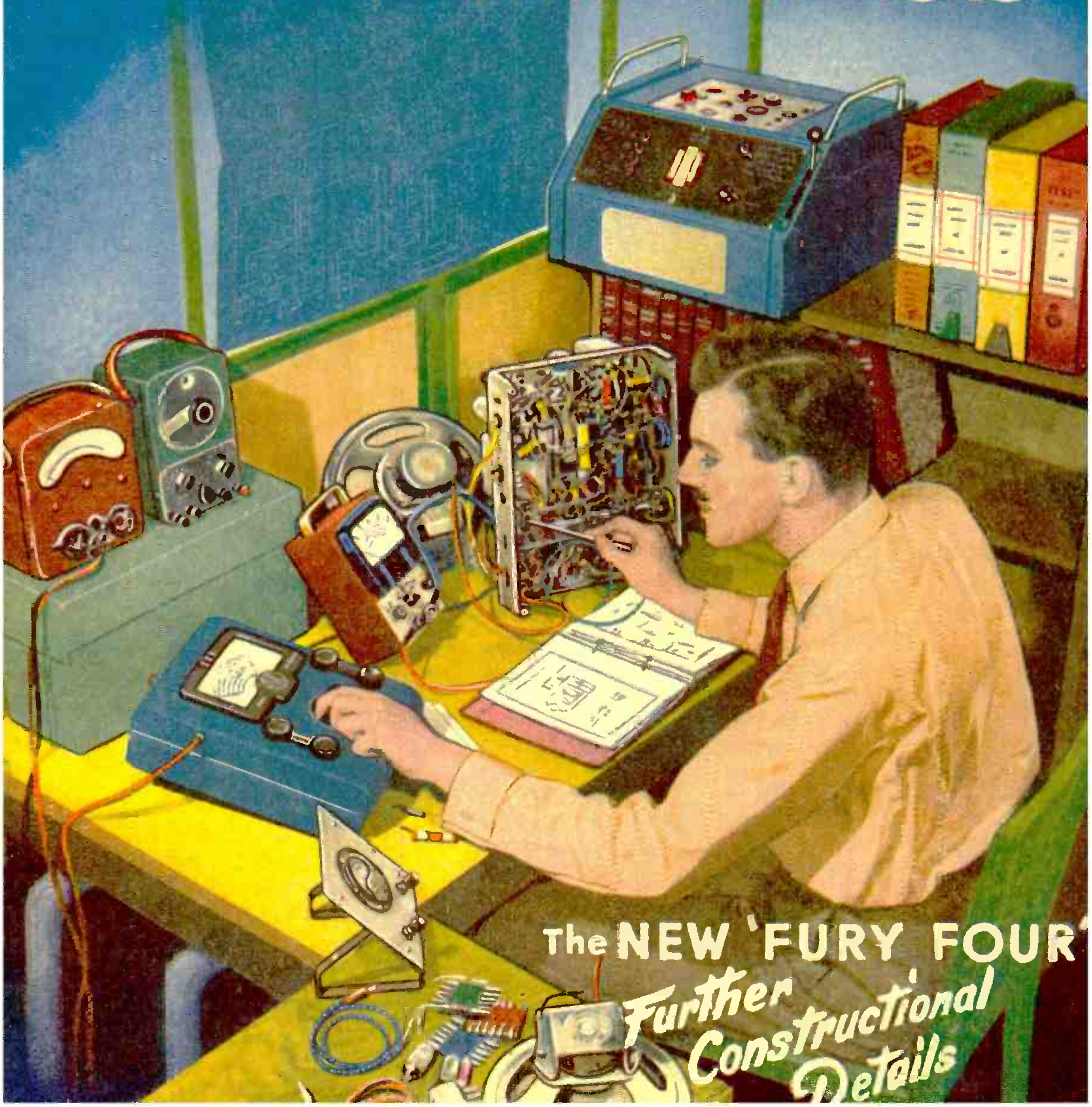
• USING TEST INSTRUMENTS •

PRACTICAL WIRELESS

1/-

JANUARY 1955

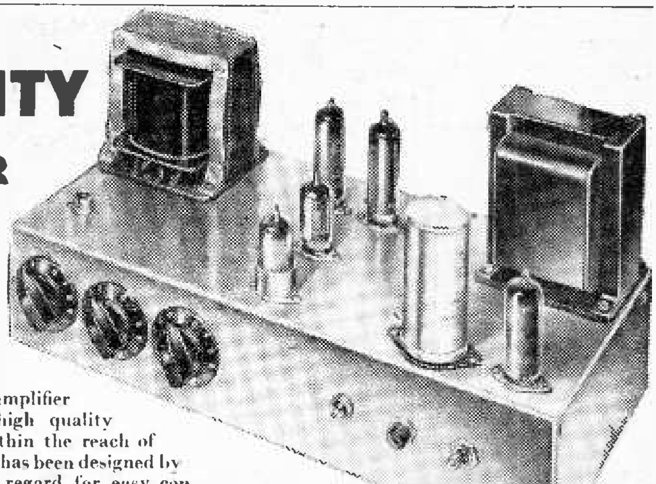
EDITOR: F.J. CAMM



The NEW 'FURY FOUR'

Further Constructional Details

BUILD THIS HIGH QUALITY LOW COST AMPLIFIER



★ Circuit designed by Mullard research engineers.

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Here's an entirely new amplifier circuit which brings high quality sound reproduction within the reach of thousands more enthusiasts. It has been designed by Mullard research engineers with special regard for easy construction and low cost. Full details of the circuit are included in the 2/6 book which is obtainable from radio dealers or direct from Mullard Ltd. Valve Sales Department — 2/10 post free. Get your copy now.

- EASY TO BUILD AT LOW COST
- NEGLIGIBLE DISTORTION AT ALL OUTPUT LEVELS
- UNIFORM FREQUENCY RESPONSE IN AUDIBLE RANGE
- GOOD TRANSIENT RESPONSE
- LOW OUTPUT RESISTANCE
- LOW HUM AND NOISE
- DESIGNED ROUND 5 MULLARD MASTER VALVES — EF86, ECC83 2 x EL84, GZ30 or EZ80

Mullard

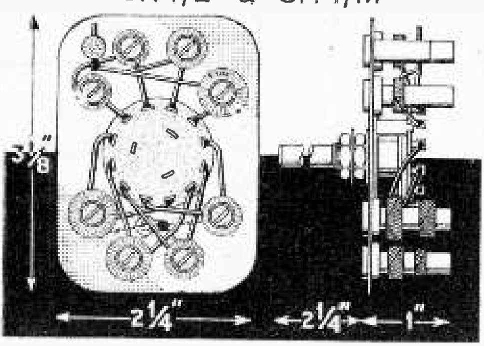
MULLARD LTD., CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2

MVM308A

