Beale Radio Receivers. Branch: Broken Hill, N.S.W. (G. G. Talbot, Manager).

SCOTT & HOLLADAY LTD., 35 Clarence Street, Sydney, N.S.W. BW1278, BW1279. P.O. Box 1918KK. Telegrams/Cables, Hollasid. Managing Director, G. L. Murray; Director, E. A. Richards; Secretary, E. McCooey. Wholesalers, specialising in Electrical Radio, Motor and Allied lines, Moulding Powders of all classes. Branches at 592 Bourke Street, Melbourne, Vic. (J. Spells, Manager); Civic Chambers, Cuba Street, Wellington, N.Z. (Norman Lawn, Manager). Representatives: V. J. Griffiths, Queen Street, Brisbane, Q.; R. C. Woollard, Chesser Street, Adelaide. S.A.; V. T. Davir, St. George's Terrace, Perth, W.A.

SHARPE, RAY J., 860 Hay Street, Perth, W.A. B 8312. Distributor for Briton Radio.

SIEMENS (AUSTRALIA) PTY. LTD., 257 Clarence Street, Sydney, N.S.W. M4161. P.O. Box 2704C. Telegrams/Cables, Siemens, Sydney. Managing Director, J. P. Duggan; Sales Manager, J. R. Parrin. Manufacturers and Distributors of Siemens Electric Lamps, Siemens Wires and Cables, Siemens Intercommunication Telephones, Siemens Fluid and Dry Batteries, Siemens Ebonite, Siemens-Ellott Measuring or Recording Instruments of all types. Agents for Marelli Electric Fans, Benjamin Reflectors, Sauter Time Switches. Sole agents in Australia for the English Electric Co. Ltd., London, manufacturers of Electric Motors, Alternators, Transformers, Switchgear, etc., and Diesel Engines. Branch offices: 189-191 William Street, Melbourne, Vic.; 85 Grenfell Street, Adelaide, S.A.; 132-134 Charlotte Street, Brisbane, Q.; 45 Watt Street, Newcastle, N.S.W. Interstate representatives: H. C. Little and Co., 402 Murray Street, Perth, W.A.; W. and G. Genders (Pty.) Ltd., 53 Cameron Street, Launceston; 69 Liverpool Street, Hobart, and Marine Terrace, Burnie, Tasmania.

SIMPLEX PRODUCTS PTY. LTD., 716 Parramatta Road, Petersham, N.S.W. LM 5615. Chairman of Directors, H. J. Hankin; Director and Secretary, G. Rich. Manufacturers fixed Mica Condensers, Plastic Mouldings; Wholesalers, Carbon Resistors, Electrolytic Condensers, Vibrators, and other radio components. Interstate Distributors: Continental Carbon Co. Pty. Ltd., 174 Queen Street, Melbourne, Vic.; D. Harris and Co., 130 Rundle Street, Adelaide, S.A.; Atkins (W.A.) Ltd., 894 Hay Street, Perth, W.A.; A. E. Harrold, 123 Charlotte Street, Brisbane, Quensland; Electric and General Import Co., Manchester Street, Christchurch, N.Z.

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 Calston meters. Distributors—N.S.W.: Bloch and Gerber Ltd., Martin de Launay, Murdochs Ltd.; Queensland: J. B. Chandler and Co., Brisbane; Vic.: A.G.E. Ltd., Melbourne; W.A.: Carlyle and Co., Perth; N.Z.: New Zealand General Electric Co. and Carrick Wedderspoon, Wellington.

SMALL, HENRY G. & CO. PTY. LTD. (also Airdok Radio Valve Co. Pty. Ltd., valves only), 11 Hardware Street, Melbourne, C.1, Vic., C1.11455. Telegrams/Cables, Hengsmall, Melbourne. Managing Directors: Henry G. Small and Chas. A. Small. Secretary, C. S. Kirkland. Wholesalers and manufacturing agents. Wholesalers of radio goods. Representatives for Concourse Condensers, etc. Distributors of Columbus Radio Sets.

SMART, H. & CO., 163 Swanston Street, Melbourne, Vic., C1.7997. Indent agents for wire cables, flexes, sheet metal condensers, resistances and insulating material.

SMEDLEY, D., 22 Roe Street, Mayfield, N.S.W. Waratah 595. Distributor for Breville Radio.

SMITH SON & REES PTY. LTD., 30-32 Wentworth Avenue, Sydney, N.S.W. MA6551 (10 lines). Telegrams/Cable, Speedomet. Wholesalers, Motor Accessories, Replacement Parts, Cycles and Radio.

SOUTH AUSTRALIAN RADIO PTY. LTD., 71 Hindmarsh Square, Adelaide, S.A. Central 1932. Distributors for Howard Radio.

STANDARDISED PRODUCTS (Reg.), 14 Hedger Avenue, Ashfield, N.S.W. 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.

MANUFACTURERS AND WHOLESALERS DIRECTORY (Continued)

STANDARD TELEPHONES & CABLES (A/SIA) LTD., 258-274 Botany Road, Alexandria, N.S.W. MX1161 (6 lines). P.O. Box 525B. Telegrams/Cables "Relay, Sydney." MANAGING DIRECTOR, H. C. Trenam; Director and Commercial Manager, J. Clarke; Technical Director, R. A. Beckwith; Director and Telephone Manager, A. H. Cameron; Director and Transmission Manager, T. N. Bore; Director and Works Manager, S. D. McPhee; Secretary, E. R. Reddell; Manager, Radio Receiver Division, J. L. Coote; Radio Receiver Designs Engineer, T. P. Court; Advertising Manager, H. F. Pearce. MANUFACTURERS of Radio Receivers, Radio Receiver Parts, Radio Broadcast Transmitters, Telephones and Telephone Switchboards, Train Control Equipment, Public Address Systems, etc. Wholesalers of Radio Receivers, Radio Parts. REPRESENTATIVES for Raytheon Valves, Brimar Valves and the products of Standard Telephones and Cables Ltd., London, and associated companies. BRANCHES: Standard Telephones and Cables (A/sia) Ltd., 588 Bourke Street, Melbourne, Vic.; N.Z., P.O. Box 638 Wellington, P.O. Box 1897 Auckland, P.O. Box 938 Christchurch. REPRESENTATIVES.—Newcastle and Northern Districts: Martin de Launay Ltd., corner King and Darby Street, Newcastle; Riverina District: Wagga Wireless Distributors, Fitzmaurice Street, Wagga; Noyes Bros. (Melb.) Ltd., 597-603 Lonsdale Street, Melbourne, Vic.; Queensland: Edgar V. Hudson Pty. Ltd., 284-6 Edward Street, Brisbane; S.A., Lenroc Ltd., 123-5 Flinders Street, Adelaide; W.A., M. J. Bateman Ltd., Milligan Street, Perth; Tas., W. and G. Genders Pty. Ltd., 53 Cameron Street, 69 Liverpool Street, Hobart.

STANDEN, H. P., Hindmarsh Buildings, Hindmarsh Square, Adelaide, S.A., Central 6622. Distributor for G. P. Embelton & Co.

STAN-MOR DRY CELL CO., 212 Bay Street, Brighton, Vic. X 1423. Proprietor, A. S. Morgan. Telegrams/Cables "Magrom." Manufacturers of dry cells and batteries. Interstate Reps.—Queensland: Electrical Agencies, 193 Elizabeth Street, Brisbane; N.S.W., Boswell and Co., 40 King Street, Sydney; S.A.: E. Bown, Worando Buildings, Grenfell Street, Adelaide; W.A., Thomas W. Egan, 75 King Street, Perth.

STEPHEN, ALEX., 14 Worando Buildings, Grenfell Street, Adelaide, S.A. Central 3955. Distributor of Nally products.

STERLING RADIO PTY. LTD., 27-39 Abercrombie Street, Sydney, N.S.W. M 3261 and MA 5130. Directors: J. M. Tait, C. E. Tait, R. G. Ely. 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; Tasmania: John King and Son Pty. Ltd., King's Corner, Launceston.

STOTT & HOARE (S.A.) LTD., 21 Grenfell Street, Adelaide, S.A. Central 1300 and 1366. Distributors for Breville Radio Pty. Ltd.

STOTT & HOARE TYPEWRITERS LTD., 55 William Street, Perth, W.A. B4357. Manager, Alfred J. Case. Wholesalers Breville Radio, Easy and Connor Washing Machines.

STROMBERG-CARLSON (A/SIA) LTD., 118-124 Bourke Road, Alexandria, N.S.W. MA6283. Telegrams and Cables, "Strom," Sydney. Trade names:—"Stromberg-Carlson," "Audiola," "Roamer." Managing Director, L. P. R. Beam.. Director, R. Breden; Sales Manager and Associate Director, A. Freedman; Associate Director and Factory Manager, G. E. Eglon; Victorian and Tasmanian representative, W. C. F. Hill, 191 Queen Street, 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 and Wood Ltd., Pitt Street, Sydney; Heiron and Smith (Salonola), 91 Hunter Street, Newcastle; Wagga Wireless Distributors, Box 93 P.O., Wagga. Victoria—M. Brash and Co. Pty. Ltd., Elizabeth Street, Melbourne and 146 Ryrie Street, Geelong; A. J. Veall and 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 and 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, Launieston; Wills and Co. Pty. Ltd., 7 The Quadrant, Launceston! Findlay and 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. N.Z. Factory Representatives: Arnold and Wright Ltd., Christchurch.

SUTHERLAND, A. P., 2 Maffra Street, Melbourne South, S.C.4, Vic. M 2291 (4 lines). Telegrams/Cables, "Essanay," Melbourne. Distributors of Westinghouse Products. Proprietor: A. P. Sutherland. General Manager, H. J. Green. City showrooms: Regency House, 202 Flinders Lane, Melbourne, Vic.

SYDNEY MAGNETO AND ELECTRICAL CO., 107 Regent Street, Sydney, N.S.W. MA 7369. Managing Director, W. K. Duffy. Factory Manager, Mr. Jones. Manufacturers of Radio Potentiometers.

SYME, W.A. & CO., corner Liverpool and Bourke Streets, East Sydney, FL2463, F2730. P.O. Box 11, William Street P.O. Managing Director, W. A. Syme; Manager, R. Syme. Manufacturers of Radio and Amplifier Equipment ("Symfona" Radio). Interstate representative, Electrical Agencies, 193 Elizabeth Street, Brisbane.

T

TELEPHONE RENTALS (J. T. CAMPBELL), Cranbrook Chambers, Bentham Street, Adelaide, S.A. Distributors for Lekmek Speaker Systems.

THOM & SMITH LTD., 29-39 Botany Road, Mascot, N.S.W. Mascot 1080 (6 lines). P.O. Box 2596 EE, G.P.O., Sydney. Telegrams/Cables, "Teaness." Directors: F. W. P. Thom and J. E. Smith; Secretary, S. T. Lindsay; Sales Manager, R. H. Jennings; Chief Engineer, E. M. Fanker. Manufacturers of Tasma A.C. Electric Radio Receivers, Combined AC-DC Radio Receivers, Battery-operated Receivers, Vibrator Receivers and Auto Radio, also Valve Sockets... Interstate Representatives: R. J. S. Bryce, London Stores Building, Elizabeth Street, Melbourne, Vic.; J. A. C. Kloster, Stegga's Chambers, Market Street, Newcastle (1966); C. R. Donelly, 144 Zadoc Street, Lismore, N.S.W. Interstate Distributors of Tasma Receivers: Victoria—Hartley's Pty. Ltd., 270 Flinders Street, Melbourne (Cent. 4970), John Hollway and Sons, 40 Armstrong Street, North Ballarat (89).. Queensland—G. J. Grice Ltd., 90-92 Queen Street, Brisbane (B1674), Rosenstengels Pty. Ltd., Ruthven Street, Toowoomba (45). South Australia: O. J. Nilsen and Co. Ltd., 49 King William Street, Adelaide (Cent. 4881); Chas. Birks and Co., Ltd., 44 Rundle Street, Adelaide (Cent. 7130). Western Australia: Carlyle and Co., 915-917 Hay Street, Perth (B9371). Tasmania: Noyes Bros. (Melb.) Ltd., 36 Argyle Street, Hobart (6326); Noyes Bros. (Melb.) Ltd., 59 George Street, Launceston (Cent. 1210). New Zealand, N.Z. Electrical Equipment Ltd., Wakefield Chambers, Wellington (53-699).

MANUFACTURERS AND WHOLESALERS DIRECTORY (Continued)

THOMSONS LTD., 674 Hay Street, Perth, W.A. B 9571 (2 lines). Distributors for Beale and Co. Ltd.

TRACKSON BROS. PTY. LTD., 157-159 Elizabeth Street, Brisbane, Q. B 2804 (3 lines). 26A G.P.O., Brisbane. Telegrams/Cables, Tracksons, Brisbane. Managing Director, Philange S. Trackson. Secretary, A. A. Ewing. Wholesalers of Electrical and Radio Merchandise.

TRAVELTONE RADIO PTY. LTD., 376 Bourke Street, Melbourne, C.1., Vic., 113 Clarendon Street, South Melbourne, S.C.5. M3546. Manager, C. Solomon; Chief Engineer, E. Evans. Manufacturers of Auto Radio Receivers, Electric and Battery Sets. Wholesalers, Traveltone Radio Receivers.

TREE RADIO-ELECTRIC CO. Head office, 88 Willoughby Road, Crow's Nest, N.S.W. (X 5713) and at 185 Military Road, Neutral Bay, N.S.W. Manufacturers of Treeray Radio Receivers. Wholesale radio and electrical supplies (Northern Suburbs only).

TYME LTD., 280 Castlereagh Street, Sydney, N.S.W. M 3084. Telegrams and 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, Vic.; J. G. Pritchard Ltd., Perth, W.A.; Findlay and Wills Pty. Ltd., Devonport, Tas.; Wills and Co. Pty. Ltd., Launceston, Tas.; Findlay Bros. Pty. Ltd., Hobart, Tas. Australian distributors for Hygrade Sylvania valves.

U

UNBEHAUN & JOHNSTONE LTD., 58 Gawler Place, Adelaide, S.A. Central 3900. Distributors for Philips Lamps (A/sia) Ltd.

UNITED RADIO DISTRIBUTORS PTY. LTD., 234 Clarence Street, Sydney. MA2382. Telegrams/Cables, URD, Sydney. General Manager, H. C. Long; Sales Manager, W. J. Mawer. Wholesalers of Radio Receivers and Accessories.

V

VEALL, A. J. (AGENCIES) PTY. LTD., 127 York Street, Sydney, N.S.W. MA3524. Telegrams/Cables, Artveall. Manager, W. Blackmore. Wholesalers of Miscellaneous Electrical goods. Representatives for Velco and Kit Cat Products. Branch: Arthur J. Veall Pty. Ltd., Melbourne.

VEALL, ARTHUR J. PTY. LTD., 247 Swanston Street, Melbourne, Vic. C1.3053 (7 lines). Governing Director Arthur J. Veall. Managing Director, H. V. Prior. Wholesalers and distributors of Stromberg-Carlson and Radiola radio receivers, "Victor" accumulators. Branch offices—Vic.: 168 Swanston Street, Melbourne (C.1.10524—Manager, Mr. Winter); 301 Chapel Street, Prahran (Windsor 1605—Manager, Mr. De Figureidio); 5 Riversdale Road, Camberwell (W 1188—Manager, Mr. Grimwood). Interstate agents—N.S.W.: A. J. Veall (Agencies) Ltd., 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 and London.

VESTA BATTERY CO. PTY. LTD., 2-14 George Street, Leichhardt, N.S.W. LM4455 (5 lines). P.O. Box 15 Post Office, Leichhardt. Telegrams/Cables, Vesta, Sydney. General Manager, A. R. Allen; Asst. Gen. Manager and Sales Manager, S. J. Bickerton; Secretary, P. Lovett; Works Superintendent, E. Ashworth. Manufacturers, Storage Batteries for Cars, Radios, Homelighting. Branches: Vesta Battery Co. Pty. Ltd., 16-22 Bowen Street, Brisbane, Q. (B2383-4); 11-13 Stanley Street, Melbourne, Vic. (F2525); 886B Hay Street, Perth, W.A. (B7585); 61 Kent Terrace, Wellington, N.Z. (51-361); 58 Stanley Street, Auckland, N.Z. (46-657); 6 Carroll Street, Dunedin, N.Z. (13-267). Distributors: W. and G. Genders Pty. Ltd.; 53 Cameron Street, Launceston, Tas.; 69 Liverpool Street, Hobart, Tas.; Mount Street, Burnie; Motors Ltd., 145 Gawler Place, Adelaide, S.A. Overseas Reps.: International Forwarding Company, 431 South Dearborn Street, Chicago, Ill., U.S.A.

VOLTA DRY BATTERIES LTD., 351 Elizabeth Street, Melbourne, Vic. MU1374. Interstate Distributors: N.S.W.: Hislop Lloyd Ltd., 335 Pitt Street, Sydney; Queensland: Edgar V. Hudson Ltd., 284 Edward Street, Brisbane; S.A.: Harris Scarfe Ltd., Grenfell Street, Adelaide; W.A.: A. C. McCallum Ltd., 96 Murray Street, Perth; Tasmania: Noyes Bros. (Melb.), 36 Argyle Street, Hobart; Noyes Bros. (Melb.), 59 George Street, Launceston; New Zealand, Brown and Paul, 29 Beach Road, Auckland.

W

WAGGA WIRELESS DISTRIBUTORS, Box 93 Wagga, N.S.W. 'Phone Wagga 191. Proprietor, H. Gissing. Riverina Distributors for Stromberg-Carlson and Audiola.

WARBURTON, FRANKI LTD., 307-15 Kent Street, Sydney, N.S.W. BW1251, 1523DD, G.P.O., Sydney.. Telegrams/Cables, Booster, Sydney.. Managing Director, G. S. Warburton; Secretary, H. J. Rodgers.. Manufacturers, Watt Hour Meters.. Wholesalers, Instruments, Refrigerators, Lighting Plants and General Electrical Merchandise. Representatives for Weston, Sangamo, General Radio. Branches: Warburton, Franki (Melb.) Ltd., 380 Bourke Street, Melbourne; Warburton, Franki (Bris.) Ltd., 233 Elizabeth Street, Brisbane, Q.

WARBURTON FRANKI (MELB.) LTD., 380—82 Bourke Street, Melbourne, Vic. C1.8888. Cables "Ignition." Telegrams: "Warburton Franki," G.P.O. 487.

WATSON, W. G. & CO. LTD., 279 Clarence Street, Sydney, N.S.W. M 4331. Box 2570E. Telegrams/Cables, "Switchon," Sydney. Managing Director, W. G. Watson. General Manager, D. J. Miles. Wholesalers and Representatives for: The British Aluminium Co. Ltd., London (Aluminium Wires, Cables, Sheets, etc.); The Enfield Cables Works Ltd., London ("Enfield" C.M.A. Wires, Cables, etc.); "Erie" Radio Resistors, Suppressors, etc. ("Readrite" and "Triplett" Measuring Instruments, Valve Testers, Radio Set Analysers, etc.); Branches: W. G. Watson and Co. Ltd., 31 Hunter Street, Newcastle, N.S.W.; 400 Post Office Place, Melbourne, Vic.; 91a Currie Street, Adelaide, S.A.; 94 Liverpool Street, Hobart, Tas.; 77 York Street, Launceston, Tas.; 75 King Street, Perth, W.A.

WERRING RADIO COMPANY, 213-215 Queensberry Street, Carlton, N.3, Vic. F5483. Proprietor. O. C. Werring; Factory Manager, A. H. Buck. Manufacturers of Werring Sets and Parts. Branch offices: 285 High Street, Prahran, S.1; 47 Glenferrie Road, Glenferrie; and 22A Glenhuntly Road, Elsternwick.

WESTCOTT HAZELL & CO. LTD., 225 Castlereagh Street, Sydney, N.S.W.. M 2402 (14 lines). P.O. Box 2538E G.P.O. Telegrams/Cables, "Westhazell" Sydney. Wholesalers of Philco, Airzone and A.W.A. Radio. Branches at Newcastle, Lismore, Wagga, New South Wales.

WESTINGHOUSE SALES & ROSEBERY LTD., 13 Market Street, Sydney, N.S.W. MA6321 (2 lines). P.O. Box 2634 EE. Telegrams and Cables, REWL. Joint Managing Directors, F. G. Carr and W. V. Buzacott. Manufacturers of Radio Sets, Domestic and Commercial Refrigerators, etc. Westinghouse Licensees for Australia. Victorian representative, R. N. Morse, Temple Court, Collin Street, Melbourne.

MANUFACTURERS AND WHOLESALERS DIRECTORY (Continued)

WESTMINSTER RADIO TELEVISION CO. LTD., 26-8 George Street, Parramatta, N.S.W. UW9601. Manufacturers, Radio Receivers, Deaf Aids, Amplifiers, etc. Wholesalers, Radio Goods.

WIDDIS DIAMOND DRY CELLS, Corner Park and Wells Streets, South Melbourne, Vic. M 4601 (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 and Co., Kembla Buildings, Margaret Street, Sydney; Queensland, J. B. Chandler and Co., Adelaide Street, Brisbane; S.A., Newton McLaren Ltd., Leigh Street, Adelaide; Tasmania, Howard Radio Pty. Ltd., Hobart; New Zealand, Importers and Agents Ltd., Quay Building, Quay Street, Auckland.

WILKS, E. F. & CO., 124 Castlereagh Street, Sydney, N.S.W. M6507. P.O. Box 4095. Telegrams/Cables, Factors. Chairman of Directors, H. J. A. Howes; Secretary, E. O'Bree; Sales Manager, E. C. Foot. Wholesalers for N.S.W. of Radio Equipment (Westinghouse and Gulbransen Radio). Victorian rep.: R. N. Morse, Temple Court, Collins Street, Melbourne, Vic.

WILLERS, C. F., 111 Elizabeth Street, Brisbane, Q. B 9140. Distributor for "C.S.C." Condensers and Newton, McLaren Ltd.

WILLIAMS PTY. LTD., East Street, Rockhampton. 507 Rockhampton (4 lines). P.O. Box No. 8. Telegrams/Cables, Williams, Rockhampton. Managing Director, J. Herbert Williams; Secretary, C. S. Williams. Wholesalers, Breville Radio, all electrical material.

WILLS & CO. PTY. LTD., 7 Quadrant, Launceston, Tas. 'Phone L'ton 501. P.O. Box C232. Telegrams/Cables "Wills." Wholesalers Radio and Musical Goods.

WILLS, GEORGE & CO. LTD., 133 George's Terrace, Perth, W.A. Distributors of Nally Products, and for Newton McLaren Ltd.

WOOLLARD, R. C., 18 Chesser Street, Adelaide, S.A. Central 858. Distributor for Mullard Radio Co. (Aust.) Ltd.

WYPER BROTHERS LTD., Bourbong Street, Bundaberg, Q. 'Phone 562 (4 lines). P.O. Box No. 9. Telegrams/Cables, "Wyper." Chairman of Directors, William Wyper; Managing Director, William James Harvey. Wholesalers of Receivers and Accessories.

WYPER HOWARD LTD., 671 Hay Street, Perth, W.A. B 4697-8. Distributors for Amalgamated Wireless (A/sia) Ltd. and Amalgamated Wireless Valve Co. Ltd.

Z

ZENITH RADIO CO. LTD., 37 Oxford Street, Paddington, Sydney, N.S.W. FL2143, FL2248. Managing Director, Jose Alberti; Secretary and Sales Manager, Ray Evans; Designer, G. Bronlee; Factory Manager, M. Edwards. Manufacturers Radio Receivers, Coils IFT, Pots Dials.

Trade Names Directory

Inclusion of a trade name in this section of the Directory does not necessarily mean that 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.

ACE—(W.) Elphinstones Pty. Ltd. (Electrical replacements and motor accessories).

ACORN—(M.) Acorn Pressed Metal Pty. Ltd. (Chassis in all metals (unassembled), aluminium valve shields, square and round I.F. and coil cans, sockets, etc.).

AEGIS—(M.W.) G. P. Embelton and Co. (Coils, kits, tuning condensers, power transformers).

A.G.D.—(D.) A. G. Davis & Co. (Chassis and components).

AGEITE—(M.W.). Australian General Electric Ltd. (Wiring devices).

A.G.E.—(M.W.) Australian General Electric Ltd. (Motors, instrument transformers).

A.G.E.—(M.D.) Australian General Electric Ltd. (Insulating material).

AIRDOK—(W.) Henry G. Small and Co. Pty. Ltd. (Radio apparatus).

AIRZONE—(M.) Airzone (1931) Ltd. (Electric and Battery Receivers. Component parts, line and aerial filters).

ALPHA and Device—(M.) Alpha Engineering Co. Ltd. (Radio switches).

AMPERITE — (F.R.) International Radio Co. Ltd. (Microphones).

AMPHENOL — (F.R.) International Radio Co. Ltd. (Valve sockets and plugs).

AMPLION—(M.W.) Amplion ((A/sia) Ltd. (Loud speakers, microphones, genemotors, condensers).

"ARISTOCRAT"—(M.W.) Electrical Specialty Mfg. Co. Ltd. (Radio receivers).

ARROW—(M.&W.) Wm. J. McLellan & Co.. (Switches and wiring devices).