MAXI-Q REGD.

We GUARANTEE these seven Coil Packs to be the finest of their class in the Country. Mechanical precision, design and technical performance unsurpassed

CP.4/L & CP.4/M



These compact 4-station Coil Packs are available for either — 1 Long wave and 3 Medium wave stations (CP.4/L) or 4 Medium wave stations (CP.4/M). They are fully wired and require only four connections for use with any standard frequency changer valve.

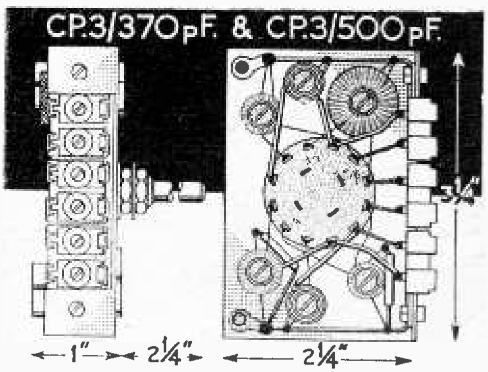
Retail Price of each unit: 25/-, plus 8/4 P.T.—Total 33/4.

With Gram. Position: 31/- plus 10/4 P.T.—Total 41/4.

Send 1/- in stamps for General Catalogue.

Obtainable from all reputable Stockists or in case of difficulty direct from works.

CP.3/370pF. & CP.3/500pF.



These 3 waveband Coil Packs are available for use with either 370 pF or 500 pF tuning condensers. The coverages are: Long wave 800-2,000 metres, Med. wave 200-550 metres, Short wave 16-50 metres. Designed for use with Jackson Bros. Full Vision Drive or SL.8 Spin Wheel Drive.

Retail Price of each unit:

32/-, plus 10/8 P.T.—Total 42/8.

CP.3/G with Gram. Position suitable for use with 500 pF tuning condenser:

39/-, plus 13/- P.T.—Total 52/-.