ASTOR MICKEY HOUSE — (M.) Radio Corporation Pty. Ltd. (Radio receivers).

ASTOR—(M.) Radio Corporation Pty. Ltd. (Radio receivers).

AUDIOLA—(M.) Stromberg-Carlson (A/sia) Ltd. (Radio receivers).

A.W.A.—(M.D.) Amalgamated Wireless (A/sia) Ltd. (All wireless apparatus and equipment).

BANDMASTER—(M.D.) Australian General Electric Ltd. (Receivers).

BATYPHONE—(M.) C. S. Baty & Co. (Radio receivers).

BEALE—(M.) Beale & Co. Ltd. (Pianos, radios, radio cabinets, etc.).

BECO—(M.) Borthwick Everitt & Co. (Radio chassis and parts).

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 and 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).

BOSS—(M.) Boss Manufacturing Co. (Battery chargers, testers).

BRADLEYOMETERS—(D.) Eastern Trading Co. Ltd. (Variable resistors).

BRADLEYUNITS—(D.) Eastern Trading Co. Ltd. (Resistors).

BREVILLE—(M.W.) Breville Radio Pty. Ltd. (Radio receivers).

TRADE NAMES DIRECTORY (Continued)

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).
CALSTAN—(M.) Slade's Radio. (Meters).
CALWYN—(M.W.) Calwyn Radio Co. (Radio receivers).
CARBONCEL—(D.) Amplion A/sia Ltd. (Air-depoliarsing primary batteries).
CENTRALIX—(M.W.) Philips Lamps (A/sia) Ltd. (X-Ray apparatus).
CHALLENGE—(M.) Arnold & Beard Ltd. (Radio chassis, coil and I.F. cans, galleries, ceiling flanges, etc.)
CHANEX—(M.) Ducon Condenser Pty. Ltd. (Condensers, metallised and wire-wound resistors).
CHORISTER—(M.W.) Eclipse Radio. (Radio receivers, etc.).
CLASSIC—(W.) John Martin Ltd. (Coils,.. intermediates, frequency transformers, speaker input transformer windings).
CLYDE—(M.) Clyde Batteries. (Accumulators).
CONTINETAL—(M.D.) Continental Carbon Co. Pty. Ltt. (Electrolytic condensers, carbon resistors, auto-radio suppressors and resistors).
CRAMMOND—(M.) Crammond Radio Mfg. Co. (Radio receivers).
CROWN—(M.W.) Crown Radio Manufacturing Co. Pty. Ltd. (Radio components, kit sets, coil kits, etc.).
CROYDEN—(M|W.) Eclipse Radio (Radio receivers).
C.S.C.—(M.) Condenser Specialty Co. Ltd. (Condensers).
DALTON—(M.) H. Dalton and Co. (Moulded products).
DIAMOND—(M.) Widdis Diamond Dry Cells Pty. Ltd. (Batteries).
DICKIN—(M.) F. Dickin Ltd.(Cabinets).
DON—(M.) Don Electrical Co. (Battery chargers, rectifiers, rotary converters).
DU-BOIS (D.) Noyes Bros. (Sydney) Ltd. (Cored solders).
DUCON—(M.) Ducon Condenser Pty. Ltd. (Electrolytic condensers).
DUNCO—(M.W.) Wm. J. McLellan and Co. (Relays for all porposes, thermostats and aquastats).
EFCO—(M.) Efco Mfg. Co. Ltd. (Dials, tuning units, visual tuners, etc.).
ELECTRO-VOICE — (D.) Amplion A/sia Ltd. (Microphones).
ELEX—(W.) A. H. Gibson (Electrical) Co. Pty. Ltd. (Radio Sets and Electrical Appliances).
EMICOL—(D.) Amplion A/sia Ltd. (Radio meters).
EMMCO—(M.) Electricity Meter Manufacturing Co. Pty. Ltd. (Radio).
E.S.M.—(M.) Electrical Specialty Mfg. Co. Ltd. (Receivers).
E.T.C.—(M.) Eastern Trading Co. Ltd. (Mica condensers).
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).
FERRANTI—(D.) Noyes Bros. (Sydney) Ltd. (Radio receivers, transformers, 2in. and 2½in. instruments, etc.).
FERROCART — (M.W.) Ferrocart (A/sia) Pty. Ltd. (Inductances and vibrators for elimination of B and C batteries).
FERRO COIL—(M.) Thom and Smith Ltd. (Radio apparatus, etc.).
FERRODINE (M.W.) Breville Radio Pty. Ltd. (Radio apparatus).
FLUXITE-CORD—(D.). Noyes Bros. (Sydney) Ltd.. (Solders).
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 INDUSTRIES—(F.R.) International Radio Co. Ltd. (Electric motors and record changers, and Magicores).
GLADSTONE—(D.) Noyes Bros. (Sydney) Ltd. (Audio and power transformers and transmitting equipment).
GOAT—(F.R.) International Radio Co. Ltd. (Valve shields).
GOLDRING—(D.) Noyes Bros. (Sydney) Ltd. (Electric pick-ups).
GRAND OPERA—(M.) L. J. Yelland. (Receivers and components).
GULBRANSEN—(W.) E. F. Wilks & Co. Ltd. (Radio sets).
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). (H.M.V.).
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).
HOTPOINT—(W.) Australian General Electric Ltd. (Soldering irons, etc.)
HOWARD—(M.) Howard Radio Pty. Ltd. (Receivers).
IMPEX LTD.— (M.D.), late New Herberholds. (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).
KELVIN—(W.) Henry G. Small and Co. Pty. Ltd. (Radio sets, parts).
KEN-RAD—(D.) Eastern Trading Co. Ltd. (Valves).
KIT CAT—(W. Agents) A. J. Veall (Agencies) Pty. Ltd. (Various elec. goods).
KRIESLER—(M.) Kriesler A/sia Ltd. (Receivers).
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.W.) Amplion. A/slia Ltd. (Microphones).
LIONEL—(D.) Amplion A/sia Ltd. (Model electric trains and aeroplanes).
LYRIC — (W.) Musgrove's Ltd. (Radios, gramophones).
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).
MAK—(W.) Newton McLaren Ltd. (Radio and electrical goods).
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).
MELTRAN—(M.) Meltran Engineering. Pty. Ltd. (Complete range of transformers and sheet metal goods)
METALIX—(M.W.) Philips Lamps (A/sia) Ltd. (X-Ray apparatus).
M.I.C.—(D.) Australian General Elec. Ltd. (English insulating materials).
MICROHM—(D.) Noyes Bros. (Sydney) Ltd. (Wire wound potentiometers).
MINSTREL—(F.R.) William Begg & Sons. (Radio goods).
MISCO—(W.M.) Mica and Insulating Suplies Co. ((Insulating materials.)
MISCOLITE—(M.W.) Mica and Insulating Supplies Co. (Heat resisting materials).
MISCOID—(M.W.) Mica and Insulating Supplies Co. (Packings).
NALLY—(M.) Nally Limited. (Plastic mouldings).
NATIONAL—(W.) National Radio Co. Ltd. (Broadcast and dual wave).

TRADE NAMES DIRECTORY (Continued)

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).
NIGHT HAWK — (W.) Newton, McLaren Ltd. (Radio and electrical goods).
OCEANIC—(M.D.) Mick Simmons Ltd. (Receivers).
OHIOHM—(F.R.) International Radio Co. Ltd. (Resistors, suppressors, volume controls).
OHMEG—(M.) Ohmegga Resistors (Aust.) Pty. Ltd. (Metalised carbon resistors).
OPERATIC—(M.) Bland Radio. (Radio sets).
OSRAM—(M.D.) British General Elec. Co. Ltd. (Valves).
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 and Television Corporation (Aust.) Pty. Ltd. (Radio receivers).
PHILIPS—(M.D.) Philips Lamps A/sia Ltd. (Valves and lamps).
PHILORA—(M.W.) Philips Lamps (A/sia) Ltd. (Vapour discharge lamps).
PIONEER—(F.R.) International Radio Co. Ltd. (Gen-e-motors and chargers).
POLIDINE—(M.W.). Breville. Radio Pty. Ltd. (Radio apparatus).
PRELUDE—(W.) Harris, Scarfe Ltd. (Radio receivers).
PYROX—(M.) Pyrox Pty. Ltd. (Auto radio).
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).
RADIOTRON — (M.) Amalgamated Wireless Valve Co. Ltd. (Valves).
RADIX—(M.) Radix Power Supplies. (Transformers and chokes).
RAYCOPHONE — (M.) Rayocophone Ltd. (Sets and components, sound reproduction equipment).
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).
REGENT (W.) Howard Radio Pty. Ltd. (Electrical goods).
REMO—(W.) Bennett & Wood Pty. Ltd. (Radio sets, etc.).
ROAMER—(M.) Stromberg-Carlson (A/sia) Ltd. (Radio receivers).
ROLA—(M.) Rola Co. (Aust.) Pty. Ltd. (Loudspeakers).
ROTETHERM—(M.W) Wm. J. McLellan & Co. Dial thermometers).
ROTOVISOR — (M.) Amalgamated Wireless A/sia Ltd. (Radio sets, parts, etc.).
SALONOLA—(W.) Heiron and Smith (Salonola). (Radios, etc.).
SAXONETTE—(M.W.) Eclipse Radio (Radio receivers, etc.).
SAXON—(M.W.) Eclipse Radio. (Radio receivers, etc.).
SELECTORLITE — (M.) Stromberg-Carlson A/sia Ltd. (Dials, etc.).
SERENADER—(W.) Harris, Scarfe Ltd. (Radio receivers).
SEYON—(M.) Noyes Bros. (Sydney) Ltd. (Radio receivers).
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.W.) Simplex Products Pty. Ltd. (Radio components, plastic mouldings).
SIMPSON—(D.) Noyes Bros. (Sydney) Ltd. (Electric turntables).
SLADE—(M.D) Slade's Radio. (Receivers and analysers).
SOLAR—(D.) Eastern Trading Co. Ltd. (Electrolytic condensers).
SPRAGUE — (F.R.) International Radio Co. Ltd. (Condensers).
S.T.C.—(M.D.) Standard Telephones and Cables Ltd. (Receivers).
STAN-MOR—(M.) Stan-More Batteries. (Dry batteries).
STERLING—(M.) Sterling Radio Ltd. (Radio receivers).
STROMBERG - CARLSON — (M.) Stromberg-Carlson A/sia Ltd. (Receivers).
SWITCHON—(M.) W. G. Watson & Co. Ltd. (Radio apparatus).
SYLVANIA—(D.) Tyme Ltd. (Valves).
SYMFONA—(M.) W. A. Syme & Co. (Radio and amplifier equipment).
TASMA—(M.) Thom & Smith Ltd. (Radio receivers, 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).
TRANCO—(M.W.) Hilco Transformers Pty. Ltd. (Transformers, chokes and allied equipment).
TRAVELTONE(M.) Traveltone Radio Pty. Ltd. (Radio receivers, all types).
TUNGSOL—(D.) Eclipse Radio Pty. Ltd. (Valves).
UDISCO—(M.) Ace Amplifiers Ltd. (Radio telegraphy-telephony equipment, sound equipment).
UNIVOX—(M.W.) Eclipse Radio (Radio receivers, etc.).
U.R.D.—(W.) United Radio Distributors Pty. Ltd. (Speaker replacement windings, B class transformers and chassis).
UTILITY—(M.W.) Wm. J. McLellan & Co. (Anti-capacity switches and precision dials).
UTILUX—(M.) J. J. Hoelle & Co. (Earthing clips and adaptors).
VELCO—(W. Agents) A. J. Veall (Agencies) Pty. Ltd. (Various electrical goods).
VESTA—(M.D.) Vesta Battery Co. Pty. 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).
WEBSTER—(D.) Amplion A/sia Ltd. (Crystal pick-ups).
WELDON—(M.) Bloch & Gerber Pty. Ltd. (Receivers and components).
WERRING—(M.) Werring Radio Co. (Radio).
WESTINGHOUSE—(W.) E. F. Wilks & Co. Ltd. (Radio sets).
WESTINGHOUSE — (D.) Amplion A/sia Ltd. (Metal rectifiers).
WESTMINSTER RADIO — (M.W.) Westminster Radio Television Co. Ltd. (Radio receivers).
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).
ZENITH—(M.) Zenith Radio Co. Ltd. (Radio receivers).
ZEVA—(D.) Warburton Franki (Melb.) Ltd. (Soldering irons).

Commercial Information of Radio Companies or Firms

ACE AMPLIFIERS LIMITED, 10 Grosvenor Street, Neutral Bay, N.S.W. Directors: E. G. Beard, R. B. Durant, E. S. T. Rodd. Managing Director: E. G. Beard. General Manager: R. B. Durant. Secretary and Accountant: E. O. Dingle. Auditor: A. G. MacGregor. Bankers: Bank of Australasia. Nominal and Subscribed Capital: £10,000. Reg . in Sydney, 22/9/1931.

ACORN PRESSED METAL PTY. LTD., Head Office, 66-72 Shepherd Street, Chippendale, N.S.W. Governing Director, E. A. E. Parmiter. Director, W. A. Rice. Acting Secretary, F. G. Barnaby. Bankers: Bank of New South Wales, Camperdown. Auditors, Gordon, Hume and Hinwood. Reg. 6/5/1931.

AIRZONE (1931) LTD., 16-22 Australia Street, Camperdown. Managing Director: Claude Plowman. Solicitors: Allen, Allen and Hemsley. Auditors: Ewing and Rae.. Bankers: E. S. and A. Bank Ltd. Nominal Capital: £100,000. Subscribed Capital: £57,457. Reg. in Sydney, 1931.

AMALGAMATED WIRELESS (A/SIA) LTD., Head Office, 47 York Street, Sydney, N.S.W. Nominal Capital: £1,000,000. Paid up capital: £744,282. Directors, Sir Ernest Fisk, K.B. (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, Sir Ernest Fisk. General Manager, L. A. Hooke. Auditors: Yarwood Vance and Co., with Sir G. Mason Allard.

AMALGAMATED WIRELESS VALVE CO. LTD., 47 York Street, Sydney, N.S.W. Directors: Sir Ernest Fisk, K.B. (Chairman), Rt. Hon. W. M. Hughes, P.C., K.C., LLd., F. Strahan, C.V.O., C.B.E., LLb, L. A. Hooke, F. B. Clapp, H. B. Tyrrell, J. W. G. Henderson. Director and General Manager, L. A. Hooke; Secretary, J. F. Wilson; Accountant, R. V. Dearman; Sales Manager, A. P. Hosking. Auditors: Yarwood, Vane and Co., with G. Mason Allard. Bankers: Commonwealth Bank of Australia, Sydney. Capital: Nominal £100,000. Subscribed £75,008. Reg. 18/4/32, Sydney.

AMPLION (A/SIA) LTD., 66 Clarence Street, Sydney. Directors: P. J. Manley, K. S. Kopsen, J. Armstrong. Managing Director: P. J. Manley. Secretary: J. Armstrong. Accountant: E. T. Russell. Sales Manager, E. S. Cox. Auditors: Perry and Johnson, 369 George Street, Sydney. Bankers: Bank of New South Wales, King and George Streets, Sydney. Nominal Capital: £20,000. Subscribed Capital: £15,193. Reg. in Sydney, 19/9/1930.

ANDERSEN, H. C. & FRANTZEN, Johnston Street, Alexandria. Proprietors: Hans Christian Andersen, Victor Frantzen. General Manager: Victor Frantzen. Accountant: C. W. Browne. Bankers: E. S. & A. Ltd., Broadway. Reg. in Sydney, April, 1916.

ARNOLD & BEARD LTD., 632 Botany Road, Alexandria, N.S.W. Managing Director, J. Arnold. Directors: J. Arnold, A. J. Williams, E. H. Beard. Secretary. E. H. Beard. Reg. in Sydney, 21/12/1935.

AUSTRALIAN GENERAL ELECTRIC LTD., 95 Clarence Street, Sydney, N.S.W. Directors: F. B. Clapp, A. Maling, S. B. Cox, L. F. Burgess, Sir Felix J. C. Pole, Clark H. Minor. Chairman and Managing Director, F. B. Clapp. Secretary, W. A. Dean. Accountant, H. R. Willcox. Sales Manager, S. B. Cox. Auditors, Robert W. Nelson and Co. Bankers, Bank of Australasia Ltd. Nominal capital, £1,300,000. Registered Sydney.

AUSTRALIAN RADIO COLLEGE PTY. LTD., cnr. Broadway and City Road, Sydney, New South Wales. MA 2419. Managing Director and Principal, L. B. Graham. Director, R. Graham. Secretary, Miss E. Pratt. Nominal Capital, £5000. Subscribed capital, £1150. Bankers: Commonwealth Bank of Australia. Auditor H. B. Hoskins. Reg. firm, March, 1931. Formed into a limited company, July, 1935.

BEALE & CO. LTD., 41-47 Trafalgar Street, Annandale, N.S.W. Directors: Sir Kelso King, K.B. (Chairman), Sir George Mason Allard, Kt., Ronald M. Beale, Rupert O. Beale, R. Russell Crane. Managing Director: R. M. Beale. Secretary: H. Adair. Accountant: L. J. Pink. Sales Manager, J. M. Davis. Auditors: H. J. Gibbons and R. R. Rouse. Bankers: Bank of N.S.W. Nominal Capital: £395,000. Subscribed Capital: £205,000. Reg. in Sydney.

BEGG, WILLIAM & SONS, 343 Little Collins Street, Melbourne, C1, Vic. Proprietor: Reginald N. Begg. Accountant: B. Kennedy. Sales Manager: A. Lake. Auditor: E. L. Barrett, Collins Street, Melbourne. Bankers: National Bank of Australasia Ltd., Western Branch. Reg. in Melbourne, 1928.

BELL, NORMAN & CO. PTY. LTD., 403 Adelaide Street, Brisbane, Q. Director: Norman M. Bell, General L. C. Wilson, C.B., D.S.O., H. E. Lintott. Managing Director, Norman M. Bell. Secretary, H. E. Mines. Auditors, Thomson and Sharland. Bankers: National Bank of Australasia. Nominal and subscribed capital: £50,000. Registered at Brisbane.

BENNETT & WOOD PTY. LTD., 284 Pitt Street, Sydney. Directors: Chas. W. Bennet (Governing), K. A. Bennett. Managing Director: K. A. Bennett. Secretary: J. P. Rowe. Bankers: Bank of Australasia, Pitt Street, Sydney. Capital: £200,000. Reg. in Sydney, February, 1882.

BLAND RADIO, Coromandel Place, Adelaide, S.A. Proprietor: W. J. Bland. Secretary and Accountant: L. H. Lindsay. Sales Manager: J. E. Vardon. Bankers: Union Bank of Australia.

BLOCH & GERBER PTY. LTD., 46-48 York Street, Sydney, N.S.W. Chairman of Directors: Eugene Gerber. Managing Director: Otta Raz. Acting Secretary, H. Lederman. Bankers: Bank of N.S.W., Head Office. Auditors: John Stewart and Co. Nominal Capital: £50,000. Subscribed Capital: £40,000. Reg. 1/4/26.

B. R. (RADIO) LIMITED, 59-65 Elizabeth Street, Melbourne Vic. Directors: H. Tatnall, R. Farquhar, A. K. Wilson. Managing Director: H. Tatnall. Secretary: R. Farquhar. Accountant: J. S. Jenkins. Sales Manager: J. I. Carew. Audtors: Flack and Flack. Bankers: Commercial Bank of Australia Ltd. Nominal Capital: £125,000. Subscribed Capital: £72,041. Reg. in Melbourne, 12/9/'33.

BORTHWICK EVERITT & CO., 33 Mountain Street, Broadway, Sydney. Proprietors: A. R. Everitt, K. B. Borthwick. Bankers: Bank of N.S.W.

COMMERCIAL INFORMATION—(Cont.)

BOSS MANUFACTURING CO., 11 Yabsley Avenue, Ashfield, N.S.W. General Manager: E. W. O'Sullivan. Secretary and Accountant: F. Eggleton. Sales Manager: F. E. O'Sullivan. Bankers: Commercial Bank of Australia, Ashfield. Capital: £2,000. Reg. 19/10/28.

BREVILLE RADIO PTY. LTD., 486 Elizabeth Street, Sydney. Managing Director: W. J. O'Brien. Secretary and Accountant: N. J. Seatree. Sales Manager: W. J. O'Brien. Auditors: G. A. Blackett and Lewis, 10 O'Connell Street, Sydney. Bankers: Bank of N.S.W. Capital: £30,000. Reg. in Sydney, November, 1932.

BRITON ELECTRICAL & RADIO PTY. LTD., 152 Parramatta Road, Petersham, N.S.W. Directors: James Briton, W. G. Forsyth. General Manager, George Hunt. Secretary and Accountant, E. Formby. Sales Manager: G. Hunt. Auditors, Yarwood Vane and Co. Bankers: Union Bank of Australia. Capital: £10,000. Registered, Sydney, 1/7/1936.

WM. L. BUCKLAND PTY. LTD., 139-141 Franklin Street, Melbourne, Vic. Managing Director: Wm. L. Buckland. Secretary: W. E. W. Hodgkiss. Accountant: A. E. Clark. Bankers: Commercial Bank of Aust. Ltd. Capital: £17,105. Reg. in Melbourne, 26/1/26.

BURROWS & MEEK PTY. LTD., 93 Elizabeth Street, Hobart, Tas. Directors, A. P. and A. O. Burrows. Managing Director, A. O. Burrows. Sales Manager, R. E. M. Newton (Radio Department); T. W. Newton (Sports Department). Auditors: R. J. Shield and Hibbard. Bankers: E. S. and A. Bank, Hobart.

CHANDLER, J. B. & CO., 43 Adelaide Street, Brisbane, Q'land. Proprietor: J. B. Chandler. General Manager: W. G. Duncan. Accountant: H. W. Duncan. Sales Manager: V. F. Mitchell. Auditors: White and Hancock. Banker: E. S. & A.

CHANDLER, J. B. LTD., Australia House, Carrington Street, Sydney. Managing Director: J. B. Chandler. Sales Manager: F. B. Leate. Bankers: E. S. & A. Bank Ltd. Reg. in Sydney, 1935.

CLUBB, A. M. & CO. LTD., 76 Clarence Street, Sydney, N.S.W. B3908. Nominal Capital: £10,000 in £1 shares. Subscribed capital: £4,000. Bankers: Bank of New South Wales, head office. Auditors: Witt and Uther, Kembla Buildings, Margaret Street, 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 Avenue, Rosebery, N.S.W. Managing Director: Keith D. Davison. Secretary and Accountant: J. N. Mottram. Sales Manager: R. L. Jackson. Bankers: National Bank of Australasia. Nominal Capital: £5,000. Subscribed Capital: £5,000. Reg. Sydney, 23/4/1935.

CONLON, S. M., RADIO CO., 26 Kippax Street, Sydney, N.S.W. Proprietor and General Manager: S. M. Conlon, B.Sc. Bankers: Commonwealth Bank of Aust., Martin Place, Sydney.

CROWN RADIO MANUFACTURING CO. PTY. LTD., 51 Murray Street, Pyrmont, N.S.W. Directors: J. B. Phillips, F. P. Jones. Managing Director: J. B. Phillips. Sales Manager, Secretary and Accountant: F. P. Jones. Auditor: J. M. W. Morgan, F.C.I.A. Bankers: Bank of N.S.W. Nominal Capital: £10,000. Subscribed Capital: £5,000. Reg. in Sydney, 1/3/1937.

ECLIPSE RADIO PTY. LTD., 216-222 City Road, South Melbourne, Vic. Directors: A. Aarons, S. Aarons, C. Oliver Welsh. Secretary and Accountant: J. Glass. Sales Manager: Arch. McPhee. Auditors: Wilson, Danby and Giddy. Bankers: Bank of Australasia. Nominal Capital: £100,000. Reg. in Melbourne, 1925.

ELECTRICITY METER AND ALLIED INDUSTRIES LTD. (Incorporating Electricity Meter Mfg. Co. Ltd. and New System Telephones Pty. Ltd.). Head office, Joynton Avenue, Waterloo, Sydney. Authorised capital £1,000,000, divided into one million shares of £1 each, comprising 100,000 six per cent. cumulative preference shares of £1 each, 500,000 ordinary shares of £1 each, and 400,000 shares of £1 each reserved for future issues. Capital issued 500,000 ordinary shares of £1 each and 100,000 six per cent. cumulative preference shares. Directors, J. I. Carroll, J. K. Scharlt, R. K. Butler and J. M. MacFarlane; General Manager, J. I. Carroll; Technical Director and Chief Engineer, J. K. Scharlt. Solicitors, Clayton Utz and Co., 136 Liverpool Street, Sydney. Bankers: Commercial Bank of Australia Ltd. Auditors: Norton and Faviell, Chartered Accountants, O'Connell Street, Sydney. Secretary and Reg. office: W. A. Elder, Chartered Accountant, Joynton Avenue, Waterloo, N.S.W. This is a holding company, owning all the shares in Electricity Meter Manufacturing Co. Ltd. and New System Telephones Pty. Ltd.

EFCO MANUFACTURING COMPANY LIMITED, 108 Prince's Highway, Arncliffe, N.S.W. LX1231 (4 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 and Lewis. Reg. in Arncliffe, 1929.

ELECTRIC SHOP LIMITED, 43 Russell Street, Toowoomba, Q. Directors: A. E. Squelch, J. F. Fulcher, G. F. Alke, J. Hill, H. T. Anderson. Managing Directors, A. E. Squelch, J. F. Fulcher. Secretary and Accountant, J. B. Young, A.A.I.S. Sales Manager, A. E. Squelch. Auditors, Cecil Postle, F.A.B.I. Bankers: Commonwealth Bank of Australia. Nominal Capital, £15,000; Subscribed, £3,286. Registered Brisbane, Q., 19/7/'35.

ELECTRICAL SPECIALTY MFG. CO. LTD., 17-19 Glebe Street, Glebe. General Manager: J. T. Dunn. Secretary and Accountant: C. H. Jull.

ELECTRICITY METER MANUFACTURING CO. PTY. LTD., Joynton Avenue, Waterloo, N.S.W. Directors: J. I. Carroll, J. K. Schartl, J. M. Macfarlane, W. A. Alder, K. L. E. Schulz, J. Bryden-Brown. Managing Director: J. I. Carroll. Secretary: J. T. Fitz. Reg. in Sydney, 1/12/27.

ELPHINSTONES PTY. LTD., 342-350 Adelaide Street, Brisbane, Q. Directors: A. C. Elphinstone, R. L. Shepherd, H. L. Elphinstone. Managing Director, A. C. Elphinstone; General Manager, H. L. Elphinstone. Secretary and Accountant, H. C. R. Murray, F.I.C.A. Sales Manager, N. V. Lamont. Auditors: Tanner and Buchanan. Bankers: The Union Bank of Aust. Ltd. Nominal Capital: £50,000. Subscribed Capital: £23,000. Registered twenty years ago, originally trading as Elphinstones Agencies.

EMBELTON, G. P. & CO., 208 Lonsdale Place, Melbourne, C1, Vic. Proprietor: G. P. Embelton. Secretary and Accountant: R. J. Gibson. Sales Manager, J. H. Magrath. Auditors: Buckley and Hughes, 360 Collins Street, Melbourne, C1., Vic. Bankers: National Bank of Aust., Collins Street, Melbourne, C1.

THE EVER READY COMPANY (AUSTRALIA) LTD., Harcourt Parade, Rosebery, N.S.W. Directors: R. P. Walter (Managing), A. Jewell, S. W. H. Newman. Secretary, O. R. Armstrong. Accountant, C. C. Godley. Sales Manager, G. K. Herring, Publicity Manager, F. H. Tisbury. Auditors, Starkey and Starkey. Bankers, Bank of New South Wales. Registered, New South Wales.

EXIDE BATTERIES OF AUSTRALIA PTY. LTD., Grace Building, 77 York Street, Sydney, N.S.W. Auditors: Horley and Horley. Bankers: Bank of Australasia and National Bank of Australasia Ltd. Nom. Capital, £150,000. Sub. Capital: £110,007. Reg. Sydney, 11/8/30.

COMMERCIAL INFORMATION, Etc.

FINDLAYS PTY. LTD., Brisbane Street, Launceston, Tas. Directors: A. P. Findlay, S. H. Findlay, P. A. Findlay. Managing Director: P. A. Findlay. Secretary: P. E. Frith. Accountant: D. J. Clarke. Sales Manager: S. H. Findlay. Auditors: Wise, Lord and Ferguson. Bankers: Bank of Australasia. Capital: £50,000 fully subscribed. Reg. in Launceston.

FORBES, ROBERT C. & CO., 30a Currie Street, Adelaide, S.A. Proprietor: Ralph C. Forbes. Bankers: The National Bank of Australia, Adelaide. Reg.: Adelaide, about 1925.

FOX AND MACGILLYCUDDY LTD., 57 York Street, Sydney, N.S.W. Director, A. R. Fox. General Manager, C. H. Vaughan; Secretary, Miss H. M. Shirtley; Sales Manager, J. Richmond. Auditors: H. J. Brown and Co., O'Connell Street, Sydney. Bankers: National Bank.

GARDAM, J. R. W. & CO., 138 Murray Street, Perth, W.A. Proprietor: J. R. W. Gardam. Accountant: S. R. Stimson. Auditors: Flack and Flack. Bankers: Commercial Bank of Australia. Reg. in Perth, October, 1918.

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. Cruicksank, Creasy, Gow and Layh. Bankers, Bank of Australia.

GENERAL MICA SUPPLIES (AUSTRALIA) PTY. LTD., 499 Little Collins Street, Melbourne, C.1. Vic. Directors, Miss A. T. Coggan and Mr. S. F. Weller. General Manager, Miss A. T. Coggan. Secretary, A. L. Royce. Bankers: Bank of New South Wales. A.B.C. Branch, Melbourne. Nominal Capital, £25,000. Subscribed, £9,850. Registered 4/5/1934, Melbourne.

GERARD & GOODMAN LTD., Synagogue Place, Adelaide, S.A. Directors: A. E. Gerard, A. H. Gerard, L. D. Sobels. Managing Director: A. E. Gerard. General Manager: A. H. Gerard. Sales Manager: R. L. Culley. Bankers: Commercial Banking Co. of Sydney Ltd. Reg. in Adelaide, 1907.

GIBSON, A. H. (ELECTRICAL) CO. PTY. LTD., 23 Hardware Street, Melbourne, C1, Vic. Directors: F. J. Yourelle, C. W. Bryant. Managing Director: A. H. Gibson. Secretary: J. A. Lawrence. Accountant: A. L. Finger. Radio Manager: E. E. Seabridge.

GRICE, G. J., LTD., 90-92 Queen Street, Brisbane. Directors: R. D. Kennedy, A. Baynes, E. J. Grigg. Managing Director: A. Baynes. Secretary and Accountant: A. W. Harlen. Sales Manager: W. T. Knight. Auditors: Troup, Harwood and Co. Bankers: Bank of New South Wales. Nominal Capital: £200,000. Subscribed Capital: £95,081. Reg. at Brisbane, 17/1/1903.

HARRIS, D. & CO., 140 Rundle Street, Adelaide, S.A. C.6122 (2 lines). Proprietors: D. T. Harris and S. D. Harris. Bankers; National Bank. Auditors: Troup Harwood and Co. Brisbane. Reg. at Brisbane, 17/1/03.

HARRISON, A. S. & CO. PTY. 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.

HARRIS, SCARFE LTD., Grenfell Street, Adelaide, S.A. Directors: P. J. A. Lawrence (Chairman), Harold Law-Smith, C. C. Deeley, F. E. Robertson, F. W. Trowse. Secretary: L. B. Daymond. Accountant: S. W. Thorpe. Sales Manager: A. F. Baggott. Auditors: Annells, Powell, Tilley, Wiltshire and Co. Bankers: The Bank of Adelaide. Capital, Nominal £875,000, Paid-up £741,606/10/-. Reg.: Adelaide, October, 1920.

HARTLEY'S PTY. LTD., 270 Flinders Street, Melbourne, Vic. Directors: J. B. Young, Magnus Cohn, H. M. Murphy, F. W. Spry, H. W. Joseph. Managing Director, H. W. Joseph. Auditors: Morton, Watson and Young. Bankers: Commercial Banking Co. of Australia. Capital, £100,000 fully subscribed. Company established 1896.

HEALING, A. G. LTD., 167-173 Franklin Street, Melbourne, C.1., Vic. Directors: A. G. Healing, N. Broomhall, C. Forbes, W. W. Devling, V. R. Powell, E. M. Dumbrell. Governing Director, A. G. Healing; Managing Director, N. Broomhall. Secretary and Accountant, C. Forbes. Sales Manager, G. Atkinson. Auditors, Edward Holmes, F.C.A. (Aust.), Arthur B. Kaines, A.C.A. (Aust.). Bankers: E. S. & A. Bank Ltd. Capital: Nom. £412,000. Subscribed, £320,000. Registered as Proprietary Company 11/7/1912. As Public Company, 1/7/'27, Melbourne.

HEIRON & SMITH (SALONOLA), 91 Hunter Street, Newcastle, N.S.W. (Box 32 P.O., Newcastle). Manager, G. B. Parry. Auditors, L. E. Thompson. Bankers, Commercial Bank of Sydney Ltd. Registered 19/5/'34.

HOMECRAFTS PTY. LTD., 211 Swanston Street, Melbourne, Vic. Managing Director: Sladen Gibson. Secretary: L. Naismith. Country Sales Manager: D. Campbell . City Sales Manager: R. Blackwell. Bankers: National Bank.

HUDSON, EDGAR V. PTY. LTD., 284-6, Edward Street, Brisbane, Q. Director, Fred. Hoe. Secretary, W. A. Hubner. Set Sales Manager, H. T. Sharpe; Radio Goods, E. Cantellin; Communications, Fred. Hoe Jun.; C. Knowles, Cinema. Auditors, R. F. G. Wilson, National Mutual Buildings, Queen Street, Brisbane. Bankers: Commercial Bank of Australia Ltd. Capital: Nominal £25,000. Subscribed, £12,600. Registered Brisbane, 1930.

IMPLSX LIMITED (late New Herberholds). Head Office, 431 Hoddle Street, Abbotsford, N.9, Vic. Directors: G. F. Griffith, S. M. Winter, W. F. Winter. Managing Director, W. F. Winter. Secretary and Accountant, N. P. Womersley. Auditors, Spry, Fookes and Co., 405 Collins Street, Melbourne, C.1. Bankers: Commercial Bank of Aust. Ltd., 272 Smith Street, Collingwood. Capital: Nominal, £100,000; Subscribed, £22,235. Registered Melbourne, 4/11/1935.

INTERNATIONAL RADIO CO. PTY. LTD., 254 Castlereagh Street, Sydney, N.S.W. Directors, C. E. Forrest (Managing), C. G. Salmon, W. J. Eilbeck, H. B. Gibbons. Acting Secretary, Leslie D. Goodsall. Accountant, A. E. Reading. Sales Manager, C. G. Salmon. Auditors, Lord, Mackay and Co. Bankers, Bank of New Zealand. Private company. Registered Sydney, 18/10/1924.

INTERNATIONAL RESISTANCE CO. (A/SIA) LTD., 55 Addison Road, Marrickville, N.S.W. BW 2385-6. Directors: Wm. J. McLellan and Maxwell Walker. Secretary, G. E. Lucas. Nominal Capital: £5,000. Reg. November, 1934.

IRVINE RADIO & ELECTRICAL CO., Perry House, Elizabeth Street, Brisbane, Q'land. Proprietor: D. Irvine. Bankers: Union Bank of Australia Ltd. Reg. in Brisbane, 2/3/36.

JAMES & VAUTIN, 661 George Street, Sydney. General Manager: C. H. Vautin. Accountant: H. D. Vautin. Sales Manager: K. W. Ritchie. Auditors: Offner Hadley & Co: Bankers: Commonwealth Bank, Haymarket Branch.

KOHN BROS. PTY. LTD., 118 York Street, Launceston, Tas. Directors, G. B. Kohn and E. H. Kohn. Managing Director, G. B. Kohn. Secretary and Accountant, D. L. Forrest. Auditors, Manthieu Rose and Co., Launceston. Banks: E. S. and A. Bank Ltd., Launceston. Capital: £2,000. Registered 3/8/1933, Tasmania.

KRIESLER (A/SIA) LTD., Head Office, cnr. Pine and Myrtle Street, Chippendale, N.S.W. Nominal capital: £10,000. Chairman of Directors, P. G. Tuit.

LEKMEK RADIO LABORATORIES, 75 William Street, Sydney. FL 2626 (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 and Sons. Reg. 1931 in Sydney.

LENROC LIMITED, 211 Pulteney Street, Adelaide, S.A. Directors: P. Moody, F. W. Cornell (Chairman), W. E. H. Davey. Managing Director: P. Moody. Secretary: L. G. Watson. Accountant: Miss A. Taylor. Sales Manager: C. M. Moyse. Auditors: Counsell, Booth and Hunwick. Bankers: Bank of Adelaide. Reg. at Adelaide, 16/7/1924.

COMMERCIAL INFORMATION, Etc.

MANTLE, JOHN & CO., 804 Hay Street, Perth, W.A. Proprietor: John Mantle. Secretary: M. Eastoe. Accountant: N. Mantle. Sales Manager: F. Gordon. Auditors, W. Hayes and Co. Bankers: E. S. & A., Hay Street.

MARTIN, JOHN LTD., 116-118 Clarence Street, Sydney. Managing Director: John Martin. Secretary: W. E. Lemon. Sales Manager: J. R. Lamplough. Auditors: Robertson, Rudder and Watt. Bankers: Bank of New Zealand. Nominal Capital: £5,000. Subscribed Capital: £2,300. Reg. in Sydney, 1/8/1935.

MARTIN de LAUNAY LTD., 287-289 Clarence Street, Sydney. Directors: A. E. Martin, E. de Launay, E. P. Logan. Managing Director: E. P. Logan. Secretary: G. O. Suttor. Accountant: E. Reeve. Sales Manager: G. Mitchell. Auditor: W. J. South. Bankers: Bank of Australasia. Capital: £20,000. Reg. in Sydney, 16/11/-1923.

McCANN BROS., 180 Elizabeth Street, Sydney, N.S.W. Proprietors: B. A. and L. C. McCann. Secretary: A. Viney. Accountant: H. Thompson. Sales Manager: H. Rough. Auditors: I. W. Shottswood. Bankers: National Bank of Australia.

McCOLL ELECTRIC WORKS PTY. LTD., 104-112 Moor Street, Fitzroy, Vic. Directors: Professor Henry Payne (Chairman); Professor W. N. Kernot, L. Moran, N. D. MacDonald, Major E. H. W. Westwood. Managing Director, E. H. W. Westwood. Accountant, Miss L. Grace. Sales Manager and Engineer, L. D. Kemp. Auditors, S. B. Holder, O.B.E., Collins House, Melbourne. Bankers: Commercial Banking Co. of Sydney Ltd. Capital: £70,000. Registered Melbourne, 1922.

McLELLAN, Wm. J. & CO., Bradbury House, 55 York Street, Sydney. Proprietor: Wm. J. McLellan.

MELTRAN ENGINEERING PTY. Ltd., 8-10 Scotia Street, North Melbourne, N1, Vic. Directors: R. Lewis, R. Peterson. Managing Director: R. Lewis. Accountant: O. W. Parkinson, Bank House, Melbourne. Bankers: Commercial Banking of Sydney Ltd., North Melbourne.

MICA AND INSULATING SUPPLIES CO., 562-4, Bourke Street, Melbourne, Vic. Partners, J. W. Griffiths, G. W. Griffiths, W. C. Pitcher. Bankers: Bank of New South Wales, Collins Street, Melbourne. Registered at Melbourne.

MUSGROVES LTD., Lyric House, 223 Murray Street, Perth, W.A. Directors: M. D'O. Musgrove H. B. Jackson. F. C. Kingston. Managing Director, M. D'O. Musgrove. Secretary and Accountant, Robert Peart. Auditors: Flack and Flack. Bankers: Commonwealth Bank of Australia. Nominal Capital: £100,000. Subscribed Capital: £70,000. Registered 14/11/'23, Perth.

NALLY LIMITED, 15 Castlereagh Street, Sydney. Directors: Messrs. Dowd, McCullagh, Davis, Finigan. Managing Director and General Manager: A. A. Kelly. Secretary: H. R. Griffith. Accountant: C. J. Grill. Sales Manager: R. L. Fountain. Auditors: S. H. Jackson and Co., 160 Castlereagh Street, Sydney. Bankers: Bank of N.S.W. Nominal Capital: £50,000. Subscribed Capital: £35,000. Reg. in Sydney, October, 1930.

NATIONAL RADIO CORPORATION LTD., 96 Pirie Street, Adelaide, S.A. 'Phone C.1780 (2 lines). Directors, E. R. Smith, Oswald Smith, G. J. Smith, W. Smith. Accountant and Secretary: John A. Schird. Auditors: W. H. O'Flaherty. Bankers: National Bank of Australasia, Rundle Street, Adelaide. Nominal Capital, £5,000. Registered 16/3/1933, Adelaide.

NEW SYSTEM TELEPHONES PTY. LTD., 276 Flinders Street, Melbourne, Vic. Directors, R. H. Butler, J. I. Carroll, T. Brentnall and W. A. Elder. General Manager, J. I. Carroll. Secretary, W. A. Elder. Accountant, C. W. Pearson. Sales Manager, R. M. Davies. Auditors, R. W. Nelson and Co. Bankers: Commercial Bank of Australia Ltd., and Bank of New South Wales. Capital: Nominal, £150,000. Subscribed, £100,500. Registered 10/11/1920. Melbourne.

NEWTON, McLAREN LIMITED, 17 Leigh Street, Adelaide, S.A. Directors: Sir Howard W. Lloyd (Chairman), Arnold M. Moulden, John P. Hale. General Manager: J. P. Hale. Secretary: H. E. Morgan. Auditor: Chas. J. Horrocks, A.I.A.S.A. Bankers: E. S. & A. Bank Ltd. Nominal Capital: £50,000. Subscribed Capital: £27,000. Reg . in Adelaide, 13/2/1905.

NOYES BROS. (SYDNEY) LTD., 115 Clarence Street, Sydney. Directors: E. F. Moates, E. R. Mitchell, W. S. Jones, Mrs. C. C. Noyes. Managing Director: T. Malcolm Ritchie. Secretary: W. J. Wilson. Bankers: Commercial Bank of Australia Ltd. Auditors: E. S. Wolfenden. Solicitors: Stephen, Jacques and Stephen. Nominal Capital: £100,000. Paid-up Capital:. £99,993. . Reg.. in. Sydney, 3/9/1907.

OHMEGGA RESISTORS (AUST.) PTY. LTD., 21 Station Street, Carlton, N.3., Vic. Directors, S. P. Stroud, E. Petterson, R. Ramelli. Manager, Secretary and Accountant, S. P. Stroud. Bankers: Commonwealth Bank of Australia, Collins Street, Melbourne. Nom. Cap., £5,000. Sub. Cap.: £3,000. Registered 25/2/'35, Melbourne.

OSBORNE, ALEX. PTY. LTD., Head Office, corner Wilmot and Mount Streets, Burnie, Tas. Managing Director, Alex. Osborne. Accountant, Miss A. L. Sharpe. Auditors, A. Nicol. Bankers: Commercial Bank of Australia. Capital: £8500. Registered Hobart (approx. 1927).

PARSONS & ROBERTSON LTD., 172-174 Pulteney Street, Adelaide, S.A. Directors: F. L. Parsons, H. A. Power, W. L. Parsons. Managing Director: F. Lancelot Parsons. Secretary: A. L. De Laine. Accountant: W. D. H. Thomas. Sales Manager: R. J. Pain. Auditor: E. A. Gibson, A.C.U.A., A.I.C.A., A.A.I.S. Bankers: English, Scottish and Australian Bank Ltd. Nominal Capital: £40,000. Subscribed Capital: £23,027. Reg. in Adelaide, 23/3/1937.

THE PATON ELECTRICAL INSTRUMENT CO., 90 Victoria Street, Ashfield, N.S.W. UA1960.. Proprietor, Frederick H. Paton. Bankers: Bank of N.S.W., Ashfield. Reg. at Sydney, 23/4/'35.

PETERMAN, W. E., 160 Edward Street, Brisbane, Q'land. Proprietor: W. E. Peterman. Secretary: E. Read. Auditor and Accountant: E. N. Ham. Sales Manager: C. Watson-Will. Bankers: Bank of N.S.W. Capital: £4,000. Commenced business 23/7/-1923.

PHILCO RADIO & TELEVISION CORPORATION (AUST.) PTY. LTD., Joynton Avenue, Waterloo. Directors: J. I. Carroll, R. H. Butler, J. M. Macfarlane, J. K. Schartl. Secretary: W. A. Elder. Sales Manager: E. M. Searson.

PHILIPS LAMPS (A/SIA) LTD., Philips House, 69-73 Clarence Street, Sydney. Managing Directors: A. den Hertog, J. A. Overdiep. Secretary: H. E. Scott.

PRITCHARD, J. G. LTD., 18 William Street, 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 and Wheatley. Auditors: S. F. Anderson and Co. Reg. Perth, 1934.

RADIO CORPORATION PTY. LTD., 21 Sturt Street, South Melbourne, Vic. Joint Managing Directors: Louis Abrahams and A. G. Warner. Secretary: N. D. Gray. Sales Manager: C. V. Eutrope. Nominal Capital: £100,000. Subscribed Capital, £52,950.. Bankers: National Bank of Australasia Ltd., Melbourne, London. Solictors: Herman and Coltman.. Auditor: G. Wright, Chartered Accountant (Aust.), 440 Little Collins Street, Melbourne. Reg. Melbourne 1/7/1923.

COMMERCIAL INFORMATION, ETC.

RADIO MERCHANTS LTD., Australia House, Carrington Street, Sydney. N.S.W. Directors, E. D. Huckell. F. Webb, F. Clay, R. Green; Managing Director, R. A. Wright. Auditor: A. Arrand. Bankers: Union Bank of Australia. Nom. Cap.: £10,000 £1 shares. Reg. 19/9/1933.

RADIO WHOLESALERS LTD., James Place, Adelaide, S.A. Directors: A. D. Young (Chairman); J. A. Hele, H. R. Pinkerton (Managing), W. Queale. Manager, A. E. Stephen. Secretary, A. J. Carvosso. Accountant, L. R. Askland. Auditors: Counsell, Booth and Hunwick. Bankers, Bank of New South Wales, Adelaide. Registered Adelaide, 2/8/'32.

RADIX POWER SUPPLIES, 64 Lawler Street, Subiaco, W.A. Proprietor: E. A. Dix.. Reg. 1/10/35.

R.C.S. RADIO, Head Office, 26 Ivy Street, Darlington, N.S.W. Proprietor: Ronald A. Bell. Reg. 28/7/'32.

RICKETTS & THORP PTY. LTD., Hatterley Street, Rockdale, N.S.W. Directors, G. S. Ricketts and F. Thorp; Secretary and Accountant, Miss M. McLauchlan; Sales Manager, E. A. Maulen. Auditors: G. A. Beackett and Lewis. Bankers: Commercial Bank of Aust. Ltd. Nominal Capital: £50,000. Sub.-Capital: £37,000. Reg. 26/3/20.

ROLA CO. (AUST.) PTY. LTD., 77-83 City Road, South Melbourne, SC4, Vic. Managing Director: A. L. C. Webb. Manager and Secretary: R. H. Yeend.

ROSENSTENGELS PTY. LTD., 482 Ruthven Street, Toowoomba, Q'land. Directors: E. M. Rosenstengel, A. G. Rosenstengel, F. O. Rosenstengel. Managing Director: E. M. Rosenstengel. Secretary and Accountant: J. McMaster. Auditors: Symington and Fowler. Bankers: Union Bank of Australia. Nominal Capital: £50,000. Subscribed Capital: £32,000. Reg. as Joint Stock Company, 28/9/1913; as Private Company, 1931.

SCOTT & HOLLADAY TLD., 35 Clarence Street, Sydney, N.S.W. Directors: G. L. Murray, Wm. Arnott, E. A. Richards. Managing Director: G. L. Murray. Secretary, E. McCooey. Accountant, G. A. Rogers. Auditors: Milne and Perrett, 56 Hunter Street, Sydney. Bankers: E. S. & A. Bank, King and George Streets, Sydney. Capital: £5,000. Reg. 1/4/1913, Sydney.

SAVERY'S PIANOS LTD., 29 Rundle Street, Adelaide, S.A. Directors: A. D. Young (Chairman), H. R. Pinkerton (Managing Director), W. Queale, J. A. Hele. Secretary, A. J. Carvosso; Accountant, L. R. Ackland. Auditors, Counsell, Booth and Hunwick. Bankers: Bank of New South Wales. Capital: Nom., £50,000; sub., £40,625. Registered, Adelaide, 22/9/-'22.

SIMPLEX PRODUCTS PTY. LTD., 716 Parramatta Road, Petersham, N.S.W. Directors, H. J. Hankin and G. Rich; Managing Director, H. J. Hankin; Secretary, Accountant and Sales Manager, G. Rich. Auditors: Smith Johnson and Co. Bankers: E. S. & A. Bank, Ashfield branch. Nominal Capital £20,000. Sub-Capital £4,000. Reg. Sydney, 7/4/'37.

SLADES RADIO, Lang Street, Croydon, N.S.W. UJ5381-2. Proprietor, Charles W. Slade. Secretary, M. Featherstone. Auditors: Klynock and Ligman. Bankers: Commonwealth Bank. Registered 20/5/'25.

SMITH SONS & REES PTY. LTD., 30-32 Wentworth Avenue, Sydney. Managing Director: M. W. Rees. Secretary: C. H. French. Sales Manager: E. A. McLean.

STERLING RADIO PTY. LTD., 27-39 Abercrombie Street, Sydney, N.S.W. M 3261 and MA 5130. Directors: J. M. Tait, C. E. Tait, R. G. Ely. Secretary, F. Howe Talbot. Nominal capital, £5,000. Bankers: Bank of N.S.W. Auditors, Ludowici and Caldwell. Solicitors, Boyle and Co. Registered in Sydney, 11/5/'34.