DENCO (CLACTON) LTD., 357/9 OLD ROAD, CLACTON-ON-SEA

STOP PRESS: "Mullard" "Five-Ten" High Quality Amplifier Chassis, 14/6. Bronze Front Panel for same, 6/6. "Osram" "912" Amplifier Chassis, 14/6. Bronze Front Panel, 6/6.

HENRY'S (RADIO LTD.)

We have over 20,000 American and B.V.A. valves in stock
ALL VALVES NEW AND GUARANTEED

SETS OF VALVES

Ten EF50 (Ex-Brand New Units), 5/- each ... ...45/- Set
6K8G, 6K7G, 6Q7G, 5Z4G, 6V6G ...37/6 ..
1R5, 1S5, 1T4, 1S4, or (3S4 or 3V4) ...27/6 ..
TP25, HL23/DD, VP23, PEN25 (or QP25) ... ...25/- ..
6K8G, 6K7G, 6Q7G, 25A6G, 25Z5 or 25Z6G, ...37/6 ..
12K8GT, 12K7GT, 12Q7GT, 35Z4GT, 35L6GT or 50L6GT 37/6 ..
12A7GT, 12SK7GT, 12SQ7GT, 35Z4GT 35L6GT or 50L6GT 37/6 ..

CRYSTAL MICROPHONE INSERTS

8/6 POST FREE

8/6 POST FREE

Ideal for tape recording and amplifiers. No matching transformer required.

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RF24 20-30 mc/s 15/- post free
RF25 40-50 mc/s 19/6 post free
RF26 50-65 mc/s 35/- post free

1A5GT	10/-	6AK5	9/-	35Z4GT	8/6	TDD2A	8/6	PCC84	12/6
1A7GT	12/6	6J7G	6/6	35Z5GT	8/6	DK40	11/-	PCF82	12/6
1N5GT	11/-	6K7G	6/6	25A6	8/6	UL41	11/-	PEN25	6/6
1LD5	7/6	6K8G	9/-	35L6GT	8/6	UY41	11/-	PEN46	7/6
1R5	7/6	6L6G	10/-	50L6GT	8/6	D41	5/-	QP25	6/6
1S4	7/6	6U5	7/6	42	8/6	KT2	5/-	SP61	4/-
1S5	7/6	6N7GT	7/6	43	8/6	U52	8/6	SP41	4/-
1T4	7/6	6Q7GT	8/6	75	8/6	U19	10/-	HL23/DD	6/6
1C5	8/-	6SJ7GT	8/6	80	8/6	Y63	8/6	VP23	6/6
3A4	9/-	6X5G	8/6	866A	15/-	MU14	8/6	VP41	7/6
3V4	7/6	6SA7GT	8/6	TZ40	37/6	PL81	11/-	U22	8/6
3S4	7/6	6SQ7GT	8/6	931A	50/-	PL82	10/-	ATP4	4/-
5Z3G	8/6	6SG7	7/6	EA50	2/-	PX25	12/6	TP22	8/6
5U4G	8/6	6SK7GT	7/6	ECH35	12/-	PY81	10/-	TH233	10/-
5Z4G	8/6	6SL7GT	9/-	EF54	6/-	PY82	8/6	41MP	7/6
6A7G	8/6	6SN7GT	9/-	EB34	3/6	KT33C	10/-	42SPT	6/-
6AC7	6/6	6SC7	10/-	EBC33	8/6	KT66	12/6	215SG	4/-
6A8G	8/6	6V6GT	7/6	EF36	6/6	GU50	12/6	MS/PEN	7/6
6AM6	9/-	6AG7	12/6	EF39	6/6	XP2V	4/-	MS/PENB	
6B8	7/6	12K7GT	8/6	EY51	12/-	XH (1.5)	4/-		7/6
6C5GT	5/-	12K8GT	8/6	EK32	6/6	VU111	4/-	VT501	7/6
6C6	6/6	12Q7GT	8/6	EF91	9/-	VU133	4/-	AC/PEN(7)	
6D6	6/6	12SA7GT	8/6	EL33	10/-	VU120A	4/-		10/-
6F6G	8/6	12SQ7GT	8/6	EL32	7/6	QP230	8/-	PENDD4020	
6G6G	6/6	12SJ7	8/6	EF50		VR105/30	8/6		12/6
6H6GT	5/-	12SK7	8/6	Red Syl.	10/-	VR150/30	8/6	FC13C	10/-
6J5GT	5/-	12SR7	7/6	EF50	5/-	CK510AX	5/-	VP4(7)	8/6
								ID5	8/6
6J6	9/-	25Z6GT	8/6	SP2	8/6	DI	2/-	EF80	10/6
6L7	7/6	25Z5	8/6	VP2	8/6	AC6PEN	6/6	ECL80	10/6

MORSE PRACTICE BUZZER

Complete with tapper and 4 volt buzzer on baseboard, 6/-, brand new. Post paid.