STOTT & HOARE TYPEWRITERS LTD., 55 William Street, Perth, W.A. Directors: S. A. Stott, H. Stott, F. B. South. Manager: A. J. Case. Auditors: S. V. Eaton. Bankers: National Bank of Aust. Ltd. Reg. Perth.

SYME, W. A. & CO., Cnr. Liverpool and Bourke Streets, East Sydney. Proprietor: W. A. Syme. General Manager: R. Syme. Accountant: N. Shaw. Bankers: Bank of N.S.W., William Street, Sydney. Reg. in Sydney, November, 1930.

TRACKSON BROS. PTY. LTD., 157-9 Elizabeth Street, Brisbane, Q. Directors, P. S. Trackson, J. Trackson, A. A. Ewing. Managing Director, Philange S. Trackson. Secretary, A. A. Ewing. Accountant, K. J. W. Lewis. Auditors: G. S. Hutton and Macfarlane, Queen Street, Brisbane. Bankers: National Bank of Australasia Ltd., Eagle Street, Brisbane. Registered Brisbane. Established 1883.

THOM & SMITH LTD., 29-39 Botany Road, Mascot, N.S.W. Directors: F. W. P. Thom, J. E. Smith. Secretary: S. T. Lindsay. Sales Manager: R. H. Jennings.

TRAVELTONE RADIO PTY. LTD., 113 Clarendon Street, South Melbourne, S.C.5, Vic. Directors: G. Scott, D. Monffort, C. Solomon. Manager: C. Solomon. Secretary: H. Melville. Accountant: R. Thomas. Sales Manager, A. Walters. Auditor: A. R. Holmes. Bankers: Commercial Banking Co. of Sydney. Capital: £2000. Reg. 16/4/32 as Radio Maintenance Pty. Ltd. Name changed to Traveltone, 23/3/36.

UNITED RADIO DISTRIBUTORS PTY. LTD., 234 Clarence Street, Sydney. Managing Director: H. C. Long. Secretary: R. Mitchell. Sales Manager: W. J. Mawer. Auditors: Robert Mitchell and Bailey. Bankers: Bank of N.S.W., King and George Streets, Sydney. Nominal Capital: £5,000. Reg. in Sydney, 15/10/35.

VEALL, A. J. (AGENCIES) PTY. LTD., 127 York Street, Sydney. Directors: A. J. Veall, H. V. Prior, R. K. McDougall, S. G. Humberg. Sydney Manager, Sales Manager and Secretary: W. Blackmore. Accountant: B. Vyner. Auditors: Stuckey and Colvin. Bankers: Commercial Bank of Aust. Ltd. Reg. in Sydney.

VESTA BATTERY CO. PTY. LTD., 2-14 George Street, Leichhardt, N.S.W. Director, A. R. Allen, S. Airens, F. S. Kelynack, L. E. Easy; Managing Director, A. R. Allen Secretary and Accountant, P. Lovett, A.A.I.S.; Asst. General and Sales Manager, S. J. Bickerton. Auditors: E. S. Kelynack and Higman, 7 Wynyard Street, Sydney. Bankers: E. S. & A. Bank Ltd. Nom. Capital: £20,000. Reg. Sydney, 19/3/28.

WESTMINSTER RADIO TELEVISION CO. LTD., 26-28 George Street, Parramatta, N.S.W. Managing Director, C. Whatmuff. Bankers: Commercial Bank of Australia Ltd.

WARBURTON, FRANKI LTD., 307-15 Kent Street, Sydney, N.S.W. Directors: G. S. Warburton, R. J. N. Franki, F. J. Carrick. Managing Director: G. S. Warburton. Secretary: H. J. Rodgers. Auditors: Allard Way and Hardie. Bankers: Commercial Banking Co. of Sydney Ltd. Nominal Capital: £200,000. Sub-Capital: £100,000. Reg. 3/11/1910, Sydney.

WERRING RADIO CO., 213 Queensberry Street, Carlton, N3, Melb., Vic. Proprietor: O. C. Werring. Bankers: National Bank of Australia Ltd. Reg. in Melbourne 6/8/26.

WESTINGHOUSE SALES & ROSEBERY LTD., 13 Market Street, Sydney. Joint Managing Directors: F. G. Carr, W. V. Buzacott. Secretary: H. R. Gourlay, A.F.I.A., A.A.I.S. Auditors: Priestley and Norris. Bankers: Bank of N.S.W. Nominal Capital: £300,000, of which £250,000 Ordinary and £50,000 Preference Shares. Paid-up Capital: Ordinary £125,000 and £25,000 Preference. Reg. Sydney, N.S.W.

COMMERCIAL INFORMATION, ETC.

WESTCOTT HAZEL & CO. LTD., 225 Castlereagh Street, Sydney, N.S.W. Directors: E. J. Hazell, A. R. Booth, Dr. S. A. Smith, Managing Director, E. J. Hazell. Secretary, A. F. Loosen, F.A.I.S., and Accountant: Sales Director, A. R. Booth. Auditors: P. J. G. McGrath. Bankers: E. S. and A. Bank. Nominal capital: £200,000; Subscribed capital: £100,366. Registered Sydney, 15/6/1914.

WIDDIS DIAMOND DRY CELLS PTY. LTD., Park and Wells Street, South Melbourne, Vic. M 4601. Managing Director, Clive W. Evans. Secretary: G. O'Byrne. Sales Manager, C. Swift. Bankers: Bank of New South Wales.

WILKS, E. F. & CO. LTD., 124 Castlereagh Street, Sydney. Directors: H. J. A. Howes (Chairman), G. H. Horton, E. F. Wilks. Secretary: E. O'Bree. Accountant: E. D. Ousby. Sales Manager: E. C. Foot. Auditors: Dean Vick and Co. Bankers: Bank of N.S.W. Capital: £300,000. Reg. in Sydney, 1917.

WILLIAMS PTY. LTD., East Street, Rockhampton, Q. Managing Director: H. J. Williams. Secretary: S. C. Williams. Accountant, G. Pocock. Auditors: J. Kenna and Co., Queensland National Bank Ltd. Nominal Capital: £50,000. Sub-Capital: £31,835. Reg. Rockhampton.

WILLS & CO. PTY. LTD., 7 Quadrant, Launceston, Tas. Directors, N. A. Findlay, P. A. Findlay. Managing Director, N. A. Findlay. Secretary, N. Gray. Accountant, M. H. Joynt. Sales Manager, N. A. Findlay. Auditors, Cruickshank, Creasey Gow and Layh. Bankers: Bank of Australasia Ltd.

WYPER BROTHERS LTD., Bourbong Street, Bundaberg, Q. Directors: Chairman, Wm. Wyper; Managing Director, Wm. Jas. Harvey; R. G. Curtis and Douglas S. Wyper. Secretary and Accountant, Percival Moller. Sales Manager, Stuart C. Pettigrew. Auditors, J. S. Inglis. Bankers: Queensland National Bank. Nominal Capital: £100,000. Sub. Capital: £78,595. Registered 13/2/1924, Brisbane.

ZENITH RADIO CO. LTD., 37 Oxford Street, Paddington, Sydney, N.S.W. Directors: J. Alberti, J. Cairns. Managing Director: J. Alberti. Secretary: R. Evans. Accountant: G. Powell. Sales Manager: R. Evans. Auditor: G. Powell. Bankers: Union Bank of Australia Ltd. Capital: £5,000. Reg. Sydney.

Prominent Radio Traders

This list comprises the trading name, address and 'phone of prominent radio traders throughout Australia who have submitted their particulars for insertion.

BEGG, William and Sons, 343 Little Collins Street, Melbourne, Vic.

BRITISH GENERAL ELECTRIC CO. LTD., 393 Murray Street, Perth, W.A. Tel. B5141-3.

CARTER MOTORS & RADIO, Clarendon, S.A. Clarendon 12.

CLANCY BROS., Yambil Street and Banna Avenue, Griffith, N.S.W.

CROKE, C. M., Koorawatha, N.S.W. Tel.: 5.

DOWSE, E. A., E. H. (Radio Mechanic), Marsden Street, Boorowa, N.S.W.

DUNCAN & PEADON, Narrabri, N.S.W.

FIELDS, Cycle, Electrical and Radio Dealer, 142-144 Victoria Street, Mackay, Q'land.

GLEN INNES MOTORS, Radio Specialists, Grey Street, Glen Innes, N.S.W. Tel. 144.

GOULBURN RADIO HOUSE, Sales and Service. 78a Auburn Street, Goulburn. 'Phone: Day 930, night 240.

GUILLE & CO. LTD., 264-266 King Street, Newtown, N.S.W. L1227. Box 43 P.O. Newtown.

HARTLEYS PTY. LTD., 270 Flinders Street, Melbourne, C.1.

HEPPELL, C. L., Gnowangerup, Western Australia.

HIGRADE RADIO SUPPLIES (W. E. B. Menzel). Box 196, Hamilton, Vic.

HINTERMAN, J. R., 32 Arden Street, Clovelly, N.S.W.

HOLT, E. A., 77 Stanley Street, South Brisbane. (Also at Logan Road, Stone's Corner, Brisbane), Q'land.

HUCKELL RADIO ("Radio Patrol"), 285 Military Road, Cremorne. Y5086.

IRVINE RADIO & ELECTRICAL CO., 1st Floor, Perry House, Elizabeth Street, Brisbane, Q.

JOHNS, R., Radiotrician, 194 Pakington Street, Geelong West, Vic. Tel. 2715.

JUNCTION RADIO (A. N. Hopkinson), 336 Oxford Street, Woollahra. FW 4365.

LANDERS, L. B., Castlereagh Street, Coonamble, N.S.W.

MILTON'S RADIO & ELECTRICAL SERVICE, 100 Church Street, Mudgee, N.S.W.

PELL, E. M. B., Carp Street, Bega. N.S.W. Box 28 P.O., Bega. 'Phone 5 and 201.

PIDGEON, Arthur, 818 Hay Street, Perth, W.A.

RAPLEY & WHYTE, Tocumwal, N.S.W.

ROGERS & KING, Box 61, Goondiwindi, Texas and St. George, Q'land.

ROSE, R. W. Eagle Street (Box 84), Longreach, Q'land.

ROSENSTENGELS PTY. LTD., Ruthven Street, Toowoomba, Q'land.

RYMOLA RADIO & ELECTRICAL PTY. LTD., 411-413 Adelaide Street, Brisbane, Q'land. Tel. B6341 and J6864.

WHO'S WHO IN THE AUSTRALIAN RADIO INDUSTRY

A

AARONS, Albert: Director Eclipse Radio Pty. Ltd., Melbourne. Founded Eclipse Radio Pty. Ltd., with nephey Saul, 1926. Private address: 279 Beaconsfield Parade, Middle Park. Born 24/5/1892.

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. Private address: 3 Vautier Street, Elwood.

ABRAHAMS, Louis: Educated at Melbourne Grammar School. Served 4 years with A.I.F. in France. A Director of Neutrodyne Pty. Ltd., Radio Corporation Pty. Ltd., Universal Guarantee Ltd., Homecrafts Pty. Ltd., and a number of other companies. Has been associated with radio since 1922. Is most interested in flying and has won a considerable number of trophies in this field. Introduced the Astor Radio Landing Ground Campaign in 1927-28, which was of considerable interest around the country areas of Victoria. Was chief executive in Louis Cohen Wireless Co., which was the biggest distributor of radio parts in Australia. This company eventually bought out Radio Corporation in 1930, and he is now Joint Managing Director of that company.

ALBERTI, Jose: Director since inception of Zenith Radio Co. Ltd., 37 Oxford Street, Paddington. Became associated with radio when founding the Acorn Pressed Metal Co. Ltd. Clubs: R.A.C.A., S.A.S.C., E.S.I.H.C. Private address: 78 Lang Road, Centennial Park. Born Spain, 10/10/'99.

ALLEN, Arthur Robt.: General Manager, Vesta Battery Co. Pty. Ltd., Leichhardt, N.S.W. Private address: 9 Blaxland Road, Bellevue Hill, and Noble Street, Mona Vale. Clubs: Legacy, Bonnie Doon Golf Club.

ALLSOP, Raymond Cottam: Director and Chief Engineer, Raycophone Ltd., 62 Booth Street, Annandale. Fellow Society of Motor Engineers, America, Councillor and Member, Institution of Radio Engineers (Aust.). One of the early 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 Randwick, March 11th, 1898. Recreation: Golf.

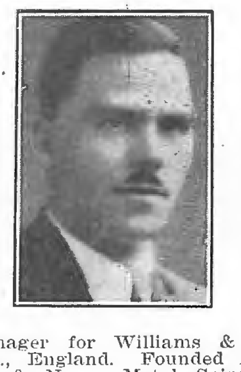
ANDERSON, Hans Christian: Director, H. C. Anderson and Frantzen, Johnson Street, Alexandria, manufacturers of wireless cabinets. Private address: 10 Sellwood Street, Brighton-le-Sands, N.S.W.

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.): Manager of Communications, 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 Beam Wireless investigation. 1937 in England. Born 24th March, 1887.

ARMSTRONG, Oscar Reginald: Secretary, the Ever Ready Co. (Aust.) Ltd., Harcourt Pde., Rosebery, N.S.W. Educated Sydney Grammar School. Joined Ever Ready Co. 7/1/'33. Private address: 2 The Vanderbilt, Bennett Street, Bondi, N.S.W. Recreations: Wrestling, walking and swimming. Born 30/1/'04.

ARNOLD, J.: Managing Director Arnold and Beard Ltd., 632, Botany Road, Alexandria, New South 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 Street, Manly.

B

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.

BAIN, J. W. Duncan, Superintendent Philco Radio and Television Corp. (Aust.) Pty. Ltd., Joynton Avenue, Waterloo. Was with British General

Electric Co., in junior capacities in Sydney, subsequently became Departmental Manager in Melbourne. Joined New System Telephones Pty. Ltd., Melbourne in 1927, as Radio Sales Manager, subsequently handling their country refrigeration activities as well. Appointed to present position, March, 1937. Private address: 32 Pine Avenue, Five Dock, N.S.W. Born 27/4/'04, Sydney.

BAIRD, William Reginald, A.M.I.R.E. (U.S.A.): Amalgamated Wireless (A/sia) Ltd., 47 York Street, Sydney, N.S.W. Joined A.W.A. Marine Service, 1921. Transferred Coastal Radio Service in 1926, and later to technical section of Broadcasting Department. Transferred Head Office Engineering Department 1932. Private address: 687 Old South Head Road, Rose Bay. Born Fremantle, 1902.

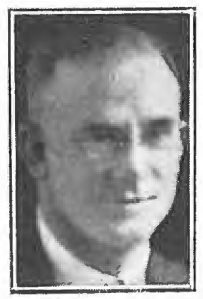
BAKER, Wiliam George, B.Sc., B.Eng., D.Sc. Eng.: Superintendent Technical Engineering Section of Marconi School of Wireless. Gained Deas-Thomson Scholarship for Physics, 1920. Graduated Bachelor of Science 1921 with University Medal for Mathematics and Honours in Mathematics and Physics. Graduated Bachelor of Engineering 1923 with first class Honours and University Medal. Became demonstrator in Physics in 1923, and science research scholar in 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, 1927-28. Radio Research Officer, Council of Science and Industrial Research, 1928-31. Joined Amalgamated Wireless 1931. Graduated Dr. of Science and Engineering Sydney University 1932. Born 27th May, 1902, South Australia.

BATES, Arthur V.: Factory Superintendent, Lekmek Radio Laboratories. 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.

BEAMES, Eric: Manager, Philips Lamps A/sia Ltd., Newcastle Branch. 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, Leslie Percival Reed, A.M.I.E.E., M.I.E.E. (U.S.A.), M.Inst.R.E., Aust., Electrical Engineer: Chairman and Managing Director, Stromberg-Carlson (A/sia) Ltd., Est. 1927, 72 William Street, Sydney, N.S.W. Councillor, N.S.W. Chamber of Manufactures; Pres. Australian



Radio Manufacturers' Patents Assn. Ltd.; Vice-Pres. Radio and Telephone Manufacturers' Association; Vice-Pres. I.R.E. Aust. Born Melbourne, Vic., 7th May, 1884. Educated Melbourne Technical College, Melbourne, Vic., and West Australian University, Perth, W.A. Commenced career as an electrical engineer in 1904 with Federal Public Service, P.M.G.'s Dept., and subsequently specialised in Telegraph and Telephone Engineering. In 1907 appointed Assistant Engineer for Country Lines, Victoria. In 1908 appointed First Assistant to Chief Electrical Engineer, Melbourne, Vic., and in 1912 Engineer for Lines, Perth, W.A. Appointed State Supervising Engineer in charge of Northern Division of N.S.W. 1914, and for one year prior to resigning in 1919 Acting Deputy State Engineer, Sydney, N.S.W. In 1919 founded L. P. R. Bean & Co. Ltd., of which he was Governing Director. Representing Stromberg-Carlson Telephone Manufacturing Co. of Rochester, New York, U.S.A., and other American and English concerns. In 1923 he established the first Australian factory for the mass production of Telephone apparatus. In the same year he, with others, founded the first Australian Broadcasting Station 2BL, and was Chairman of Directors for 5 years. This station being later absorbed by the Australian Broadcasting Commission. In 1927 he entered into partnership with Stromberg-Carlson Telephone Manufacturing Co., of Rochester, N.Y., U.S.A., when they founded the firm of Stromberg-Carlson (Australasia) Limited, which company incorporated L. P. R. Bean & Co. Ltd., he being appointed Chairman and Managing Director of the new concern. Clubs: Tattersall's and R.A.C.A. Recreations: Golf and caravanning. Home address: "Rochester," Orana Ave., Pymble, N.S.W.

BEARD, Edwin, H.F.I.I.A., A.A.I.S., F.S.B.M., F.C.I.: Director and Secretary, Arnold & Beard Ltd., 632 Botany Road, Alexandria, Sydney. 14 years Manager, W. G. Huthwaite & Co., Wagga Wagga. In January, 1935, joined Mr. Arnold and formed Arnold & Beard Ltd. Private address: 13 James Street, Manly. Recreations: Bowls and photography. Born July 23, 1885.

BEARD, Ernest Gordon, M.Inst.R.E. Aust.: Director Ace Amplifiers Ltd., 10 Grosvenor Street, Neutral Bay. 1914, joined R.N. for wireless work; 1919, Christiana W.T. Station, Jamaica, experimental work R.N. Signal School, Devonport. 1920, transferred R.A.N. 1924-29, Chief Engineer, United Distributors Ltd.: 1930, President Wireless Institute of Australia (N.S.W. Div.). 1931, Chief Engineer and Managing Director Ace Amplifiers. Built original 2GB and 2KY broadcasters. Patentee of numerous inventions. Private address: 14 Dalkeith Street, Northbridge. Born March, 1897, Derby, England.

BEGG, Reginald H.: Proprietor William Begg & Sons, 343 Little Collins Street, Melbourne, C.1. B.E. (Adelaide), F.S.A.S.M. (Adelaide), A.M.I.E. (Aust.). Member Institution of Engineers of Australia. Was with Australian Metal Co. Ltd., as Assistant Engineer; Strachan Murray and Shannon, Ltd., Engineer and Manager; Director and Manager of Lascelles Parrington Ltd.; Past President, Victorian Radio Association. Private address: 6 Yarradale Road, Toorak, Vic. Born 31/3/1889, Adelaide.

BELL, Norman McLeod, M.I.M.E., A.M.I.C.E., A.I.E.E., and M.I.E. (Aust.): Chairman and Managing Director, Norman Bell and Co. Pty. Ltd., 403 Adelaide Street, Brisbane, Q. Educated Brisbane Grammar School. Five years apprenticeship in Queensland and seven years in Glasgow at College, and obtaining engineering experience. On returning to Queensland acted as consulting engineer for four years before founding present company. Past Chairman of Queensland Division, Institution of Engineers, Australia. Clubs; Brisbane, Johnsonian, United Services, Constitutional. Private address: "Hazelwood," Beaconsfield Street, Brisbane. Born Glasgow, Scotland.

BELL, Ronald Albert, A.Inst. R.E., Aust.: Proprietor R.C.S. Radio, 26 Ivy Street, Darlington, N.S.W. Member of Royal Motor

Yacht Club. Licensed Electrician, engaged in radio elec. eng. since 1919. Founded R.C.S. Radio in 1932. Private address: "Birrilee," Walsham Parade, North Bondi. Born 13/1/1902. Recreations: Angling, fish breeding and speed boat racing.

BICKERTON, Stephen J.: Assist. Gen. Man. and Sales Manager, Vesta Battery Co. Pty. Ltd., Leichhardt, N.S.W.

With Nicholson's (London), 1917. H. J. Hapgood (Manufacturers' Products Pty. Ltd.), 1926. Joined Vesta, 1928. Private address: 45 Tunstall Ave., Kingsford, N.S.W. Recreations: Golf and tennis. Born London, 24/4/'02.

BLACKMORE, W.: Appointed Manager, A. J. Veall (Agencies) Ltd., Sydney, 1/7/'35. Original 4th Bn. Anzac. Born Nowra, N.S.W., 2/5/1893. Recreations: Golf and swimming.

BLAND, William Joseph, M.Inst.R.E. Aust.: Proprietor and Manager Bland Radio, Coromandel Place, Adelaide. Born in India, 1902. Educated St. Joseph's College, Conoor, India. Commenced in radio with Wireless Supplies Ltd. Commenced own business as Harland Radio Co. in 1925. Commenced the firm of Bland Radio in 1927. Owned Amateur Station S173, later 5AG. Foundation member S.A. division of Wireless Institute of Australia. Chief Petty Officer, Royal Australian Naval Reserve, Wireless Division. 1st class operator's ticket 1921. Private address: 28 Brandreth Street, Tusmore, South Australia. Born 27/9/'02 Conoor, India.

BORTHWICK, Kevin Bernard: Partner, Borthwick Everitt & Co., 33 Mountain Street, Broadway, Sydney. With the Raycophone Co. as Engineer for five years, and with Amalgamated Wireless for six years. Private address: 33 River Road West, Lane Cove, N.S.W. Born 20th February, 1908, at Bingalow.

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.

BOULTON, Richard John: (Late Manager Radio Department, G. J. Grice Ltd., 90-92 Queen Street, Brisbane.) Joined up in radio in 1925. Wide experience in design and construction of receivers. Held sales executive positions in Sydney and Brisbane. Radio manager for G. J. Grice Ltd., Brisbane, in July, 1933, until May, 1937. Private address: "Enselle," Toorak Road, Hamilton, Brisbane. Born Sydney, 14/9/'01.

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., 108/10, Elizabeth Street, Melbourne, C.1. Also Managing Director of Brash's Electric Pty. Ltd. President Victorian Radio Association 1933 and 1934. Vice-president, 1937. Clubs: Naval and Military Club, Victoria Golf Club, Sorrento Golf Club. Private address: "Lindfield," Mandeville Crescent, Toorak, Vic. Born Melbourne, 2/8/1881.

BRITON, John Noel: Partner and Chief Engr. Briton Elect. & Radio Pty. Ltd., 152 Parramatta Road, Petersham, N.S.W. Graduate of Sydney University. B.E. (first class honours in Electrical Engineering), B.Sc., Councillor and M.Inst.R.E.,

BRITON, J. N. (Cont.)

Aust., chairman Examinations Board I.R.E., A.M.I.E.Aust. Born 1907. Private address: 5 Brand Street, Artarmon.

BROAD, Archibald Du Bourg: Secretary Victorian Radio Association and Manager Electrical Federation (Victoria) since 1928. Recreations: Sport and golf.

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. Recreation: Reading. Born 11th Feb., 1899.

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.

BROWN, Stafford Meredith: Sales Manager, Amalgamated Wireless (A/sia) Ltd., Melbourne. Graduated Marconi School of Wirelss, Sydney, and joined A.W.A. 1915. Transferred to Sales Department (Melb.), 1924. Born 20th January, 1896, Narrabri, N.S.W. Private address: 12 New Street, Surrey Hills, Vic.

BROWN, Basil F. A.: Technichal Staff, Thom and Smith (Tasma). Lieutenant, 2nd Div. Signals. Educated North Sydney Boys' High School. Born 18/10/'09. Private address: 26 Longueville Road, Lane Cove, N.S.W.

BROWN, Harold Percival, C.M.G., M.B.E., M.I.E.E.: Director-General, Postmaster General's Department, Commonwealth of Australia, Treasury Gardens, Melbourne. As a youth on the

WHO'S WHO (Continued.)

BROWN, H. P. (Cont.)

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 Dept. Appointed present position December, 1923. Born 28/12/1878.

BUCHANAN, N. H.: Director and Chief Engineer, Sterling Radio Ltd., 27 Abercrombie Street, Sydney. Previously

Chief Engineer, Zenith Radio, and Chief Engineer, Sydney Branch Eclipse Radio Pty. Ltd. Born 21/11/'04.

BUCK, A. H., Mem. Wireless Inst. of Aust.: Workshop Manager, Werring Radio Company, 213-215, Queensberry Street, Carlton, Melbourne. Started in radio business as a mechanic in 1926. Has operated amateur transmitters for over ten years. Private address: 47 Glenferrie Road, Glenferrie, Melbourne. Born Sale, 1905.

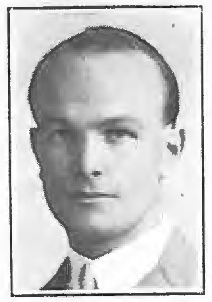
BUIK, Harold E.: Superintendent Marine Section Marconi School of Wireless. Joined Sydney branch of the M.I.M.C.

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 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.) M.Inst.R.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.

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 Aus-

tralian 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.

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. 1919-22 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.

BYERS, Geoffrey A.: Sales and Advertising Department, Lekmek Radio Laboratories, 75 William Street, Sydney. Private address: 6 Wallaringa Avenue, Neutral Bay. Recreation: Tennis.

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.

C

CALDER, J.: Amalgamated Wireless Valve Co. Ltd., 47 York Street, Sydney, N.S.W. Joined A.W.A., 1927—A.W. Valve Co., 1934,

CANNING, Frederick Gerald: M.Inst.R.E. Aust. Chief Radio Engineer, The Gramophone Co. (His Master's Voice), 2 Parramatta Road, Homebush, N.S.W.

1921-24 Marine Operator Amalgamated Wireless (A/sia) Ltd. 1930-31, was Chief Radio Engineer, Targan Electric Co., and Radiokraft Pty. Ltd., Melbourne until early 1937. Joined H.M.V. Sydney, 1937. Born, England, 16/3/1900.

CANTELIN, Eric H., Chief of Technical Staff and Radio Components Manager Edgar V. Hudson Pty. Ltd., 284-6 Edward Street, Brisbane, Q. Entered Australian Radio trade as technician with Radio Supplies Unlimited, T. & G. Building, in 1927. In the year 1928, joined Crammond Radio Manufacturing Co. as Technical Designer. 1930-32 Technical Editor, "Queensland Radio News." Entered into present position in 1930. Clubs: Gailes Golf Club, Constitutional Club. Private address: Blackett Street, Annerley. Born Worksop, Notts, England, 3/1/1910.

CASE, Alfred John: Manager Stott and Hoare Typewriter Co. Ltd., 55 William Street, Perth. Associated with Stott & Hoare Typewriters Ltd. for 23 years. Associated with radio for five years. Treasurer and member of Committee of W.A. Radio Traders' Association and Radio Exhibition. Member Mt. Yokine Golf Club. Private address: "Greenbanks," cnr. Walcott and Alexandra Drive, Mt. Lawley, W.A. Born Hobart, Tasmania, 3/1/'93.

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 interested in several Broadcasting Stations,

WHO'S WHO—(Continued)

CHAPMAN, Aubrey A.: In charge of radio sales and production section at Bloch and Gerber Pty. Ltd. 14 years radio

and electrical experience, Australian and American. Private address: 16 Ranger Road, 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 freelance journalist for many years; joined "The Listener-In" Editorial Staff 1933. Born Shepparton, Victoria, Nov. 11, 1907.

CHESTERFIELD, John Henry: Amalgamated Wireless (A/sia) Ltd., 47 York Street, Sydney, N.S.W. Engineer Operator P.M.G.'s Dept., 1914. Served in Royal Australian Naval Radio Service. Manager Radio Department James Marshall and Co. Ltd., Adelaide, 1923-5. With A.W.A. Coastal Radio Service 1925-35. Transferred to A.W.A. Special Products Dept., February, 1935. Private address: 45 High Street, Strathfield, N.S.W. Born 6/9/-1895, Avoca, Vic.

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.

CHILTON, Robert Ralph, Technical Dept., Mullard Radio Co. (Aust.) Ltd., 28 Clarence Street, 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 Avenue, Warrawee, N.S.W.

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, Fred W.: Managing Director Continental Carbon Co. Pty. Ltd., Melbourne. Commenced manufacturing "Ad-

vance" radio products in 1922. Business became Radio Corporation (Aust.) Pty. Ltd., in 1926. Manager of Radio Parts Dept. and Director of Tilbury and Lewis Pty. Ltd., 1927-33. Commenced Continental Carbon Co. Pty. Ltd. on return from America in 1934. Private address: 75 Ivanhoe Parade, Ivanhoe ('Phone Ivanhoe 791).

CLARKE, W. G.: Supt. Coastal and Island Radio Services, Amalgamated Wireless (A/sia) Ltd. Served O.I.C. Brisbane, Townsville and Perth Radio Telegraph Stations, 1912-20. 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 Manager. 1930, apptd. Adelaide Manager.

COLVILLE, Sydney: Councillor and Member Inst.R.E.Aust. Proprietor Colville Wireless Equipment Co. Pty. Ltd., 8 Small Street, Broadway, Sydney. Entered Radio field experimentally in 1911 and commer-

cially in 1921. Founder of Queensland Wireless Institute, 1914-19. Colville-Moore Wireless Supplies Ltd., 1921. Commissions: Technical Adviser to Siamese Government, 1928. 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.

CONLON, S. M., B.Sc. (Melbourne University): Proprietor and General Manager, S. M. Conlon Radio Co., 26 Kippax Street, Sydney. Had ten years experience as Telephone Exchange and Equipment Engineer P.M.G.'s Department. Went to U.S.A. for three years, and afterwards spent three years in N.S.W. as representative of overseas electrical firms. In 1929 went to Leipzig Fair, Berlin, and London Radio Exhibitions. On his return went to Lekmek Radio Laboratories as Sales Manager. Holds Expert Electrical Engineer's Certificate, Melbourne Technical College. Club: Woollahra Golf Club. Private address: 1024 Old South Head Road, Rose Bay.

CONRY, William Henry, M. Inst. R.E. Aust.: Radio Inspector, P.M.G.'s Dept., Melbourne, 1910, appointed Engineer's Branch, P.M.G.'s Dept. 1915-1918, Wireless Operator R.A.N. Radio Service (Transport). Born, 3/6/1892.

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.

COOTE, Jasper L.: Radio Manager, Standard Telephones and Cables (A/sia) Ltd., 258 Botany Road, Alexandria, New South Wales. Joined S.T.C. (then Western Electric Co.) in 1921 as junior clerk. Transferred to New Zealand as Sales Manager in 1927. Appointed to present position in February, 1937. Private address: 45 Taplee Street, Croydon. Born Sydney, 30/10/'04.

COURT, T. P.: Councillor and Member I.R.E. (Aust.). Vice-chairman Sydney Division I.R.E. Design Engineer, Standard Telephones and Cables (A/sia) Ltd., Sydney. Joined S.T.C. 1925. Private address: 14 Boyle Street, Cremorne. Educated Prahan College and Melbourne Technical College. Born 2/12/'94.

COX, Edmund S. ("Ted"): Sales Manager, Amplion (Aust.) Ltd. Educated at Trinity Grammar School, Sydney. Active

interest in radio since inception of broadcasting. Appointed first Metropolitan representative Philips Lamps (A/sia) Ltd., 1927—associated 5 years. Joined Amplion (Aust.) Ltd., 1933. Private address: 23 Barry Street, Neutral Bay, N.S.W.

CRAWFORD, W. T. S.: Senior Radio Inspector for New South Wales. Councillor and Member I.R.E. (Aust.). Appointed O.I.C. Hobart Radio,

1912. O.I.C. V.I.M. Melbourne, 1914. Transferred to Naval Wireless, October, 1915, as Radio Inspector, Melbourne. Appointed Radio Lieutenant and Inspector Sydney, January, 1918. After the war reverted to P.M.G.'s Department as Radio Inspector October, 1920. Classified Senior Radio Inspector May, 1934. Born Bendigo, 14/12/1880.

D

DARE, Eric.: General Manager, Mullard Radio Company (Aust.) Ltd., Head Office, Box 2118L, G.P.O. Sydney. Educated Napier Boys' High School. Amateur radio transmitter. 1912-193. With Philips, 1926 to

WHO'S WHO (Continued.)

ERIC DARE (Cont.)

June, 1930, as Technical-Commercial and Advertising Manager, taking over Mullard in August, 1930. Private address: 17 Streatfield Road, Bellevue Hill. Married. Born N.Z., 17th February, 1897. Recreations: Swimming and amateur wrestling.

DAVIDSON, George Robert: Sales Manager (Radio Division) Philips Lamps (A/sia) Ltd. Educated North Sydney High School. Joined radio industry

1928. Previous to this motor business eight years. Country traveller Philips, 1930-1932. Sales Manager Ducon Condenser Pty. Ltd., 1932-1935. Rejoined Philips Lamps early 1935. Private address: "The Cabin," 69 Spencer Road, Killara. Born 7/7/'03. Recreations: Golf, gardening.

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, J.: Superintendent Special, Products Factory, Amalgamated Wireless Radio-Electric Works. Educated Caulfield Grammar School, Melbourne, and Sydney Grammar School. Sydney Technical College Electrical Engineering Diploma. Born Melbourne, 1907.

DAVIS, Russel: 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. Commenced radio experimenting 1913. Joined Raycophone 1929. Joined Wetless Electric Mfg. Co. Ltd. 1930 until early 1935 to found own company. Private address: 23 Willis Street, South Kensington, N.S.W. Recreation: 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. Served in A.I.F. 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 with Noyes Bros. (Sydney) Ltd. Private address: "Santa Barbara," Edward Street, Bondi. Born 27/8/1909. Recreations: Surfing and fishing.

De DASSEL, Henry: Engineer-in-charge Beam Transmitting Station, Fiskville, Vic. Joined A.W.A. Marine Dept., 1914. Visited Japan in 1914, installing A.W.A. marine equipment. Later transferred to Marconi School of Wireless as Assist. Instructor, and 1924 to Marine Dept. A.W.A. Senior Technician Beam Stations 1926-35. Private address: Fiskville, Vic. Born 1893, Launceston, Tas.

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.

DIX, Edgar Albert: Proprietor Radix Power Supplies, 64 Lawler Street, Subiaco, W.A. Commenced manufacture of power transformers and chokes in 1928. Private address: 64 Lawler Street, Subiaco, W.A. Born 20/4/'07, Kalgoorlie.

DOBBIE, L. G., B.E., M.E. Univ. of Queensland: Development Engineer, A.W.A. Radio-Electric Works. Educated Grammar School, Maryborough, Q. Six years' experience in Receiver and Test Equipment Development. Joined A.W.A. March, 1933.

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.

DONNER, W. A.: Managing Director, Columbia Gramophone (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 Gramophone Co. Ltd., Clerkenwell Road, London. Came to Australia as Managing Director Columbia Graphophone (A/sia) Ltd., 1929. Married. Private address: Olphert Avenue, Vaucluse. FU 7113.

DOYLE, George W., Australian Radio Publications Ltd., 30 Carrington Street, Sydney. Advertising Manager, "Radio Retailer." Educated Melbourne. Joined Australian Radio Publications July, 1932. Private address: 106 Cottenham Avenue, Kingsford, N.S.W. Born Melbourne 19/10/02.

DRAFFIN, James Charles, M. Inst. R.E. Aust.: Engineer, Broadcasting Department, 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, Industrial and Cine Sonor Department, Philips

Lamps (A/sia) Ltd., 69-73 Clarence Street, Sydney. 1919-1928, Royal Navy and Royal Australian Navy. 1928, to date Philips Lamps. Married. Private address: 31 Bunyula Road, Bellevue Hill, Sydney. Born London, 2/7/03.

DUKE, Alan S.: Proprietor Alan S. Duke Pty. Ltd., 486 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 1932. Chairman Exhibition Committee, 1930-31-32. Born January, 1897. Recreations: Tennis and swimming.

DUNN, John T.: General 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: 2A Kent Street, Rockdale. Married. Born 2/10/1896. Recreations: Motoring and golf.

DUNNE, Peter Edmund Langton, M. Inst. R.E. Aust.: Radio Inspector, P.M.G.'s Department, Melbourne. 1914-1919 P.M.G.'s Dept. 1919-1925, served in Coastal Wireless Service as

WHO'S WHO (Continued.)

Radio Telegraphist. 1925-28, P.M.G.'s Dept., Radio Station. 1928 to date, Radio Inspector. Born 19/12/1892.

DUVAL, John Claude: Advertising Manager, Stromberg-Carlson (A/sia) Ltd., 118 Bourke Road, Alexandria, N.S.W., with

the Paton Advertising Service for 2½ years, then with National Cash Register Co. on sales promotion work. Two and a half years as Assistant Advertising Manager, E. F. Wilks & Co. Ltd. Private address: 100 Blair Street, Bondi, N.S.W. Born Sydney 10/12/11.

DWYER, Stanley G.: Secretary Australian Valve Merchants' Association, Sydney.

Secretary, Stromberg-Carlson (A/sia) Ltd., 1929-34. Trained in Accountancy, 1915. Born 3/6/96.

E

EDWARDS, James Roy, A.M. Inst. R.E. (Aust.): Technical Editor and Director, Australian Radio Publications Ltd., 30 Carrington Street, Sydney. Honorary Secretary, Sydney Division, Institution of Radio Engineers, Australia. Entered radio as amateur experimenter 1919. General experience in radio, sound and broadcasting fields in South Australia until trans-

ferring to Sydney during 1930. Took over Factory Management of Custom Built Radio. Transferred to Kriesler Radio Company as Chief Engineer, and has held similar positions at Paramount, Radio and Crown Radio. Joined Australian Radio Publications Ltd. in July, 1935. Experience covers practically every phase of radio and sound equipment design and production, and special attention has been paid to the design and construction of testing and measuring equipment for laboratory, production and service work. Private address: "Brantwood Hall," Edgecliff, N.S.W. Born, 11/12/1907.

EGLON, George: Director and Factory Manager, Stromberg-Carlson (A/sia) Ltd., Sydney. Born March 18, 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. Recreations: 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.

ELLIOT, Samuel. Educated at Melbourne Technical College, 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.

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.

EMBLETON, George Pearson, B.A.: Proprietor G. P. Embleton & Co., 208 Lonsdale Place, Melbourne, C.1, Vic. Educated Wesley College and Melbourne University. Graduated B.A. (Melb.). Recreations: Golf and swimming.

EVANS, Clive Walter, M. Inst. R.E. Aust., A.M. Inst. Min. E., London: Managing Director, Widdis Diamond Dry Cells, Cnr. Park and Wells Sts., South Melbourne. 1918-19, Engineer, Ironside Son and Co., London. 1919-21, Chief Engineer, Mount Bishop Tin Mines, Tas. 1921, Joined present company as Factory Manager, afterwards becoming Manager, and Manager and Director. Club: Stock Exchange. Private address: Enfield Road, Brighton, Vic.

EVANS, Raymond: Sales Manager and Secretary, Zenith Radio Co. Ltd. 37 Oxford Street, Paddington. Pre-war experimenter (licensed). Served

during war with Navy Department (Technical Wireless Civilian Service). Actively associated with radio parts business from 1919 to 1929 in an executive capacity. Was Sales Manager for Eclipse Radio Pty. Ltd. for three years. Private address: "Garth Craig," 6 Flood Street, Clovelly. Born Sydney, 1889.

EVERITT, Arthur Raymond, A.M. Inst. R.E. Aust.: Partner, Borthwick, Everitt & Co., 33, Mountain Street, Broadway, Sydney. Private address: 15 Carr Street, Coogee. Born Sydney, April 9, 1908.

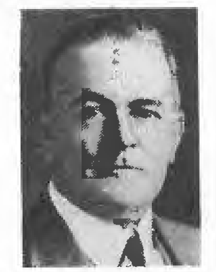
F

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.

FACER, Reginald: Director Efco Manufacturing Co. Ltd., Princes Highway, Arncliffe.

Superintendent radio side of business. Born 12/4/1898. Recreation: Golf and motoring.

FACER, Thomas: Director and Supervisor of hardware manufacturing side of Efco



Mfg. Co. Ltd., Princes Highway, Arncliffe. Private address: 12 Westminster Street, Bexley. Recreations: Gardening, motoring and golf.

FERRAR, Leonard Houghton: Radio Manager, Newton, McLaren Ltd., 17 Leigh Street, Adelaide. A.M. Inst. R.E. (Aust.) Joined Newton McLaren 1925. In 1927 went to Wellington office of National Electrical and Engineering Co. (then distributors of Fada Radio). Rejoined Newton McLaren 1928. Has rank of Lieutenant in Australian Corps of Signals. Private address: 46 Ebor Avenue, Mile End, South Australia. Born Adelaide, January, 1911.

WHO'S WHO (Continued.)

FINDLAY, Selwyn H.: Director, Findlay's Pty. Ltd., 80-82 Elizabeth Street, Hobart Twenty years' experience in Piano and Music Business, ten years in handling Radio Merchandise. Proprietor and present General Manager of first commercial broadcasting station in Tasmania, 7HO (1930). Afterwards followed Findlays' Chain of Stations, 7HO, 7LA and 7BU; Director of Commercial Broadcasters Pty. Ltd.; Findlay & Wells Pty. Ltd.; Wells & Co. Pty. Ltd. Clubs; Royal Hobart Golf Club; Kingston Beach Golf Club; Athenaeum Club; Royal Tennis Club; Royal Yacht Club; Autocar Club, etc. Private address: 14 Lord Street, Sandy Bay, Hobart. Born Launceston 13/2/1897.

FISK, Sir Ernest Thomas, K.B.: Chairman and Managing Director, Amalgamated Wireless (A/sia) Ltd., 47 York Street, Sydney. F. Inst. R.E., A.M.I.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 Sir Ern. Fisk, who, during the past 20 years, has developed wireless in Australia and in the Pacific from a national point of view. He 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. Created Knight Batchelor in Coronation Honours, 1937.

FITZGERALD, R.: Special Valve Representative for Philips Lamps (A/sia) Ltd., 69-73 Clarence Street, Sydney. Born October 1899, Petersham, N.S.W. Educated Petersham Commercial High School. First

entered radio trade as manager of the Wholesale Radio Department of Harringtons Ltd., Sydney, in 1924. Joined staff of Philips Lamps (A/sia) Ltd., in January, 1925, as radio representative. 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.

FOX, A. R. ("Terry"): Director, Fox and MacGillycuddy Ltd., 57 York Street, Sydney, N.S.W., associated with radio trade for about 14 years. Keen golfer.

FRANTZEN, Victor, Managing Director, H. C. Andersen & Frantzen, wireless cabinet manufacturers, Johnson Street, Alexandria. Started business in April 1916, in a small shop in Wellington Street, Chippendale. Business expanded and in 1923 commenced the manufacture of furniture, and later became contractors to H.M.V. Gramophones. President of the Danish Society in Sydney; 'Decorations: "Knight of Dannebroz." Private address: 62 Princes Street, Brighton-le-Sands. Born Denmark 23/7/1880.

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.

FREEMAN, F. W.: Superintendent Australian Radio College Pty. Ltd., Broadway and City Road, Sydney, N.S.W.

Prior to joining Australian Radio College in 1934 was actively concerned in sales promotion in the electrical industry, both in this country and in England. Private address: Cabramatta. Born, 8/3/1910.

FROST, Harold John: Sales Superintendent, Radioplayer Division, Philips Lamps (A/sia) Ltd., 69-73 Clarence Street, Sydney. Educated at Puteney Grammar School, S.A. Salesman-in-charge, W. Harry Wiles, 6 years. Metropolitan

Radio and Electrical Depts., Noyes Bros. (Sydney) Ltd., 7 years. Joined Philips Nov. 1935 as Metropolitan Representative. Appointed present position February 1937. Born Jamestown S.A., 25/11/03. Recreations: Golf and swimming. Private address: 271B Edward Street, Bondi, N.S.W.

G

GARDAM, J. R. W.: Managing Partner, J. R. W. Gardam & Co., 138 Murray Street, Perth. mem. Inst. Elec. Eng. (London); Mem. Inst. Eng. (Aust.); Assoc. Mem. American Inst. of Elec. Eng.. From 1897 to 1908 was Managing Engineer of the Empire Electric Light Co. Ltd., Sydney; 1908 to 1913, Manager, Noyes Bros., Perth: 1913 to 1918, owner of J. R. W. Gardham, Perth; 1918 onwards in present position. Club: Weld Club, Perth. Private address: 33 Colin Street, West Perth. Born Hull, England.

GARTH, Alfred Henry, A. Inst. R.E. Aust., F. Inst. of Commerce, England: Manager, Radio Section, Colton, Palmer and Preston Ltd., Currie Street, Adelaide, S.A. Hon. Sec., Adelaide Division, I.R.E., Aust. Educated at Riverton High School and Adelaide University. Commenced radio retailing, 1925. Appointed superintendent Industrial School, Edwardstown, 1929, and in 1932 joined staff of New System Telephones Pty. Ltd. Private address: 148 North East Road, Walkerville, SftA. 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 Pty. Ltd., 46-48 York Street,

Sydney. Private address: "Norwood," 22 St. John Avenue, Gordon. Born July 10, 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: Orong Road, Toorak. Sport: Polo.

GIBSON, Sladen: Manager Homecrafts Pty. Ltd., Melbourne. Entered Victorian Radio trade in 1926 on the sales side of Louis Cohen 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 Cohen Wireless and afterwards appointed Manager Homecrafts Pty. Ltd. Recreation: Golf.

WHO'S WHO (Continued.)

GIDLOW, C.: Radio Parts Manager, Efco Mfg. Co. Ltd., Princes Highway, Arncliffe, N.S.W. 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 Institu-

tion 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 Street, Waterloo, N.S.W. Join-

ed Ducon 1933 as Chanex Production Manager. Commenced experimental radio, 1925. Student Marconi School. Four years motor trade. 1929 Country Representative Amplion (A/sia) Ltd. Private address: Wakeford Road, Strathfield. Recreations: Surfing and tennis. Born 1906.

GLASS, John Alexander, A.F.I.A., A.A.I.S., Secretary of Eclipse Radio Pty. Ltd. Private address: 35 Dow Street, South Melbourne. Born 2/4/1905.

GODLEY, William: Airzone (1931) Ltd., Sydney. On leaving school, entered Admiralty Hydrographic Survey Branch, as a cadet. Joined Harringtons Ltd., 1912, and had considerable executive experience. 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

GODLEY, W. (Cont.)

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 L1335. Recreation: Golf.

GOW, Donald N., Metropolitan (Sydney) Representative, Airzone (1931) Ltd. Joined A.I.F. in 1916 Corps Signals in last year of war. Became as-

sociated with radio almost immediately after War and has been in it ever since. Has had practical and executive experience 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: 1 Ashley Parade, Manly, N.S.W. 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. Member 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.

GUTHRIE, James Henry Frencham: Manager, Radio and Valve Departments, British General Electric Co. Ltd., 104 Clarence St., Sydney. Jackeroo-

ing 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 Street, Double Bay (FM 5559).

HALL, P. R.: J. B. Chandler Ltd., Australia House, Carrington Street, Sydney, N.S.W. Commenced in radio in 1926, holding positions with S.T.C., W. A. Syme, Nock & Kirby, Odon & Griffin. Heiron & Smith etc. Club: RIF. Private address: 7 Carrington Street, Penshurst, N.S.W. Born Kalgoorlie, W.A.

HALE, John Palmer, Mem. Inst.R.E.Aust.: General Manager and Director, Newton McLaren Ltd., 17 Leigh Street, Adelaide. Joined this company in 1917. Inaugurated Radio Department 1923. Appointed As-

sistant Manager, 1936. Appointed to present position, March, 1937. Club: Naval and Military Club of S.A. Private address: Elderslie Avenue, Fitzroy, S.A. Born 7/10/1900, North Adelaide.

HANKIN, H. H. J.: Proprietor, Simplex Products Pty. Ltd., 716 Parramatta Road,

Petersham. Private address: Old Castlehill Road, 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 and 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 Gramaphone Trade in Queensland. Private address: Clayfield, Brisbane. Born in Sydney, N.S.W.

WHO'S WHO (Continued.)

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. 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, Sangringham, 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.

HEALY, C. P., B.E.E.: Development Engineer, A.W.A. Radio-Electric Works, Ashfield. Diploma Electrical Engineering Melbourne Technical College, Graduate of Melbourne University, Senior Technical Instructor, Education Department, Victoria, 1925. Radio Patents Office 1928, Airzone 1929-32, Raycophone 1932-4, Ducon 1934-5, Continental Carbon 1935-6. Appointed Development Engineer A.W.A., March, 1936. Private address: 10, Flandillo Ave., Strathfield, N.S.W.

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: Metropolitan Radioplayer Rep., Radio Division, Philips Lamps (A/sia) Ltd., 69-73 Clarence Street, Sydney. Previously in publicity department, Philips Lamps, for 18 months. Educated Sandgate College, Queensland. Fifteen years in general publicity, seven years at Anthony Horderns; four years "Sun" Newspapers and later Advertising Manager of "The Advocate," Burnie, Tas. Private address: 40 Aubin Street, Neutral Bay. Born 10/10/1900. Recreations: Cap-

HENRY, B. R. (Cont.)

tain 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., Sydney. Educated Sydney Grammar School. Pri-

vate 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.

HILL, William Fitzmaurice: 191 Queens 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. Is a well-known radio play writer for B.B.C. and A.B.C.

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.