R.F. OSCILLATOR COIL UNIT

6-18 kV., including EY51 valve. 37/-.

CRYSTALS

200 kc/s, 2-pin (U.S.A.) ... 10/-
465 kc/s, 2-pin (U.S.A.) ... 10/-
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T.C.C. .1/5/7,000 v. wkg. Type CP58Q0. Bakelite Case, 7/6 each.

8-page Catalogue, 3d. Open Mon.-Sat. 9—6. Thurs. 1 p.m.

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This unit contains VCR517 Cathode Ray 6in. tube, complete with Mu-metal screen, 3 EF50, 4 SP61 and 1 5U4G valves, W/W volume controls, resistors and condensers. Suitable either for basis of T/V or Oscilloscope. "Radio Constructor" 'Scope constructional circuit included. 67/6 (plus 7/6 carr.).

Kit of necessary parts, including "182A" Unit, for constructing "Radio Constructor" Oscilloscope, £8/18/6.

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VCR97 (slight cut-off) 15/-
VCR97, guaranteed full T/V Picture ... 40/-
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Carr. & packing on all tubes, 2/-.

DENCO F.M. FEEDER UNIT

Finest Audio available. Complete kit of parts, including drilled chassis, 5 valves: types 6AM6, 12AH8, EB91 and 2 6AB6. Also complete circuit and wiring diagram. £6/7/6. Or assembled and aligned. £8/10/-. Alignment only, 7/6. Demonstration daily.

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INVITE YOU TO BUILD THIS PORTABLE FOR ONLY

6½ GNS.

Full details, circuit diagram, point to point wiring instructions, and complete list of components. Available 2/- ea. Case can be supplied separately. Available in the following attractive colours:

- Lizard Grey;
- Blue;
- Maroon;
- Brown.

Dial, 1/3 each. Chassis, 3/-.

VALVES GUARANTEED AND BOXED

OZ4	6/-	6AJ5	9/-	6K7G	6/-	7H7	8/-	12Q7GT	9/-
1A3	9/-	6AK5	9/-	6K7GT	6/6	7Q7	8/-	12SC7	7/6
1A5GT	6/-	6AL5	7/-	6K7M	6/9	7R7	8/6	12SH7	5/6
1C5GT(DL35)		6AM5	7/6	6K8G	8/-	7S7	8/6	12SJ7	8/6
	8/6	6AM6	7/6	6K8GT	9/6	7Y4	8/6	12SK7	6/6
1L4 (DF92)	7/6	6AQ5	8/6	6L6G	9/-	75	10/-	12SL7	9/-
1LD5	6/9	6AT6	8/-	6L7M	7/6	77	8/-	12SQ7	8/6
1R5	7/6	6B4	6/-	6L18	11/-	80	8/6	12SR7	7/6
1S4	7/6	6B8G	4/-	6N7	7/6	807	7/6	20D1	10/6
1S5	7/6	6BA6	8/-	6Q7G	9/-	8D2	2/9	20F2	12/6
1T4	7/6	6BE6	8/-	6Q7GT	9/-	9001	5/6	20P1	15/-
1U5	8/-	6BR7	9/6	6R7G	8/-	9002	5/6	25A6G	9/-
220VSG	6/9	6BW6	8/6	6SA7GT	8/-	9003	5/6	25L6GT	8/6
2A3	6/9	6C4	8/-	6SG7	7/6	9004	5/6	25U4GT	12/-
2X2	5/-	6C5GT	7/6	6SH7	6/-	9006	6/-	25Y5	9/-
3A4	8/-	6C6	6/6	6SJ7GT	8/-	954	2/-	25Y5G	9/-
3Q4	9/-	6C9	8/-	6SK7	6/3	955	4/9	25Z4G	9/-
3Q5	10/-	6D3	7/6	6SL7	8/-	956	3/6	25Z5	9/-
3D6	5/-	6D6	7/3	6SN7GT	9/-	10F1	10/-	25Z6GT	9/6
3S4	8/6	6F6G	7/6	6SQ7	8/-	10LD11	11/-	35L6GT	8/9
3V4	8/-	6F6M	8/6	6SS7	8/-	10P13	11/6	35W4	10/-
4D1	3/-	6F8G	7/-	6ST7	7/6	10P14	11/6	35Z4GT	8/6
42	8/-	6F13	12/6	6U4GT	15/-	12A6	6/9	50L6GT	8/6
5R4	9/6	6F15	11/6	6U5G	8/6	12AH8	11/6	AC/P	6/9
5U4	8/6	6G6G	6/6	6U7G	9/-	12AT7	9/-	AC6/PEN	5/6
5Y3GT	8/6	6H6	3/6	6V6G	7/6	12AU7	9/-	ATP4	6/6
5Z3	8/6	6J5G	5/-	6V6GT	7/6	12AX7	10/-	CL33	12/6
5Z4G	8/6	6J5GT	5/6	6X4 (U78)	8/-	12C8	8/-	CV71	1/-
6A7	10/-	6J5M	6/6	6X5GT	7/9	12H6	5/-	CV173	10/-
6A8G	10/6	6J6	8/-	7B7	8/6	12J5	6/-	CV286	7/6
6AC7	6/6	6J7G	6/6	7C5	8/6	12K7	9/-	DH73M	10/-
6AG5	7/6	6K6GT	6/6	7C6	8/6	12K8GT	9/-	EB41	11/-