HOBDEN, Hillstead Inigo: Radio Manager, Eastern Trading Co. Ltd., 470 Elizabeth Street, Sydney. Served with B.E.F. in France during war. Member Millions Club. Private address: Lindfield. Born 1893. Recreations: Golf, motoring.

HOE, Frederick: Director Edgar V. Hudson Pty. Ltd., 284-6 Edward Street, Brisbane, Q. Mechanical and Electrical Engineer by profession, graduated to business side Machinery Department, Manager Dalgety and Co., 1915. Sales Manager and Director Buzacotts (Q.) Ltd. 1917, Founded Edgar V. Hudson, Radio Merchants, with E. V. Hudson, 1924. Private address: Killarney Street, Yeronga Q. Born 1887, Melbourne.

HOE, Fred. Jun., A.M.I.R.E. Aust.: Manager Communications Department, Edgar V. Hudson Pty. Ltd., 284-6 Edward Street, Brisbane, Q. Radio Engineer, Assistant Engineer at 4BK Brisbane, 1931. Engineer in charge 4IP Ipswich, 1935. Appointed present position, 1937. Address, Killarney Street, Yeronga. Born Melbourne, 1913.

HOMEWOOD, Walter B.: Director and Sales Manager, Airzone (1931) Ltd., 16 Australia Street, Camperdown, Sydney.

HOOKE, Lionel Alfred: General Manager, Amalgamated Wireless (A/sia) Ltd., 47 York Street, Sydney, N.S.W. 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, 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 1925. Appointed to present position 1936. Travelled Europe and America for A.W.A. in 1930-32 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 Rd., 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.

HOSKING, A. P.: Sales Manager, Amalgamated Wireless Valve Co. Ltd., 47 York Street, Sydney, N.S.W. M.Inst.R.E. (Aust.). Joined South African

Post and Telegraph 1905—Beira and Mashonaland Railways 1910—Rhodesian Post and Telegraph 1912, South African Forces August, 1914—Oct., 1915—R.A.N. Radio Service 1916. Commercial side of A.W.A. 1923, Sales Manager A.W.A. 1924, Sales Manager A.W. Valve Co. 1932, Chairman Aust. Valve Merchants' Association. Recreations: Golf, fishing, motoring.

HUCKELL, Edward Dean: Proprietor Huckell Radio, 285 Military Road, Cremorne, New

South Wales. M.Inst.R.E.Aust. Chairman Radio Merchants Ltd. Life Governor Picton Lakes T.B. Settlement. 1921 Salesman Beale & Co., Q., Ltd. 1926 established radio at Guille & Co., Newtown. 1928 established Huckell Radio. Private address: 285 Military Road, Cremorne. Born 24/11/'97.

WHO'S WHO (Continued.)

HULL, Allan Galbraith: Mem. 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.

HUEY, R. M., B.Sc., B.E. (Hons.) Univ., Sydney, A.M. Inst. R.E. Aust.: Quality Control Supervision, A.W.A. Ltd., Radio-Electric Works. Joined A.W.A. 1935 as Research Engineer.

HUMPHERY, R. C. V.: Amalgamated Wireless (A/sia) Ltd., 47 York Street, Sydney, N.S.W. 1910-13 studied Wireless Telegraphy and Marine Eng. in France. Came to Australia in 1913, and from 1915-20 served with 3rd Battalion A.I.F. 1922-25 with A.W.A. Marine Service. 1925-31 in A.W.A. Engineering Department. Appointed Instructor Marconi School of Wireless. Author "Concise Radio Handbook." Club: English Public Schools. Holds 1st Class P.M.G. Wireless Certificate. Marine Engineering Certificate (French). Private address: "Calulu," Old South Head Road, Vaucluse, N.S.W. Born London, 26/7/-1895.

HUNT, George: General Manager, Briton Elec. & Radio Pty. Ltd., 152 Parramatta Road, Petersham, N.S.W. Joined radio

industry, 1932. Was General Manager E.S.M. Co. Ltd. 1932-36. Private address: 4 Mitchell St., Marrickville. Born 15/10/'04. Recreations: Tennis and motoring.

I

IRVINE, David: Proprietor, Irvine Radio and Electrical Co., Terry House, Elizabeth Street, Brisbane. Was for fifteen years with Harringtons Ltd., Brisbane Manager Radio Section for three years. Present business commenced 2/3/'36. Private address: Moola Road, Ashgrove, Brisbane. Born 31/10/'06, Glasgow, Scotland.

J

JENNINGS, R. H.: Sales Manager, Thom and Smith Ltd., 29-39, Botany Road, Mascot. Joined Thom and Smith Ltd., November, 1932. Private ad-

JENNINGS, R. H. (Cont.)

dress: 26 Cecil Street, Killara. Recreations: Golf, tennis and yachting. Born 27/7/'03.

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.

JOHNSTON, Hector, Amalgamated Wireless (A/sia) Ltd., 47 York Street, Sydney. Joined A.W.A. in Sydney, 1912, as Marine Operator. War Service, 1914, to December, 1919. R.A.A.F. as Wireless Officer until 1922. Marine Operator, A.W.A., 1922/24, and Broadcasting Department, 1924-36. Joined Aviation Department, 1/1/37. Private address: 24 Cranbrook Road, Rose Bay, N.S.W. Born Dunedin, N.Z., 15/8/1881.

JONES, Francis Percival: Crown Radio Mfg. Co. Pty. Held position as secretary Queensland Radio Refrigerator Co. Pty. Ltd.; Accountant, The Music Masters Radio Co., Brisbane; Customs Agent and

JONES, F. P. (Cont.)

Credit Officer; E. C. Eager & Son Ltd., Brisbane; General Manager, Radiokes Ltd., Member RIF Club and Federated Customs Clerks' Association of Australia. Private address: 15a Vicar Street, Coogee, N.S.W. Born Swansea, Glam., 1898.

KEFFORD, Harold: Sales Manager, Kriesler (A/sia) 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.: Manager, Siemens & Halske Division, also Chief Engineer, Telephone Division, New System Telephones Pty. Ltd., 12 years Electrical Engineers' Branch P.M.G.'s Department. 11 years Chief Engineer, New Systems Telephones. Member Institution 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.

KENTISH, Harold Bruce, Radio Manager, Lenroc Ltd., 211-5 Pulteney Street, Adelaide. Joined Universal Radio Engineers, Mile End, at age of 15, and later joined A. W. Dobbie & Co. (Adelaide). Private address: 330 Sea View Road, Henley Beach, S.A. Born 18/11/'11. Lameroo, S.A.

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. Founded firm of Kerr and Muir Wireless Pty Limited. 1922. later absorbed by Eclipse Radio Pty. Ltd. Company address: 216-222 City Road, South Melbourne. Vic. Hon. Secretry Brighton Radio Club. Private address: 211 North Rd., Caulfield. Born 23/1/'04.

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, stablished 6ML, W.A.'s first "B" class 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.

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 Burwood, N.S.W. Educated Central Technical School. Employed by Home Recreations, 1930. Fore-

man of Radio Department 1931. With Aizone Ltd., 1932. Joined the Australian Radio College during 1932. 1933 to date, Chief Instructor of the Australian Radio College.

LAMBIE, R.: Amalgamated Wireless Valve Co. Ltd., 47 York Street, Sydney. Production Engineer. Educated Dartford Technical College, Eng. Apprenticed Toolmaker with Vickers Ltd., 6 years with the Gramophone Co. Ltd., Sydney. Joined A.W. Valve Co. January, 1933.

LAMPLOUGH, John Richard, Technical Manager, John Martin Ltd., 116-118 Clarence St., Sydney. Was 3 years with Western Electric Co. (A/sia) Ltd., and Philips Lamps (A/sia) Ltd., on Sound Picture Equipment. Joined John Martin Ltd. at its inception. Private address: 3a Battery Street, Clovelly. Born Sydney, 2/4/'10.

LARCHER, Ernest John: Sales Manager of "Limberts," Adelaide. Commenced business London, 1910, with Stirling Record Co., The Zonophone Co., and H.M.V. Co. 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. Private address: Kentish Hotel, Stanley Street, North Adelaide. Born April, 1893, London. Single. Recreations: Work, Political Economy.

WHO'S WHO (Continued.)

LARKINS, Albert John: Radio Sales Manager, Efco Mfg. Co. Ltd., Princes Highway, Arncliffe. 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.

LARKINS, 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 and Commerce (Syd-

ney University). Joined Australasian Wireless Co. Ltd., as 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.

LEADBETTER, Charles: Manager, buying department, Eclipse Radio Pty. Ltd., Melbourne. Private address: 28 Linacres Road, Hampton. Born 17/2/1898.

LEEMAN, John: Branch Manager, The Ever Ready Co. (Aust.) Ltd., 360 Collins Street, Melbourne, Vic. Joined organisation as country representative March, 1932. Appointed present position June, 1933. Born, 2/7/-1901. Recreations: Tennis and swimming.

LEWIS, Reginald: Managing Director, Meltran Engineering Pty. Ltd., 8-10 Scotia Street, North Melbourne. Late managing director Tilbury & Lewis Pty. Ltd. Is also a director of Van Ruyten Radio Supplies Pty. Ltd. Private address: 43 Cookson Street, Camberwell. Born Melbourne, 1910.

LIMBERT, Charles Cameron: Proprietor of "Limberts," 49a Grenfell Street, Adelaide, S.A.

LIMBERT, C. C. (Cont.)

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, Elof Richard, M.Inst.R.E.Aust.: Manager and Engineer, National Radio corporation Ltd. Two years S.A. Electric Supplies. Four years on own account. Five 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, D.G., A.M. Inst., R.E. Aust.: Design Engineer A.W.A. Radio-Electric Works, Ashfield, N.S.W. Educated North Sydney High School and Sydney University. 2 years with St.omberg-Carlson Ltd. Joined A.W.A., August, 1933.

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.

LINDSAY, J.: In charge Service Dept., Amalgamated Wireless (A/sia) Ltd., Ashfield, N.S.W. Educated Willoughby Public School, North Sydney Commercial and Boys' High Schools. Sydney Technical College. Joined A.W.A., 1919.

LOGAN, Edgar P.: Managing Director, Martin de Launay Ltd., 287-9 Clarence Street, Sydney. Joined Martin de Launay twenty years ago, served in head office for five years; transferred to Newcastle branch as traveller; promoted branch manager eleven years ago; appointed director four years ago. In July, 1936, was appointed Managing Director and moved to Head Office. Chairman of the Newcastle branch of ERDA (now defunct). Chairman of first Electrical and Radio Exhibition in Newcastle Town Hall. Clubs: United Services Institution, Imperial Service Club. Is a Major on active list Australian Military Forces. Private address: 33 Grosvenor Road, Lindfield. Born Mosman, 26/12/1902.

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.

M

McDONALD, Arthur Stephen: Chief Engineer and Assistant

Manager, Amalgamated Wireless (A/sia) Ltd., 47 York St., Sydney. M.Inst.R.E. (America) and M.Inst.R.E. (Aust.). Councillor of I.R.E.Aust. Born Castle Donnington, now Swan Hill, Vic. Educated at public school and Melbourne Technical College.

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.

McLEAN, Eric Archibald: Sales Manager, Radio Depart-

ment, Smith Sons and Rees Ltd., Company address: 30-32 Wentworth Avenue, Sydney. Educated public schools, South Australia. Entered Postal Department, 1912. Address: Cambridge Avenue, Vaucluse. Born 4/2/1897. Recreations: Literature, gardening, tennis.

MACNEE, Douglas Hamilton, B.Sc. (Eng.), Assoc. Mem. Inst. of Elec. Eng. 1929, Mem. Inst. of Radio Eng. (Aust.), 1936: From 1926-1928 in European Engineering Department, International Standard Electric Corporation, London; 1928-9 in Telephone Laboratory of same Company; 1929-31, International Telephone and Telegraph Laboratories, Hendon, London; 1931-34 Callenders Cable & Construction Co., Lahore, India; 1934-35, The Gramophone Co., Hayes, London. Joined the Gramophone Co. (Aust.) Sydney in 1935, where now in charge of the Radio Designs Department. Educated Glasgow University. Private address: 58 The Avenue, Strathfield. Born 6/2/'03.

McPHEE, Stuart Duncan: M.Inst.R.E.Aust., Works Manager, Standard Telephones & Cables (A/sia) Ltd., 258 Botany Road, Alexandria, N.S.W. Born and educated in Melbourne. Born 1899.

McQUILLAN, Cecil John: Chief Radio Systems Engineer, Standard Telephones and Cables (A/sia) Ltd., 258 Botany Rd., Alexandria, N.S.W. B.Sc. (Engineering) Honors London University, D.I.C. (Diploma of the Imperial College, London), Whitworth Exihition, 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.

MADDERN, Clarence Arthur: Proprietor own business manufacturing Keystone Radio. Wireless operator, 2nd Div. Sig. Co., A.J.F. Employee Adelaide Observatory until 1922. Radio Manager, Bullock Clyde & Radio Stores seven years. Radio Manager, Harrington, Adelaide Branch one year. Private address: 25 Dixon Street, Clarence Park. Born 21/3/1896. Rose Park, S.A. Married. Recreations: Tennis, golf, fishing.

MAGRATH, James H.: Manager, Radio Department, G. P. Embelton & Co., 208 Lonsdale Place, Melbourne, C.1. Was with Myer Emporium Radio Department, and become Manager G.M. Radio for two years. Went to England and the Continent in 1926. On return formed Regent Radio Company until 1934. joined Tilbury & Lewis Pty. Ltd., later joining G. P. Embelton & Co. Private address: Goodall Street, Hawthorn, Vic.

MALONE, James J.: M.Inst. R.E.Aust. Chief Inspector Wireless Postmaster-General's

Department, Treasury Gardens. Melbourne. Chairman Melbourne Division, Institution Radio Engineers Australia, 1935-6-7. Served as Wireless Officer R.A.A.F. in France. Recreation: Golf.

WHO'S WHO (Continued.)

MANLEY, Patrick Joseph: Managing Director, Amplion (A/sia) Ltd., 66 Clarence St., Sydney. Member Institution of Radio Engineers, Australia. Councillor of United Service Institute. Commenced Victorian Railways, Telegraph and Tele-

phone Division. 2nd Lieut. Signal Engineer, 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) Ltd., 1927. Formed Speakers (Australasia) Ltd. 1930, with position of Managing Director. Made careful study of Radio Manufacturing and merchandising abroad on several occasions. Private address: "Altona," 15 Princess Avenue, Vaucluse. Born Melbourne, Vic., 11th September, 1894. Member Tattersall's Legacy Club, Imperial Service and Royal Sydney Yacht Squadron. Recreation: Army Signals (Major 1st Cav. Signals).

MARTIN, Albert F.: 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 and 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, Bert.: Proprietor B. Martin, Wilson House, Charlotte Street, Brisbane. Started business with T. H. Martin in 1938 as wholesalers and agents. Partnership dissolved 1935, and Bert Martin took over the whole business on 1/1/'36. Business conducted as general agency and wholesalers, and B. Martin is Factory Representative for Stromberg-Carlson (Aust.) Ltd., Sydney. Private address: Carew Street, Toombul, Brisbane. Born Walsall, England, 3/7/1906.

MARTIN, Charles I.: Managing Director, Radio Maintenance Pty. Ltd., Swanston Street, Melbourne. Recreations: 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 Magestic Ltd. in August, 1934, and acquired a complete interest in February, 1935, and changed the name to John Martin Ltd. Private address: Hillcrest Ave.,

MARTIN, John (Cont.)

Hurstville, N.S.W. Recreations: Tennis and surfing. Born Aug. 19th, 1889.

MASHFORD, Rupert Leslie: Liverpool Electric Cable Co. Ltd., Sydney. Technical, Publicity and 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. Served in Signals, A.I.F. 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. Private address: Carlingford. Born 16/4/'11. Recreations: Tennis, motoring, flying.

MATHESON, E.; Production Superintendent, Special Products Section, Amalgamated Wireless Radio-Electric Works. Educated Sydney High School. Took Higher Trades Course, Sydney Technical College. Joined A.W.A. July, 1918.

MATTHEWS, Thomas John: Manager Specialty Dept., Radio Hall, David Jones Ltd., Sydney. Supervising Electrical Specialty

and Radio Accessories Divisions. Previously N.S.W. Manager Firth Bros. Pty. Ltd.; Manager Radio and Television Mfrs. Ltd. Recreations: Fishing, swimming, golf. Born 14/11/1903.

MILLINGEN, Arthur Clarence: Managing Director, Eastern Trading Company Ltd., 470 Elizabeth Street, 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 Australia," "Broadcasting Business," 30 Carrington Street, Sydney. Hon. Gen. Secretary Institution of Radio Engineers Australia, since its inception in 1932; Hon. Secretary, RIF (Radio Industry Functions) Club of Sydney. Served in Signals A.I.F. 1915-1919. Member Millions Club, Imperial Service Club, Sydney Legacy Club. Founded Australian Radio College 1930-33. Founded Australian Radio Publications 1930. Private address: 4 Woodside Avenue, Lindfield, N.S.W. Born 1/7/'95.

MINGAY, O. F. (Cont.)

MITCHELL, George W.: Manager Radio Department, Martin de Launay Ltd., 287-9 Clarence Street, Sydney. Joined Martin de Launay fifteen years ago. Appointed Manager of Radio Department, 1931. Graduate of Marconi School of Wireless. Private address: 4 Wilson Street, Kogarah. Born Botany, 1/4/'06.

MITCHELL, V. F.: General Sales Manager, J. B. Chandler & Co., 43 Adelaide Street, Brisbane. Director 4BC, 4GR, 4MB, 4RO, 4SB. Clubs: R.A.C.Q., Royal Aero Club. Born Bendigo, Vic.

MENON, Geoffrey John, A.M. I.R.E. (America): Airzone Ltd., 16 Australia Street, Camperdown, N.S.W. Associated with radio since inception of broadcasting. Engaged in electrical engineering till 1926. Radio Service Manager, Bennett and Wood Ltd., 1926 to 1928. Engineer, Radio Division Stewart Warner Corp., Chicago, 1929 to 1931. Assistant Engineer, Firth Bros. Pty. Ltd., from 1932 until joining Airzone Ltd. in 1934, where he now holds the position of Chief Radio Engineer. Educated St. Ignatius College, Adelaide, and Melbourne Technical College. Private address: 11 Macartney Avenue, Chatswood, N.S.W. Born Adelaide, 1903.

MEYER, Hendrik, Ing.M.T.S.A. (similar to B.Sc.E.): Philips Valve Factory, 100 Mallett St., Camperdown, N.S.W. After joining Philips became assistant to Mr. Van Gessel in the Experimental Factory. Then went to England as Assistant Works Manager with the Mullard Radio Valve Co., later transferred to Australia. Private address: 21 Brentwood Avenue, Turramurra, N.S.W. Born 5/8/'07 at Schiedam, Holland.

McKENNA, George T.: Sydney Sales Rep. O. H. O'Brien (Sydney), Pitt Street, Sydney, N.S.W. Educated Blayney, Molong and Sydney. Served with 1st Batt. Pioneers and A.S.C. in A.I.F. during Great War. Entered radio and electrical trade 1922 as traveller for Weldon Electric Supply Co. Ltd. Joined O. H. O'Brien (Sydney)

McKENNA, George T. (Cont.)

Oct., 1925. Recreation: Golf. Private address: 37 Knowles Avenue, North Bondi, N.S.W. Born Bathurst 10/3/1899.

MONTAGUE, P.: Production Supervisor Quantity Production Factory, A.W.A. Radio-Electric Works. Educated Sydney Technical College. Joined A.W.A. 1917. Number of years instrument making, then promoted foreman.

MOORE, Eric J. T.: Consulting Radio Engineer. M.Inst. R.E.Aust. Educated 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.

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, December 1934, Chief Engineer Stromberg-Carlson (A/sia) Ltd. In 1935 established own consulting business. Born 12/7/'94.

MOORE, Thomas James: Secretary, Stromberg-Carlson (A/sia) Ltd., 118 Bourke Road, Alexandria, N.S.W. A.C.A. (Aust.). Member of the Chartered Institute of Accountants. Has had ten years as a Public Accountant.. Private address: 14 Mosman Street, Mosman. Born Sydney, 29/10/'03.

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.

WHO'S WHO (Continued.)

MULHOLLAND, J. L. (Cont.)

Traffic Manager, Marine Department, 1920-22. Assistant Manager, A.W.A. Head Office, 1922. Melbourne Manager, 1928-34. Chairman RIF Club, Sydney, 1937. Private address: Wallaroy Road, Woollahra. Born 19/4/'91. Recreations: Golf, motoring, bridge.

N

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.

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.

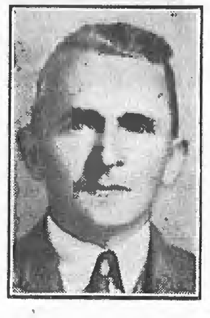
NORVILLE, Charles Henry: Late Director and Chief Engineer, Breville Radio Pty. Ltd., 486 Elizabeth Street, Sydney. M.

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. Co-partner Breville Radio, 1932. Hon. Treasurer Institution of Radio Engineers, Australia. Private address: Cottenham Ave., Kensington. Born 20th February, 1902. (Resigned from Breville June, '37, and left for visit to U.S.A.)

NEWMAN, S. W. H.: Director and Works Manager, The Ever Ready Co (Aust.) Ltd., Harcourt Parade, Rosebery, N.S.W. Joined organisation 1916; appointed present position 1930. Private address: 19 Tunstall Avenue, Kingsford, N.S.W. Born 13/7/1900. Recreations: Cricket, golf and fishing.

O

O'BRIEN, William J.: Director and Sales Manager Breville Radio Pty. Ltd., 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 Department, Suttons Ltd., and later Sales Manager for Thom & Smith. Commenced above business in November, 1932. Vice-President and Councillor of Aust. Radio Mfrs. Patents' Association 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: Homeden, 84 Anzac Highway, Everard Park, S.A. Born 27/12/1908, Adelaide. Married. Masonic Club, Tattersall's, Holdfast Bay Yacht Club. Recreations: Swimming, tennis and cricket.

OVERDIEP, J. A.: General Manager and Director of Philips

Lamps (A/sia) Ltd., 69-73 Clarence Street, Sydney. Appointment made by Mr. A. den Hertog, Managing Director as from January 1, 1936. 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 Setlements. Has been connected with the Australian organisation of Philips since 1930. Private address: "Ashcroft," Bogota Avenue, Cremorne. Born 17/10/'01.

P

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, Airzones (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 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 Superintendent A.W.A. Ltd., Ashfield. Educated Sale High School, Saltaire, and Technical College, Bradford, Yorks. Apprenticeship J. Parkinson & Son, Machine Tool Makers, Shipley, York. Joined A.W.A. 1929 as Works Production Superintendent. Private address: 12 Coventry Road, Homebush, N.S.W. Born 28/12/1898, Keighley, York, Eng.

PARMITER, Ernest Albert: Governing Director, Acorn Pressed Metal Pty. Ltd., 66 Sheppard Street, Chippendale, 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.

PATON, Frederick Henry: Proprietor Paton Electrical Instrument Co., 90 Victoria St.,

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. 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.

PEARCE, Harry Frank: Publicity Manager, Standard Telephone & Cables (A/sia) Ltd., Sydney. Organised Radio Department for S.T.C. in 1923 when the Company was then Western Electric Co. Ltd. Recreation: Fishing. Born December, 1898.

PERSSON, O.: Factory Manager, Ducon Condenser Pty. Ltd., 73 Bourke Street, Waterloo, Sydney.

PERSSON, Andrew Rudolf: A.Inst.R.E. (Aust.). Managing Director Ducon Condenser Pty.

Ltd., and Manager H. Hecht & Co., 73 Bourke Street, Waterloo. Vice-President Radio & Telephone Mfrs. Assn. Born 1892.

PETERMAN, William Ernest: 160 Edward Street, Brisbane. Commenced business on own account 23/7/'23. Clubs: Tattersall's, Royal Queensland Yacht Club, Royal Queensland Golf Club, Peninsula Golf Club. Private address: Hawthorne Road, Galloway's Hill, Brisbane. Born 4/10/1897, Brisbane.

PETERSON, Rupert Clarence: Director and Chief Engineer, Meltran Engineering Pty. Ltd., 8-10 Scotia Street, North Melbourne. From 1928 to 1929 was assistant sales engineer with Warburton Franki (Melb.); from 1930 to 1936, designer Radio Department, Tilbury & Lewis Pty. Ltd.; later factory manager, same department; Chief Engineer and Designer, Transformer Department, Tilbury & Lewis Pty. Ltd. Private address: 88 Eglington Street, Moonee Ponds, Melbourne, W.4. Born Melbourne, 1910.

PHILLIPS, J. B.: Proprietor Crown Radio Mfg. Co., 51 Murray Street, Pyrmont. Private address: "The Garden," Carr Street, Coogee. Club: RIF.

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.

WHO'S WHO—(Continued)

PHILLIPS, Arthur John, Assoc.I.R.E.: Manager, Merchandising Division, Howard Radio Pty. Ltd., Vere Street, Richmond, Vic. 10 years in

Royal Australian Navy as Wireless and Aircraft Operator. Two years proprietor of own business at Frankston. Radio Technical Representative, Lawrence & Hanson (Melb.). Commenced present company and started as wholesalers, Feb. 1934. Private address: 107 Dendy Street, Middle Brighton, Vic. Born Wellington. N.Z., 18/8/'08.