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50 PF. 20 PF.
All 4½d. each.

THE COMPACT TELEVISION AERIAL BY ANTIFERENCE LTD.

Supplied complete with universal mounting and back-plate in neutral brown finish. Overall length 5ft. 6in. Packed in carton 3ft. 4in. long. Complete with full instructions. Cat. No. CD4. Original price 50/-. Our price 12/6

Post, etc., 2/6.

TERMS: Cash with order or C.O.D. Postage and Packing charges extra, as follows: Orders value 10/- add 9d.; 20/- add 1/-; 40/- add 1/6; £5 add 2/- unless otherwise stated. Minimum C.O.D. fee and postage 2/3

MAIL ORDER ONLY

WHEN ORDERING PLEASE QUOTE "DEPT. P.W."

ALPHA RADIO SUPPLY CO.

5/6 VINCES CHAMBERS, VICTORIA SQUARE, LEEDS 1.

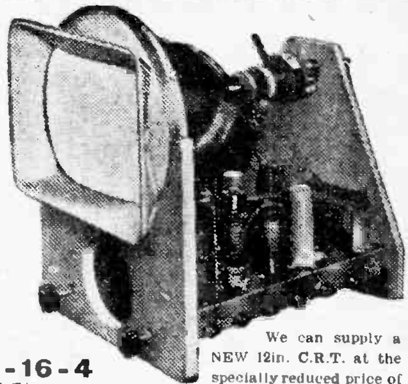
Positively the 2 BEST T/Vs yet built for the Home Constructor!

The STERN'S "TELE-VIEWERS"

5 CHANNEL SUPERHET RECEIVERS

Suitable for any transmitting channel and for which commercial adaptors will be available.

PERFECT PICTURE QUALITY
SIMPLE DIAGRAMS MAKE CONSTRUCTION EASY
PERFECT FRINGE AREA RECEPTION
BETTER RECEPTION AT HALF COMMERCIAL COST



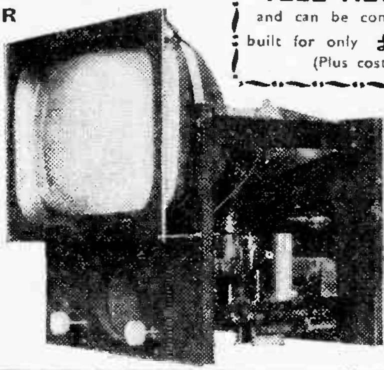
The "WIDE-ANGLE" TELE-VIEWER

- ★ This is the most efficient large screen TV yet offered to constructors.
- ★ Excellent Time Base efficiency producing 15 to 16 Kv with ample scanning power for C.R.T.'s up to 17 inch.

CAN BE COMPLETELY BUILT FOR

£33-0-0

(Plus cost of C.R.T.)



This is the 12" **TELE-VIEWER** and can be completely built for only **£28-16-4** (Plus cost of C.R.T.)