PINKERTON, Harold Richard: Managing Director, Savery's Pianos Ltd., 29 Rundle Street, Adelaide, S.A. Also Managing Director Radio Wholesalers Ltd., and River Murray Broadcasters Ltd. (5RM). Director Hume Broadcasters Ltd. (5DN). Has been in music and radio business for past 27 years. Broadcasting for the past five years. Private address: 159 Young Street, Parkside.

PLOWMAN, Claude: Managing Director Airzone (1931) Ltd. 16 Australia St., Camperdown, Sydney. 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.

POGONOWSKI, Louis Alexander: Manager Radio and Valve Department, British General Electric Co. Ltd., Melbourne. 1934, Sales Promotion Philips Lamps Ltd. Appointed Manager of Elec. & Radio Department of Wm. Adams Ltd., 1934. Joined Firth Bros., Radio Sales Manager, 1935. Private address: 1 Lovell Street, Hawthorn, Vic. Born Feb. 5th, 1906. Recreation: Golf and swimming.

PRINGLE, Albert, M.Inst.R.E. Aust., Engineer - in - Charge, Braybrook Radio Centre, Melbourne. Joined A.W.A. 1919. Private address: 1, Glenroy Rd., Hawthorn, Vic. Recreations: Motoring and golf. Born 1902 at Clementson, Vic.

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.

PULLEY, O. O., B.Sc., Ph.D., B.E., A.M.I.E. (Aust.): Design Engineer, A.W.A. Radio-Electric Works, Ashfield. Educated London and Sydney Universities. Two years with Standard Telephones and Cables, London. Two years research in radio under Prof. Appleton, London University. One year research Sydney University. Joined A.W.A. 1935.

PURVES, Bartholomew: Manager Brisbane Branch Eclipse Radio Pty. Ltd., 156 Creek Street, Brisbane. Joined W. H. Eutrope and Sons, Melbourne, in 1921. 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.

R

RALPH, Arthur Mitchell: 68 Flinders Street, Adelaide; established 1926 as manufacturers' representative. Private address: 60 Essex Street, Goodwood, S.A. Born Adelaide, 18/9/'87.

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.

RAZ, Otto: Managing Director, Bloch & Gerber Pty. Ltd., 46-48 York Street, Sydney. Private address: 14 Russel Avenue, Lindfield.

REED, Joseph Griffiths, A.M.I.E. (Aust.). M.Inst.R.E.Aust.: Design Engineer, Amalgamated Wireless (A/sia) Ltd. Transferred from Professional Division, P.M.G. Radio Service, 1922. Carried out experimental radio telegraph transmissions in association with R.A.N. Reserve at Newcastle, in 1914. Visited England 1935 in connection with large transmitter design. 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 addsess: 37 Bundarra Road, Bellevue Hill, Sydney. Recreations: Motoring and golf.

RICH, Gordon: Sales Manager, Simplex Products Pty. Ltd., 716 Paramatta Road, Petersham. Office Manager, Biden and Roberts during 1924-1929, Radio Sales Bebarfalds, Sydney, 1929-31. Joined Simplex Radio as

RICH, G. (Cont.)

Sales Manager 1931. Private address: 6 Fitzroy Street, Croydon. Born 12/4/02. Recreations: Tennis and motoring.

RICHARDS, Wm. Frazer: Amalgamated Wireless (A/sia) Ltd., 47 York Street, Sydney, N.S.W. Commenced with A.W.A. September, 1919. Engaged in Accounts, Works and Purchase Departments until 1927, when he was transferred to the Sales Department. For past seven years has been associated with Radiola Country Sales Section. Private address: 29 Ness Ave., Dulwich Hill. Born 11/6/1905, Cowra, N.S.W.

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.

RISLEY, 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. 1929-37 Engineer, Western Electric Co. (Aust.) Ltd. Private address: 9 Day Road, Glenunga, S.A. Born November 25, 1906, Semaphore, S.A. Married.

RITCHIE, T. Malcolm: Managing Director, Noyes Bros. (Sydney) Ltd., Director Crompton Parkinson Australia Ltd.; Director Godfrey Ltd.; Director, H. P. Gregory and Co. Ltd.; Member Inst. Engineers, Australia; Vice-President Chamber of Manufacturers, N.S.W.; Member of Council Metal Trades Employees' Association, N.S.W.; Member Electricity Advisory Committee to the Government of N.S.W.

ROBERTSON, John Ross: International Radio Co. Ltd., 403 Bourke Street, Melbourne. Educated at Scotch College, W.A. On leaving college joined Ford Motor Co. of America when they first commenced operations in Australia. Resigned from Ford Co. and joined Kolynos Inc. when they first started factory in Sydney, as interstate representative. Then joined New System Telephones on household refrigeration and washing machines. From there went to W.A. as Sales Manager for Blackman & Law Ltd., handling radio, refrigerators, washing machines, and vacuum cleaners. While there, accepted position with International Radio Co. Ltd., Sydney. Played Australian rules football W.A. and S.A., Rugby Union in N.Z. for College Rifles Football Club, Auckland. Refereed boxing and wrestling matches, Sydney and N.Z. Born, 22/5/04.

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.

ROWE, Harry Edwin, A.F.I.A.: Amalgamated Wireless (A/sia) Ltd., 167 Queen Street, Melbourne, Vic. Diploma Commerce (Melb. Uni.). Educated at Shepparton High School and at Melbourne University. Joined staff of A.W.A. in 1927. Appointed as Melbourne Accountant in 1928, which position is still held. Private address: 83 Toorak Road, Hawthorn East, E.3., Vic. Born Kalgoorlie 14/10/'01.

S

SALMON, Clifford Grist: Sales Manager and Director 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.

SALMON, Stanley John: Manager and Director, Lawrence & Hanson Elec. Pty. Ltd., 172-6 William Street, Melbourne. Clubs: Elec. Federation, Rotary Club, Yarra Yarra Golf Club. Private address: "Tasma," Parliament Place, Melbourne.

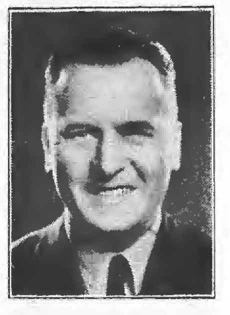
SCHLIESMAN, George: Director and Chief Radio Engineer E.S.M. Co. Ltd. In radio since 1913. Joined staff Electricity Meter Mfg. Co. Ltd., in 1922. Private address: 91 Arthur Street, Moore Park. Born 11/4/85. Recreations: Fishing, motoring and E.S.M.

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. Member Examination Board I.R.E. Aust. Born 17/11/1906.

SCOTT, Harry Edward: Secretary Philips Lamps (A/sia) Ltd., 69-73 Clarence Street, Sydney. Educated at Latimer School, London. War service from 1914-1918. Gallipoli, 29th Div., France, 56th, 58th and 47th Divisions; achieved the rank of Captain. Previous commercial activities embraced

WHO'S WHO (Continued.)

SCOTT, H. E. (Cont.)



banking in London and Africa, and auditing in London. Joined Philips Lamps in November, 1927. Private address: 15 Eastern Road, Turramurra. Born London, 17/1/1899. 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.

SEARSON: Edward M.: Sales Manager, Philco Radio and Television Corp. (Aust.) Pty. Ltd., Joynton Avenue, Waterloo. Has been associated with radio industry for many years, having been connected with Bergin Electric Co., Harringtons Ltd., and for several years past was Sales Manager for Radio Industries Ltd. Appointed to present position, March, 1937.

SEARLE, Geoff. D.: Managing Director Regent Radio Pty. Ltd., 288 Burke Road, Camberwell, E.6., Vic. 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, Vic. Recreation: Motoring. Born 22/8/'10.

SHARPE, H. R.: Sales Representative, Amalgamated Wireless Valve Co. Ltd., 47 York Street, Sydney, N.S.W. Joined Marconi Co. London, 1916; A.W.A., 1926; A.W. Valve Co., 1932. Committeeman Sales and Business Management Association, Sydney. Recreations: Motoring, tennis, swimming.

SHARPE, Hiram T.: Set Manager, Edgar V. Hudson Pty. Ltd., 284-6 Edward Street, Brisbane. Timber interests and motor salesman for several years, entered Radio as Manager of Radio Department, G. J. Grice Ltd. 1931. Joined Edgar V. Hudson Pty. Ltd. as Country Representative 1933. Private address: Ellimatta Drive, Ashgrove. Born Allora, 1906.

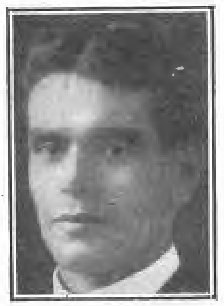
SHUTTLEWORTH, Alfred E.: Lawrence & Hanson Elec. Pty. Ltd., 172-6 William Street, Melbourne. Joined present Company 1920, and has been in all departments. Now in charge of Radio Department. Club: Rostrum. Recreation: Tennis. Private address: 292 Mt. Albert Road, Surrey Hills, Victoria. Born 6/10/1906.

SIMPSON, J.: Transmitter Test Room, A.W.A. Ltd., Ashfield. Educated Sydney Technical College. Joined A.W.A. 1925. Holds Electrical Engineering Diploma Sydney Technical College, Jun. Institute of Engineers.

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 Department 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 Road, Woollahra. FM 2278. Born 1901. Recreation: Golf.

SLADE, Charles William: 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 Feb-



ruary, 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 Office 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 at 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 Rathmines 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, 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.), Member I.R.E. (U.S.A.), Chartered Electrical Engineer, London. 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, G. W.: Engineer-in-Charge, Drawing Office, A.W.A. Ltd., 47 York Street, Sydney. Educated at Fort Street High School. Joined A.W.A. August, 1927. Holds Diplomas in Electrical and Mechanical Engineering at Sydney Technical College.

SMITH, Harvey Lyon: Airzone Ltd., 414 Bourke Street, Melbourne, Vic. Metropolitan Radio Representative A.G.E. Sydney, 1928-29; then transferred to Perth to manage Atkins (W.A.) Ltd., Radio Department. Joined Airzone (W.A.) Ltd., in Perth in 1934 as Sales Manager and transferred to Melbourne branch February, 1935. Private address: 11 Queen's Road, Melbourne, S.C.2, Vic. Born Sydney.

SMITH, John Edwin: Thom and Smith Ltd. (Tasma), 29-39 Botany Road, Mascot, 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.

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 and 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 Telephones 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.

SPENCER, Thomas: Studio Manager, 2CH. Joined A.W.A. Coastal Radio Service, Melbourne Accounts Section, 1927. Later in year appointed Beam Traffic Accountant, Melbourne office. Transferred in 1936 to 2CH Broadcasting Station. Private address: Chatswood. Born 1/5/1893, at Ayrshire, Scotland.

STEPHEN, Alexander Ernest: 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: 2 Sixth Avenue, Helmsdale, S.A. 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.

STEWART, W. A.: Manager, Philips Radioplayer Factory, 10 Dowling Street, Woolloomooloo.

Educated at Randwick High School. Started out in journalistic work, but joined radio in 1921. After working with Wireless Supplies Ltd., became radio

WHO'S WHO (Continued.)

STEWART, W. A. (Cont.)

parts importer on own account. Joined Miss F. V. Wallace. In 1929 joined Western Electric as Sound Engineer. Joined Zenith Radio in 1932, finally attaining the position of Manager. First became associated with Philips Lamps (A/sia) Ltd., in 1935, commencing as Sydney Rep. for Philips Valves and Radioplayers. Was appointed present position when Radioplayer Factory opened in 1936. Born Sydney 26/11/06. Recreations: Golf and fishing.

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.

STRANGMAN, W. J.: Strangman Bros. Radio, 270 Pacific Highway, Crow's Nest. Commenced radio business in 1924 at

present address in partnership with brother, R. C. Strangman. Private address: Lane Cove. Hobby: Motoring.

STROUD, Stanley Price: Manager Ohmegga Resistors (Aust.) Pty. Ltd., also Secretary and 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 Disraeli Street, Kew. Date and place of birth: Southall, Middlesex, England, 24/10/-1901. Married with son and daughter. Recreations: Soccer and tennis.

SUTHERLAND, A. P.: Proprietor A. P. Sutherland, Maffra Street, South Melbourne, Vic. Has been in business for 30 odd years and is widely known in the electric and motor trades. Private address: 39 Black Street, North Brighton, Vic. X 3576.

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 January, 1887.

SYKES, Robert: Chief Engineer Eclipse Radio Pty. Ltd. Private address: 271 Jasper Road, McKinnon. Born 8/3/-1902.

SUTHERLAND, Douglas Macnicol: Amalgamated Wireless (Aust.) Ltd., Research Laboratories, Ashfield, N.S.W. B.Sc. in Physics, Melbourne, 1931. Two years research in Physics, Melbourne, 1932-3. Staff of Geelong Grammar School, Vic., 1934. Joined Research Laboratories, A.W.A., 1935. In charge Measurements Section of A.W.A. Research Laboratories, 1937. Club: Royal Sydney Golf. Born 13/1/1911, Wedderburn, Vic.

SWIFT, Clifford: Sales Manager, Widdis Diamond Dry Cells Park and Wells Street, South Melbourne. 1916-23, Officer, British Colonial Civil Service, British Solomon Islands. 1924-6, own business. 1927-30, Manager for Victoria, South Australia, West Australia and Tasmania, Ellis & Co. (Aust.) Ltd. "Columbia Batteries." Has held present position for past seven years. Club: C.T.A. Private address: 31 New Street, Brighton Beach, Vic.

T

TAIT, John Mitchell: Director, Sterling Radio Ltd., 27 Abercrombie 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 Department. B.G.E. 1931. Born 11/12/1899.

TAYLOR, John Peebles: Sales Manager, Commonwealth Moulding Company Ltd., 242

Princes Highway, Arncliffe, N.S.W. Served in A.I.F. Engaged in radio service 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), 29-39 Botany Road, Mascot. 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: Tattersall's. Recreations: Golf, surfing, fishing. Born 11/7/1904.

THOMAS, Alfred: Manager for Philips Lamps (A/sia) Ltd., Adelaide Branch. G.E.C. Eng-

land before and after war, three years Ireland wholesale radio early days. Came to Australia 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 Street, 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.

TRACKSON, Philange S.: Managing Director, Trackson Bros. Ltd., 157-159 Elizabeth St., Brisbane. Assoc. M.I.E.E., London. Private address: "Norvie," 102 Racecourse Road, Ascot, Brisbane.

TREE, Ernest E.: A.M. Inst. R.E. (Aust.) and Member Sydney Division Committee I.R.E. Proprietor, Tree Radio-Electric Co., 128 Willoughby Road, Crow's Nest, N.S.W. Captain Singer Car Club, N.S.W. President Radio Retailers' Association of N.S.W. Associate of Illuminating Engineering Society. Born, 1904.

TISBURY, Frederick H.: Publicity Manager, The Ever-Ready Co. (Aust.) Ltd., Mar-

shall 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 Peter-

sham Inter. High School and Sydney Technical College. Recreation: Cricket. Private address: 24 Narooma Rd., Northbridge.

TRENAM, Harold C.: Managing Director, Standard Telephones and Cables (A/sia) Ltd., 258 Botany Road, Alexandria, N.S.W. 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 and Cables Ltd., London. To 1932, Managing Director Creed and Co. Ltd. Telegraph Engineers, London. Director Standard Telephones and Cables Ltd., London. Director International Telephone and Telegraph Co. Ltd., 1933, came to Australia in present position.

TUIT, Percy George: Chairman of Directors of Kreisler (A/sia) Ltd., Myrtle Street, Chippendale, N.S.W. Member of Millions Club and City Tattersall's Club. Born, 1896. Reconstructed the old Kreisler Radio Co. in October, 1933. Home address: Latimer Road, Bellevue Hill.

WHO'S WHO (Continued.)

TYLER, C. F.: In charge of sales promotion and dealer welfare of the Gramophone Co. Ltd., 2 Parramatta Road, Homebush. 3 years with the Gramophone Co. in England. 7 years in Australia.

TYLER, Herbert Murray: Sales Engineer, Stromberg-Carlson (Aust.) Ltd. M. Inst.

R.E. (Aust.) Diploma Trade Certificate, W.I.A. Educated at Technical High School. Service Engineer Anthony Hordern's many years. Private address: Rosedale Road, Gordon. Born, 18/4/06.

TYRELL, Charles W., M. Inst. R.E. (Aust.): Technical

Superintendent Philips Lamps (A/sia) Ltd., Sydney. Councillor I.R.E. (Aust.). Joined Philips 1930. Private address: "Mentone," Beach Street, Coogee. Born, 8/11/05. Captain 2nd Divisional Signals.

V

VAN GESSEL, Karel Marinus: Philips Lamps (A/sia) Ltd., Valve Factory, 100 Mallet St., Camperdown, N.S.W. Has had 18 years' experience in valve making in Philips Company, Holland. Four trips to U.S.A. to study manufacture of American types, glass and metal. Has had experience in condenser making and neon lamps. Private address: "Villa Maria," Yosefa Avenue, Warrawee, N.S.W. Born 4/1/1901, Hertogenbroch, Holland.

VARDON, 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 Road, Fullarton. Married. Born Unley, 30/4/05. Adelaide Rowing Club. Recreations: Rowing and tennis.

VAUGHAN, C. H.: General Manager, Fox & MacGillycuddy Ltd., 57 York Street, Sydney, N.S.W. Private address: Newlyn, Nichol Parade, Strathfield, N.S.W. Born Sydney 25/6/1911.

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. Joined E.T.C. July, 1934; visited U.S.A. on business during 1936. Private address: 182 Queen Street, Ashfield. Born 21/7/'07. Recreations: Tennis and billiards.

VEALL, Arthur J. Governing Director, A. J. Veall and 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.

W

WADHAM, Kevin: Sales Manager National Radio Corporation Ltd., 96 Pirie Street, 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, Maxwell Allen George: Joint Managing Director, International Resistance Co. A/sia Ltd., 55 Addison Road, Marrickville.

WALKER, Ross M.: Manager Radio and 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. Private address: 10 Fairmont Avenue, Camberwell, E7, Vic. 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 Thursday Island 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.

WARNER, Arthur: Educated at St. George Monoux Grammar School, Essex, England. Born, 1899. Educated in the first place in telephone engineering

with Western Electric and Siemens in the early part of the War. Served 2 years as a lieutenant in the R.M.A.S. during the War, and came to Australia just after. Qualified as accountant in Federated Institute of Accountants, Australia. Started Wireless Tasmania Pty. Ltd. in 1922, and in February, 1923, amalgamated with Louis Cohen Wireless Pty. Ltd., Melbourne, which company later bought out Radio Corporation of Australia Ltd., the name later being changed to Radio Corporation Pty. Ltd., manufacturers of Astor Receivers. Joint Managing Director of Radio Corporation Pty. Ltd. Hobbies: A little golf and some tennis. Father in radio business in England under the name of A. Warner and Sons.

WEBB, A. L. C.; Managing Director Rola Co. Aust. Pty. Ltd., 81-3 City Road, Sth. Melbourne, Vic. Private address: Berkley Court, Toorak Rd., Toorak. 'Phone U1130. Recreations: Flying. Married. Born, St. Kilda.

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, 1929. Marconi School Training and Diploma. Became Technical Sales Manager of E. F. Wilks and Co. Ltd., Sydney, in 1936. Born, 1906.

WELSH, Charles O.: Director since 1931, Eclipse Radio Pty. Ltd. Born, March, 1892. Private address: 11 Vickery Street, Bentleigh.

WERRING, O. C.: Proprietor, Werring Radio Co., 213-215, Queensberry Street, Carlton, Melbourne. Commenced as radio manufacturer in 1924. Clubs: Royal Brighton Yacht Club, Elsternwick Club. Private address: 58 Lewisham Road, Windsor, Melbourne. Born, Sydney, 13/8/1906.

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.

WETLESS, A. P. J.: Proprietor, Wetless Electric Manufacturing Co., 281 Prince's Highway, St. Peters. Electrical Engineer, specialised in condenser manufacture since 1923.

WHITBURN, Douglas Roy: Manager City Radio Department, Savery's Pianos Ltd., 29 Rundle Street, Adelaide, S.A. Member W.I.A. (S.A. Division). Secretary W.I.A. 1927-31, President 1931-32. Amateur Radio VK5BY 1927. Started in radio 1928 with Mechanical Supplies Ltd., transferred to Savery's Pianos Ltd., 1929. Sales Manager Radio Wholesalers Ltd., 29 Rundle St., Adelaide, 1933. Resigned to join A. G. Healing Ltd. as Manager Retail Radio Department. Accepted present position 1935. Recreation: Tennis, Amateur Radio. Born July, 1904.

WHITE, F.: Superintendent Quantity Production Factory, Amalgamated Wireless (A/sia) Ltd. Educated Sydney Technical College, Ultimo. Trades Course & Diploma Course. Joined A.W.A. August, 1915, and left in 1929 to join Raycophone as Works Manager; resumed at A.W.A. October, 1933, in Special Products Factory, then transferred to Quantity Production Factory. Born 5/6/1900, Sydney.

WHITE, Gilford James, Technician-in-Charge Service Maintenance Laboratory, Charles Birks & Co. Ltd., 44-58 Rundle Street, Adelaide. Educated Thebarton Technical High School. Took electrical engineering course at Adelaide University completing course S.A. School of Mines. Holder of broadcast station operator's certificate. Fellow of Television Society of Gt. Britain, Assoc. Mem. Inst. of Radio Engineers, Mem. W.I. Aust. Lecturer Wireless Institute, S.A. Division. Private address: Galway Avenue, Broadview. Born, Adelaide, 25/4/15.

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: Recreations: Cricket, tennis, swimming.

WILLIAMS, C. J., A.I.C.A., A.C.A.A.: Assistant General Superintendent and Works Accountant, A.W.A. Ltd., Ashfield, N.S.W. Educated Double Bay

WHO'S WHO (Continued.)

WILLIAMS, C. J. (Cont.)

Superior Public School. Joined Navy August, 1914, and served until December, 1918. Joined A.W.A. December, 1918. Member of Council Cost Research Society of Australia. Born 10/7/1892.

WILLIAMS, George F., M. Inst. R.E. Aust.: Chief Laboratory 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, 13/5/1892.

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.

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 advertising. Joined Philips Lamps 1927. Private address: 4 Clement Street, Rushcutters Bay (F3438). Recreations, golf, tennis.

WRIGHT, R. G. C.: Amalgamated Wireless (A/sia) Ltd., 47 York Street, Sydney. Commenced Wireless by joining troop ship "Ceramic" 1916. Graduated Marconi School of Wireless, 1919. Joined A.W.A. Marine staff 1921. Transferred to A.W.A. Sales Department, 1927. At present A.W.A. Metropolitan Radiola Sales Representative. Born 5/6/'01, Auckland, N.Z.

WYLES, David G., M. Inst. R.E. (Aust.), M. Inst. R.E.

(U.S.A.): Technical and Commercial Manager, Radio Division, Philips Lamps (A/sia) Ltd., 69-73 Clarence Street, Sydney. Councillor Institution Radio Engineers Aust. Served engineering apprenticeship. Joined Amalgamated Wireless, 1914. Visited Europe, Gt. Britain 1922-23, investigating radio on behalf of 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 Philips Lamps, 1933 and 1935. Private address: 36 Burra Road, Artarmon. Born Adelaide, 20/7/94.

WYNNE, Wallis Watkin: Amalgamated Wireless (A/sia) Ltd., 167 Queen Street, Melbourne, Vic. Joined A.W.A. Sydney in 1923. Wide experience all A.W.A. sales activities. Now in charge Victorian Country Sales Section at A.W.A., Melbourne, where located for the past two years. Born Bondi, N.S.W., 2/9/'07. Private address: 339 Dandenong Road, East Malvern, S.E.5, Vic.

Y

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, 44 Glen Eira Road, Elsternwick, Vic. Born, 26/7/-'06. Recreation: Cricket.

YELLAND, Leslie J.: Proprietor, Grand Opera Radio, 44 Glen Eira Road, Elsternwick, Vic. Certified electrical engineer (Australia). Entered business in 1927 as Grand Opera Radio. Born Maldon, 24/8/03. Private address: 4 Peacock Street, Middle Brighton, S.5, Vic.

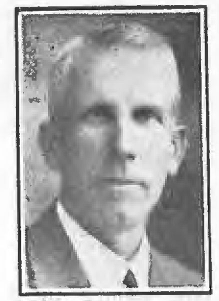
YOUNG, Frederick Cavin: Sales Manager, Battery Section, Clyde Engineering Co. Ltd., Wentworth Ave., Sydney. Member Australian Institute Marine Engineers. Served apprenticeship general engineering at Clyde Engineering Works, Granville, N.S.W., and took full engineering course at Granville Technical College. 1910-1914, had 4 years' service as Marine Engineer. At outbreak of war enlisted in Field Engineers and transferred to A.N. and M.F., eventually rising to rank of 1st Lieutenant. Rejoined Clyde Co,

YOUNG, F. C.

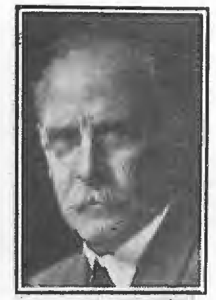
1923, in General Engineering Section, and became foreman engineer-fitter in steel car construction dept. Feb., 1929, appointed Production Manager, Battery Dept., and Sales Manager in Oct., 1935. Interested in Masonic and returned soldier movements. Private address: "Looee," Kuroki St., Penshurst, N.S.W.

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.

The Members of the Australian Broadcasting Commission



Mr. W. J. Cleary, Chairman A.B.C.



Mr. Herbert Brookes, Vice-Chairman A.B.C.

Hon. R. B. Orchard Commissioner.

Mr. J. W. Kitto Commissioner.

Mrs. Claude Couchman. Commissioner.

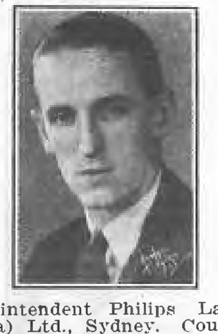
WHO'S WHO (Continued.)

TYLER, C. F.: In charge of sales promotion and dealer welfare of the Gramophone Co. Ltd., 2 Parramatta Road, Homebush. 3 years with the Gramophone Co. in England. 7 years in Australia.

TYLER, Herbert Murray: Sales Engineer, Stromberg-Carlson (Aust.) Ltd. M. Inst.

R.E. (Aust.) Diploma Trade Certificate, W.I.A. Educated at Technical High School. Service Engineer Anthony Hordern's many years. Private address: Rosedale Road, Gordon. Born, 18/4/06.

TYRELL, Charles W., M. Inst. R.E. (Aust.): Technical



Superintendent Philips Lamps (A/sia) Ltd., Sydney. Councillor I.R.E. (Aust.). Joined Philips 1930. Private address: "Mentone," Beach Street, Coogee. Born, 8/11/05. Captain 2nd Divisional Signals.

V

VAN GESSEL, Karel Marinus: Philips Lamps (A/sia) Ltd., Valve Factory, 100 Mallet St., Camperdown, N.S.W. Has had 18 years' experience in valve making in Philips Company, Holland. Four trips to U.S.A. to study manufacture of American types, glass and metal. Has had experience in condenser making and neon lamps. Private address: "Villa Maria," Yosefa Avenue, Warrawee, N.S.W. Born 4/1/1901, Hertogenbroch, Holland.

VARDON, 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 Road, Fullarton. Married. Born Unley, 30/4/05. Adelaide Rowing Club. Recreations: Rowing and tennis.

VAUGHAN, C. H.: General Manager, Fox & MacGillycuddy Ltd., 57 York Street, Sydney, N.S.W. Private address: Newlyn, Nichol Parade, Strathfield, N.S.W. Born Sydney 25/6/1911.

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. Joined E.T.C. July, 1934; visited U.S.A. on business during 1936. Private address: 182 Queen Street, Ashfield. Born 21/7/'07. Recreations: Tennis and billiards.

VEALL, Arthur J. Governing Director, A. J. Veall and 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.

W

WADHAM, Kevin: Sales Manager National Radio Corporation Ltd., 96 Pirie Street, 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, Maxwell Allen George: Joint Managing Director, International Resistance Co. A/sia Ltd., 55 Addison Road, Marrickville.

WALKER, Ross M.: Manager Radio and 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. Private address: 10 Fairmont Avenue, Camberwell, E7, Vic. 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 Thursday Island 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.

WARNER, Arthur: Educated at St. George Monoux Grammar School, Essex, England. Born, 1899. Educated in the first place in telephone engineering

with Western Electric and Siemens in the early part of the War. Served 2 years as a lieutenant in the R.M.A.S. during the War, and came to Australia just after. Qualified as accountant in Federated Institute of Accountants, Australia. Started Wireless Tasmania Pty. Ltd. in 1922, and in February, 1923, amalgamated with Louis Cohen Wireless Pty. Ltd., Melbourne, which company later bought out Radio Corporation of Australia Ltd., the name later being changed to Radio Corporation Pty. Ltd., manufacturers of Astor Receivers. Joint Managing Director of Radio Corporation Pty. Ltd. Hobbies: A little golf and some tennis. Father in radio business in England under the name of A. Warner and Sons.

WEBB, A. L. C.; Managing Director Rola Co. Aust. Pty. Ltd., 81-3 City Road, Sth. Melbourne, Vic. Private address: Berkley Court, Toorak Rd., Toorak. 'Phone U1130. Recreations: Flying. Married. Born, St. Kilda.

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, 1929. Marconi School Training and Diploma. Became Technical Sales Manager of E. F. Wilks and Co. Ltd., Sydney, in 1936. Born, 1906.

WELSH, Charles O.: Director since 1931, Eclipse Radio Pty. Ltd. Born, March, 1892. Private address: 11 Vickery Street, Bentleigh.

WERRING, O. C.: Proprietor, Werring Radio Co., 213-215, Queensberry Street, Carlton, Melbourne. Commenced as radio manufacturer in 1924. Clubs: Royal Brighton Yacht Club, Elsternwick Club. Private address: 58 Lewisham Road, Windsor, Melbourne. Born, Sydney, 13/8/1906.

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.

WETLESS, A. P. J.: Proprietor, Wetless Electric Manufacturing Co., 281 Prince's Highway, St. Peters. Electrical Engineer, specialised in condenser manufacture since 1923.

WHITBURN, Douglas Roy: Manager City Radio Department, Savery's Pianos Ltd., 29 Rundle Street, Adelaide, S.A. Member W.I.A. (S.A. Division). Secretary W.I.A. 1927-31, President 1931-32. Amateur Radio VK5BY 1927. Started in radio 1928 with Mechanical Supplies Ltd., transferred to Savery's Pianos Ltd., 1929. Sales Manager Radio Wholesalers Ltd., 29 Rundle St., Adelaide, 1933. Resigned to join A. G. Healing Ltd. as Manager Retail Radio Department. Accepted present position 1935. Recreation: Tennis, Amateur Radio. Born July, 1904.

WHITE, F.: Superintendent Quantity Production Factory, Amalgamated Wireless (A/sia) Ltd. Educated Sydney Technical College, Ultimo. Trades Course & Diploma Course. Joined A.W.A. August, 1915, and left in 1929 to join Raycophone as Works Manager; resumed at A.W.A. October, 1933, in Special Products Factory, then transferred to Quantity Production Factory. Born 5/6/1900, Sydney.

WHITE, Gilford James, Technician-in-Charge Service Maintenance Laboratory, Charles Birks & Co. Ltd., 44-58 Rundle Street, Adelaide. Educated Thebarton Technical High School. Took electrical engineering course at Adelaide University completing course S.A. School of Mines. Holder of broadcast station operator's certificate. Fellow of Television Society of Gt. Britain, Assoc. Mem. Inst. of Radio Engineers, Mem. W.I. Aust. Lecturer Wireless Institute, S.A. Division. Private address: Galway Avenue, Broadview. Born, Adelaide, 25/4/15.

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: Recreations: Cricket, tennis, swimming.

WILLIAMS, C. J., A.I.C.A., A.C.A.A.: Assistant General Superintendent and Works Accountant, A.W.A. Ltd., Ashfield, N.S.W. Educated Double Bay

WHO'S WHO (Continued.)

WILLIAMS, C. J. (Cont.)

Superior Public School. Joined Navy August, 1914, and served until December, 1918. Joined A.W.A. December, 1918. Member of Council Cost Research Society of Australia. Born 10/7/1892.

WILLIAMS, George F., M. Inst. R.E. Aust.: Chief Laboratory 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, 13/5/1892.

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.

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 advertising. Joined Philips Lamps 1927. Private address: 4 Clement Street, Rushcutters Bay (F3438). Recreations, golf, tennis.

WRIGHT, R. G. C.: Amalgamated Wireless (A/sia) Ltd., 47 York Street, Sydney. Commenced Wireless by joining troop ship "Ceramic" 1916. Graduated Marconi School of Wireless, 1919. Joined A.W.A. Marine staff 1921. Transferred to A.W.A. Sales Department, 1927. At present A.W.A. Metropolitan Radiola Sales Representative. Born 5/6/'01, Auckland, N.Z.

WYLES, David G., M. Inst. R.E. (Aust.), M. Inst. R.E.

(U.S.A.): Technical and Commercial Manager, Radio Division, Philips Lamps (A/sia) Ltd., 69-73 Clarence Street, Sydney. Councillor Institution Radio Engineers Aust. Served engineering apprenticeship. Joined Amalgamated Wireless, 1914. Visited Europe, Gt. Britain 1922-23, investigating radio on behalf of 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 Philips Lamps, 1933 and 1935. Private address: 36 Burra Road, Artarmon. Born Adelaide, 20/7/94.

WYNNE, Wallis Watkin: Amalgamated Wireless (A/sia) Ltd., 167 Queen Street, Melbourne, Vic. Joined A.W.A. Sydney in 1923. Wide experience all A.W.A. sales activities. Now in charge Victorian Country Sales Section at A.W.A., Melbourne, where located for the past two years. Born Bondi, N.S.W., 2/9/'07. Private address: 339 Dandenong Road, East Malvern, S.E.5, Vic.

Y

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, 44 Glen Eira Road, Elsternwick, Vic. Born, 26/7/-'06. Recreation: Cricket.

YELLAND, Leslie J.: Proprietor, Grand Opera Radio, 44 Glen Eira Road, Elsternwick, Vic. Certified electrical engineer (Australia). Entered business in 1927 as Grand Opera Radio. Born Maldon, 24/8/03. Private address: 4 Peacock Street, Middle Brighton, S.5, Vic.

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. and M.F., eventually rising to rank of 1st Lieutenant. Rejoined Clyde Co,

YOUNG, F. C.

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.

The Members of the Australian Broadcasting Commission

Mr. W. J. Cleary, Chairman A.B.C.

Mr. Herbert Brookes, Vice-Chairman A.B.C.

Hon. R. B. Orchard Commissioner.

Mr. J. W. Kitto Commissioner.

Mrs. Claude Couchman. Commissioner.

EXECUTIVE OFFICERS OF THE AUSTRALIAN BROADCASTING COMMISSION

MOSES, Charles Joseph Alfred: General Manager of Australian Broadcasting Commission. 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. 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 1, 1935, appointed Federal Liaison Officer, and on November 1, 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.

BEARUP, Thomas William: Federal Superintendent Aust. Broadcasting Commission, and previously manager for Victoria. Joined Amalgamated Wireless (A/sia) Ltd., in 1916. Visited England to investigate, inter alia, developments in broadcasting. December, 1923, joined 2FC

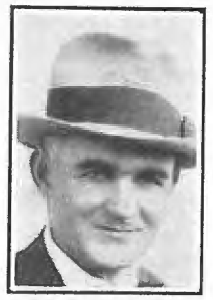
at its opening. October, 1924-July, 1929, Studio Manager 3LO—3AR, Melbourne. July, 1929-June, 1932, Victorian Manager Australian Broadcasting Commission. March, 1936, visited overseas on behalf of the Commission. Appointed present position June, 1937.

HORNER, H. G.: Manager for A.B.C. in N.S.W. Educated at King's College, Canterbury; thereafter for a period of approximately three years travel-

led 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.

KIRKE, Basil: Vic. Manager for A.B.C. 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 A.B.C. in W.A. in 1930.

KIRKE, Basil.



THOMAS, L. R., Lieut.-Col.: A.B.C. Manager for S.A., 1937. 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 1933-1934. Manager in Tasmania prior to present position.

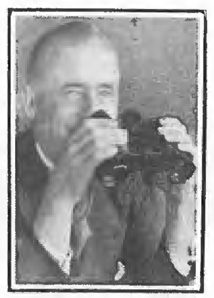
WICKS, C. C.: Acting-Manager for Tasmania comes from Western Australia. He joined Perth Division of Australian

Broadcasting Commission in 1929, commencing as accountant and controller of sporting broadcasts. Was made Programme Controller for Western Australia in 1936 and was appointed acting-Manager for Tasmania in 1937. Before going to Tasmania he was sent from Perth to Adelaide to take part in the Test match descriptions for the Commission.

FINLAY, A. N.: Recently appointed Queensland Manager of Australian Broadcasting Commission. Previously sporting

editor N.S.W. National Stations. Educated Sydney Grammar School and St. Andrew's College, Sydney University, where he studied law. Was Associate to Mr. Justice James three years. Was a member of the "Waratahs" football team. Later joined teaching staff of Sydney Grammar, specialising in sport and coaching Grammar crews for "Head of the River" race for five years. He represented Grammar and Sydney University at rowing, football, athletics and swimming. Won blues for rowing and football at University and was captain of the University football team. Represented N.S.W. in Rugby Union 1926-1931, and was captain of N.S.W. team for three years. Was vice-captain of Australian Rugby Union team 1929-1930. Generally excelled in most sports.

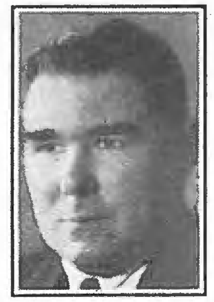
CHARLTON, Conrad: A.B.C. Manager for West Australia. Born in New Zealand. Saw ac-



tive service in Egypt and France with the N.Z. forces during the war. Rose from ranks to captain. Was badly knocked about at the Battle of the Somme and only through skill of Colonel Rigby, later Sir Hugh Rigby and physician to the late King that Mr. Charlton was able to walk again. After war was appointed vocational training officer to N.Z. Defence Department to organise training of returned soldiers in various occupations. Later came to Australia, took up the stage and eventually joined staff of 3LO National Station. Later joined 2FC. In his younger days was a prominent Rugby Union wing three-quarter in N.Z. and the army. Specialises in raising of poultry and pigeons.

EXECUTIVE OFFICERS OF THE AUSTRALIAN BROADCASTING COMMISSION.

BARRY, Dr. Keith: Federal controller of programmes for Australian Broadcasting Commission. Born at Parramatta, N.S.W., educated at Sydney Grammar and Sydney University, graduating M.B. and Ch.M.



degrees. Served as Captain in British Army during war. Although a medical practitioner. Dr. Barry has been associated with the musical life of Sydney since he graduated. Has broadcast in many countries and on the A.B.C. on many occasions prior to his appointment to the Broadcasting Commission. He is an experienced film critic, writer and music critic. He is the author of "Music and the Listener," and his brochure "Chopin and His Doctors" has been translated into French and German. In 1936 Dr. Barry returned from a two years trip to Europe where he studied broadcasting very extensively.

JAMES, W. G.: Federal controller of music of the Australian Broadcasting Commis-

sion. A brilliant pianist, has appeared at the Queen's Hall, as celebrity artist in a season when Kreisler, Melba, and other world-famous artists were engaged. His compositions are widely known, perhaps the most familiar being his six Australian bush songs, which are frequently heard over the air sung by Peter Dawson. He has been engaged in broadcasting for about 11 years.

CLEWLOW, F. D.: Federal Controller of Productions of the Australian Broadcasting Commission. Became associated with National broadcasting in

1932. Is frequently invited to adjudicate in the speech sections of eisteddfods. Has had wide experience in broadcasting including the supervision of variety, vaudeville and musical comedy as well as the more serious forms of drama.

McCALL, Robert: Controller of celebrity concerts of the Australian Broadcasting Commission. Joined the Commission Federal staff as programme

editor in October, 1936. Was previously Record Sales Manager for the Columbia Graphophone Company. Has a wide knowledge of music and of the recorded type. He is in charge of the Federal record library for the A.B.C.

Australian Radio Publications

THE following details concern the various publications issued by Australian Radio Publications Ltd. Head office, 30 Carrington Street, Sydney, 'phone B7188 (3 lines). Branch office, Mingay Publishing Co., 422 Little Collins Street, Melbourne, 'phone M5438. Interstate representatives:—C. R. Porter, C/- Broadcast Services, Queensland National Buildings, Cnr. George and Turbot Streets, Brisbane, 'phone B9659; H. L. Russack, C.M.L. Building, King William Street, Adelaide, phone C1.3244.

Managing Director and Managing Editor, Oswald F. Mingay, M. Inst. R.E. Aust. Technical Editor, J. R. Edwards, A.M. Inst. R.E. Aust. Advertising Manager, G. W. Doyle. Advertising Rep., E. R. Clark. Melbourne Rep.: R. W. Pfeil.

Publishers of BROADCASTING BUSINESS (weekly business paper for commercial broadcasting station activities); BROADCASTING BUSINESS YEAR BOOK (containing all reference matter for those interested in commercial broadcasting); RADIO RETAILER OF AUSTRALIA (established 1930; weekly trade journal covering the radio industry throughout Australia); RADIO REVIEW (monthly technical publication, recording the progress of radio in Australia); RADIO TRADE ANNUAL (an annual publication, published about May of each year, containing all reference matter required by those engaged in radio).

BROADCASTING BUSINESS, published by Australian Radio Publications Ltd., 30 Carrington Street, Sydney. National weekly trade paper covering activities of commercial broadcasting stations throughout the Commonwealth, issued every Thursday. Circulates to broadcasting stations, advertising agents, national advertisers, etc. Price 6d. per copy, or by subscription, 15/- p.a. (52 issues post free), including copy of the Broadcasting Year Book. Advertising page size 9in. x 7in., three 13 em. columns (2-1/6in) per page. Overall size 11in. x 8¾in. Blocks, half tone, 110 screen.

BROADCASTING BUSINESS YEAR BOOK, published annually, about July, by Australian Radio Publications Ltd., 30 Carrington Street, Sydney. Contains full particulars of all commercial stations in the Commonwealth, also various acts, regulations, applicable to broadcasting; complete survey of listeners' licence figures, and includes a who's who in broadcasting. 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 9in. x 7in., two columns 20 ems (3¼in.) per page. Overall size 11in. x 8¾in. First published in 1936.

RADIO RETAILER OF AUSTRALIA, published by Australian Radio Publications Ltd., 30 Carrington Street, Sydney. The only national weekly trade newspaper covering the radio industry in Australia, dealing chiefly with the merchandising side of all radio and electrical domestic appliances, and service problems.. Subscription 15/- p.a., 6d. per copy. Advertising page size 9in. x 7in., three 13 em columns (2-1/6 in.) per page. Overall size 11ins. x 8¾ ins. Blocks half tone, 110 screen.

RADIO TRADE ANNUAL OF AUSTRALIA, published about May of each year, by Australian Radio Publications Ltd., 30 Carrington Street, Sydney. A stiff-covered cloth bound year book, published every year since 1933. Contains over 300 pages, covering all subjects allied to radio, including particulars of broadcasting stations; wireless acts and regulations; patents information; trade association data; manufacturers and wholesalers' directory; a who's who in radio, and over 100 pages of up-to-date technical information of interest to all technical men. Price 10/- per copy, post free (included in subscription to Radio Retailer). Overseas price 15/- per copy. post free. Advertising page size 9ins. x 7ins., two columns 20 ems (3¼in.) per page. Overall size 11ins. x 8¾ins. Blocks half tone, 110 screen.

RADIO REVIEW OF AUSTRALIA, published by Australian Radio Publications Ltd., 30 Carrington Street, Sydney. A monthly technical journal covering the technical side of all radio activities in Australia. Price 1/- per copy, or by subscription, 10/- p.a., post free. Advertising page size 9ins. x 7ins., columns 20 ems 3¼ins., and also 13 ems 2-1/6ins. Overall size 11ins. x 8¾ins. Block half tone, 110 screen.

VALVE SOCKET CONNECTIONS

(Continued from Page 275.)

"Straight" R. F. Tetrodes and Pentodes

Type	Base	1	2	3	4	5	6	7	8	Cap
15	UY	F	P	Sc	C	F	—	—	—	G
32	UX	F+	P	Sc	F—	—	—	—	—	G
1B4	UX	F+	P	Sc	F—	—	—	—	—	G
IK4	UX	F+	P	Sc	F—	—	—	—	—	G
1E5G	O	S	F+	P	Sc	—	—	F—	—	G
SP2	6	F	Sc	M	G	Su	F	—	—	P
KFI	6	F	Sc	M	G	Su	F	—	—	P
KF4	P	M	F	F	—	Su	—	Sc	P	G
S23	UX	F+	Sc	G	F—	—	—	—	—	P
57	6	F	P	Sc	Su	C	F	—	—	G
SP4	7	F	C	Sc	M	G	—	F	—	P
E446	7	F	C	Sc	M	G	—	F	—	P
AF7	P	M	F	F	C	Su	—	Sc	P	G
MS4B	UY	F	Sc	G	C	F	—	—	—	P
EF6	P	M	F	F	C	Su	—	Sc	P	G
77	6	F	P	Sc	Su	C	F	—	—	G
6C6	6	F	P	Sc	Su	C	F	—	—	G
6J7	O	S	F	P	Sc	Su	—	F	C	G
DSB	UY	F	Sc	G	C	F	—	—	—	P
CF1	P	M	F	F	C	Su	—	Sc	P	G

Rectifiers

Type	Base	1	2	3	4	5	6	7	8	Cap
OZ4	O	S	—	P	—	P	—	—	C	—
U12	UX	F	P	P	F	—	—	—	—	—
MU12	UX	F	P	P	FC	—	—	—	—	—
U14	UX	F	P	P	F	—	—	—	—	—
MU14	UX	F	P	P	FC	—	—	—	—	—
DW4	UX	F	P	P	F	—	—	—	—	—
1561	UX	F	P	P	F	—	—	—	—	—
IW3	UX	F	P	P	FC	—	—	—	—	—
1867	UX	F	P	P	FC	—	—	—	—	—
AZ3	P	—	F	F	C	P	—	—	P	—

Type	Base	1	2	3	4	5	6	7	8	Cap
80	UX	F	P	P	F	—	—	—	—	—
83	UX	F	P	P	F	—	—	—	—	—
83V	UX	F	P	P	FC	—	—	—	—	—
5Z3	UX	F	P	P	F	—	—	—	—	—
5Y3 (G)	O	—	F	—	P	—	P	—	F	—
5Z4	O	S	F	—	•P	—	P	—	FC	—
5W4	O	S	F	—	P	—	P	—	F	—
5V4G	O	—	F	—	P	—	P	—	FC	—
5X4G	O	—	—	P	—	P	—	F	F	—
EZ4	P	—	F	F	C	P	—	—	P	—
EZ3	P	—	F	F	C	P	—	—	P	—
EZ2	P	—	F	F	C	P	—	—	P	—
IV	UX	F	P	C	F	—	—	—	—	—
84/6Z4	UY	F	P	P	C	F	—	—	—	—
6X5	O	S	F	P	—	P	—	F	C	—
12Z3	UX	F	P	C	F	—	—	—	—	—
25Z5	6	F	P1	C1	C2	P2	F	—	—	—
25Y5	6	F	P1	C1	C2	P2	F	—	—	—
25Z6	O	C	F	P1	C1	P2	—	F	C2	—
CY2	P	C1	F	F	C2	P1	—	—	P2	—

Class "B" Output Valves

Type	Base	1	2	3	4	5	6	7	8	Cap
19	6	F	P1	G1	G2	P2	F	—	—	—
1J6G	O	S	F	P1	G1	G2	P2	F	—	—
30	UX	F+	P	G	F—	—	—	—	—	—
49	UY	F+	P	G1	G2	F	—	—	—	—
PM2BA	6	F	P1	G1	G2	P2	F	—	—	—
PM2B	6	F	P1	G1	G2	P2	F	—	—	—
B240	6	F	P1	G1	G2	P2	F	—	—	—
KDD1	P	—	F	F	—	P1	G2	G1	P2	—
B21	6	F	P1	G1	G2	P2	F	—	—	—
46	UY	F+	P	G1	G2	F	—	—	—	—
53	7	F	P1	G1	C	G2	P2	F	—	—
6A6	7	F	P1	G1	C	G2	P2	F	—	—
6N7	O	S	F	P1	G1	G2	P2	F	C	—

List and Index of Advertisers

GENERAL INDEX

A

B

C

GENERAL INDEX (Cont.)

D

E

F

G

H

I

GENERAL INDEX (Cont.)

J

K

L

M

N

O

P

Q

GENERAL INDEX (Cont.)

R

S

T

U

V

W

GENERAL INDEX (Cont.)

CONTENTS TABLE

GENERAL INDEX (Cont.)

CONTENTS TABLE


Radio's most famous components
THE FINE VALVES OF RADIO
K
KEN-RAD
Piezo Astatic
CRYSTAL PICKUPS
& MICROPHONES
SOLAR
ELECTROLYTIC CONDENSERS
& "SEALDTITE" PAPER
CONDENSERS
ETC
RESISTORS
HICKOK
METERS
SWITCHES
YAXLEY
VOLUME CONTROLS
The names of Ken-Rad, Solar, Yaxley, Hickock, and Piezo Astatic . . . all famous E.T.C. lines have become the accepted standard of dependability throughout the entire radio industry.
Follow the leadership of the largest and most successful set-manufacturers . . . insist on these lines of initial equipment, and replacements.
Agents for—
Westinghouse X-ray Electronic and Rectifying Valves, United Transmitting Tubes, Visitron Photo-Electric Cells, Graf Lenses, etc.
Factory Representatives:
EASTERN TRADING Co. Ltd.
Sydney and Melbourne