We can supply a NEW 12in. C.R.T. at the specially reduced price of £12.19.6. (Carr. & Ins., 15/- extra.)

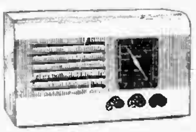
The complete set of ASSEMBLY INSTRUCTIONS for these T/Vs are available for 5/- each. They include really detailed PRACTICAL LAYOUTS, WIRING DATA AND COMPONENT PRICE LIST. ALL COMPONENTS ARE AVAILABLE FOR INDIVIDUAL PURCHASE. AN ATTRACTIVE TABLE MODEL CABINET FOR THE 12in. Model IS AVAILABLE FOR £6-19-6.

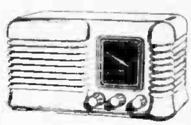
STERN RADIO LTD.
109 & 115, FLEET STREET, E.C.4.
Tel.: CENTRAL 5812-3-4.

BARTON'S (Radio)

We are pleased to inform our customers both old and new that our Mail Order Dept. has been transferred to more spacious premises at 44, Tottenham St., London, W.1 (first turning left from Goodge Street Underground). This move was made necessary by the ever-increasing demand for our goods. Due to the improved facilities at our new premises we can once again assure customers of immediate despatch.

BUILD YOUR OWN RADIO!





We can supply all the parts (including valves, 5in. moving coil speaker, cabinet, chassis, and everything down to the last nut and bolt) to enable YOU to build a professional-looking radio. The chassis is punched and drilled ready to mount the components. There is a choice of any of three attractive cabinets 12in. long, 5in. wide by 6in. high, as follows: either ivory or brown bakelite, or wooden, finished in walnut. Complete and easy-to-follow point-to-point and circuit wiring diagrams supplied.

MODEL 1. T.R.F. RECEIVER

This is a 3 valve plus metal rectifier T.R.F. receiver with a valve line-up as follows: **6K7 (HF), 6J7 (Det) and 6V6 (Output).** The dial is illuminated and when assembled the receiver presents a very attractive appearance. Coverage is for the Medium and Long Wave bands. Operates on 200/250 volts A.C. Mains.

Plus 2/6 Packing, Carriage, Insur. **£5.10.0**

MODEL 2. SUPERHET RECEIVER

This is a powerful midget 4 valve plus metal rectifier Superhet Receiver with a valve line-up as follows: **6K8, 6K7, 6Q7 6V6.** The dial is illuminated and coverage is for the Short Wave bands between 16-50 metres, the Medium Wave bands between 190-540 metres, and the Long Wave bands between 1,000-2,000 metres. Operates on 200/250 volts A.C. mains.

Plus 2/6 Packing, Carriage, Insur. **£7.19.6**

T.R.F. RECEIVER We can supply this Receiver ready built at £6 15s. 6d. plus 3/6 p.c.

ALL COMPONENTS SUPPLIED ARE GUARANTEED FOR ONE YEAR

Instruction Booklet and priced Parts List for either of the above available separately at 1/-. This money will be refunded if circuit diagram is returned as NEW within 7 days.
When ordering please state Model No.

WE CARRY LARGE STOCKS OF COMPONENTS AND WELCOME YOUR ENQUIRIES.

TERMS OF BUSINESS: Cash with order (or C.O.D. Post items only): all orders for small items totalling over £2 post free unless otherwise stated. Money back Guarantee on all goods.

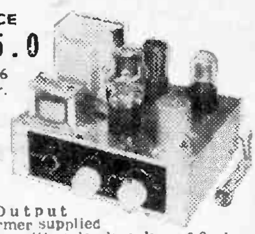
4-watt AMPLIFIER KIT

This is a 3 valve 3 stage Amplifier for use with Gramophone, Microphone or Radio. *Valve line-up is as follows:* **6SL7, 6V6, 5Z4.** Negative feed-back. Tone control. Voltage adjustment panel incorporated. 4 watts output. For operation on A.C. Mains 200/250 volts.

The complete Kit includes every item down to the last nut and bolt, drilled and punched chassis, and comprehensive point-to-point wiring circuit diagram. Chassis dimens.: 8in. x 6in. x 2½in.

ALL COMPONENTS SUPPLIED ARE GUARANTEED FOR ONE YEAR

PRICE **£4.5.0**
Plus 2/6 Pkg. Carr. & Ins.



The Output Transformer supplied is for use with a loudspeaker of 3 ohms impedance and we would suggest that the output of the completed amplifier justifies the use of one of the latest W.B. H.F. Speakers which can be supplied as follows: 8in., 60/6; 9in., 67/-; 10in., 73/6. All plus 2/6 pkg., carr. ins.

Circuit Diagram only, available separately at 1/-. To those who require this Amplifier ready-built we can supply it at £5.1.0 plus 3/6 pkg., carr., ins.

Office: (Dept. P.W.), 34, Montpelier Rise, London, N.W.11. Telephone: Meadway 1736
Works and Despatch Dept.: 44, Tottenham Street, London, W.1. Langham 1151. Open 9 to 6 p.m. Daily, Saturdays 1 p.m.
PERSONAL CALLERS WELCOMED

PRACTICAL WIRELESS

EVERY MONTH
VOL. XXXI, No. 579, JANUARY, 1955

EDITOR : F. J. CAMM

23rd YEAR OF ISSUE

COMMENTS OF THE MONTH BY THE EDITOR

Jubilee of the Thermionic Valve

ON November 16th, 1904, Mr. (later Sir) Ambrose Fleming filed his famous patent application for the thermionic valve. In view of the vast development which has taken place in valve technique in the passage of 50 years, Fleming's invention may to-day seem unimportant. The fact is, however, that it was a basic invention, which paved the way for the development of the now important electronics industry. We must not forget that the rectifying properties of the valve had been discovered previously by Edison and, indeed, Fleming himsafe as well as many others were aware of this. J. J. Thomson had identified the electron which carries the current ; Richardson had evolved a formula for electron emission. Wehnelt had in 1904 patented a rectifier embodying the oxide-coated cathode, later to assume great importance. Notwithstanding all this, it was Fleming who discerned its possibilities as a detector for wireless telegraphy, and lifted it from the laboratory to become in time an instrument of everyday use and destined for mass production. Fleming undoubtedly led the way to the development in radio telegraphy and telephony, and the first cardinal event in the sequence occurred in 1907, when de Forest introduced the control grid, which greatly increased the usefulness of the vacuum valve. It remained to develop and improve manufacturing methods, and Langmuir and his associates with the American General Electric Co. studied valve making materials and how to treat them, as well as problems of vacuum technique using high-speed pumps. Just before 1914, development in the U.S.A. was intensified, but it was stimulated in Britain by the wartime need for rapid and efficient communications. It is possible that the first thermionic triode produced in this country was made in 1915 in the B.T.H. laboratory. The first valves were bright emitters, with tungsten cathodes. The use of thoriated tungsten resulted in the production of the first dull emitter valve. Although Wehnelt had produced his improved cathode with the oxide coating in 1904, it was over 20 years before it came into general use.

In subsequent developments, the valve has become more complicated. The addition of one grid to Fleming's diode enlarged its usefulness, and new types appeared, incorporating more and more electrodes, giving improved control, and wider fields of application, enabling individual valves to perform multiple duties.

Thus, by 1939, the valve was ready for the later developments of which we are all aware, and the second World War stimulated new developments, none more important than that of the cavity magnetron, an outstanding British achievement.

In his patent, Fleming had stated that a very high vacuum should be contained in the bulb, but by comparison with present standards the early valves were "soft." This set in line new developments leading to a wide range of vacuum valves from the sub-miniature to the high-power, water-cooled transmitter valves for radio, and to thyratrons for power control. In valves for radio a high vacuum is necessary, but the gassy triodes developed into the thyratron for use in the low-frequency application of industrial control. The thyratron was introduced into this country by the British Thomson-Houston Co., who developed a range of valves for many industrial purposes, including the mercury vapour thyratron.

During the second World War, radar development introduced a new use for the thyratron, in the switching of high energy pulses and present-day radar makes still greater demands.

It is unlikely that Sir Ambrose Fleming realised to the full the importance of this invention nor where it would lead in 50 years. He could not have anticipated in 1904 that the valve would bring sound and vision into the home, transform the phonograph into an instrument for high-class musical production, result in the "animated picture," control industrial machines, perform intricate calculations for the mathematician and arm the nations with apparatus for defence and deadly power to strike.

He certainly could not have envisaged television in 1904, but oak trees from little acorns grow, and the credit which is his is no less because the modern developments of his basic invention were not due to his work. After all, these developments are only improvements, and without the basic idea improvements would not be possible. Marconi has been accorded the lion's share of the credit, but he and Fleming should share it,—F. J. C.

By "QUESTOR"

Broadcast Receiving Licences

THE following statement shows the approximate number of broadcast receiving licences issued during the year ended September, 1954. The grand total of sound and television licences was 13,527,864.

Region	Number
London Postal ...	1,529,633
Home Counties ...	1,426,283
Midland	1,209,943
North Eastern... ...	1,596,968
North Western ...	1,227,619
South Western ...	992,084
Wales and Border Counties	616,154
Total England and Wales	8,598,684
Scotland	1,032,308
Northern Ireland ...	219,076
Grand Total	9,850,068

Trade Name Changed

AS "Voltastat" is similar in name to that of another electrical product, Winston Electronics, Ltd., of Hampton Hill, have discontinued its use. Instead "Constavolt" will be used when the stabilised voltage control equipment is designed for battery charging and "Magnetrol" when it is used for rectification or as a battery eliminator.

Pye Marine Limited

BECAUSE of the vast increase in the marine radio and electronic business conducted by the Pye group of companies through their subsidiary company Rees Mace Marine, Ltd., the name of that company has been changed to Pye Marine Limited.

"Have a Go!"

THE latest series of "Have A Go!" with Wilfred Pickles, heard each Tuesday, with repeats on Saturday and Sunday, will run for 26 weeks.

More Marconi Equipment

IN accordance with plans for nation-wide coverage with the Home, Light and Third services by a chain of V.H.F. frequency-modulated broadcasting stations, the BBC has placed a further order with Marconi's Wireless Telegraph Co., Ltd. The new contract calls for 24 combining units and 24 changeover switches with the associated interconnecting feeders. This comprises equipment for six three-programme stations.

"Archie's The Boy," the new Archie Andrews series, began on November 11th. Left to right: Benny Hill, Peter Madden, Archie and Peter Brough, the main stars of the show.

Drop in Listening Figures

RECENT figures issued by the BBC Audience Research Department indicate that the number of listeners to sound radio in the July-September quarter of this year was approximately 26,000,000 on an average evening, two million fewer than in the same quarter last year.

British Institution of Radio Engineers

THE following meetings of the Institution will be held during December:—

London Section.—Wednesday, December 29th, 6.30 p.m., at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1. Discussion meeting on "Education and Training of Radio Engineers."

North-eastern Section.—Wednesday, December 8th, 6 p.m., at Neville Hall, Westgate Road, Newcastle-upon-Tyne. "Logic, Algebra and Relays."—Prof. Emrys Williams, B.Eng., Ph.D., M.Brit.I.R.E. (University College of South Wales).

West Midlands Section.—Wednesday, December 8th, 7.15 p.m., at Wolverhampton and Staffordshire Technical College, Wulfrana Street, Wolverhampton. "Industrial Applications of Electronic Control."—J. A. Sargrove, M.Brit.I.R.E. (Sargrove Electronics, Ltd.).

Lifeboat Radio

SIXTY-NINE Ellerman Lines vessels are to be provided with portable radio transmitter-receivers for use in their lifeboats, in case of emergency. The equipment to be supplied is the "Salvita," recently produced by the Marconi International Marine Communication Co., Ltd. It is waterproof and buoyant and requires no batteries, being powered by a hand-driven generator.

Sound Revival

IT is learned that the BBC Light Programme and Home Service programme planners will be concentrating on converting TV viewers back to sound radio listening this winter, now that television does not need subsidising so much as in its earlier days. The additional finance will be used to improve the quality of sound programmes.

M.C.C. Tour of Australia

THE dates and listening hours of commentaries in this country for the four remaining test matches in Australia are as follows: Sydney, December 17th-23rd, 7-7.40 a.m.; Melbourne, December 31st-January 6th, 7-8 a.m.; Adelaide, January 28th-February 3rd, 7-8.40 a.m.; Sydney, February 25th-March 3rd, 7-7.40 a.m. These commentaries will all be heard on the Light Programme.

Daily reports during the second, third and fifth matches will be heard in the Home Service at 8.10 a.m. and at noon in all five.

Training College Completed

THE new Marconi College is now virtually completed. New lecture, tutorial, laboratory and administrative accommodation is now contained under one roof and every facility for technological training in the field of electronics for nearly 100 students and residential accommodation for fifty is provided.

The college now possesses two lecture rooms, ten laboratories, a workshop, a drawing-office school, a technical library and a quiet room.

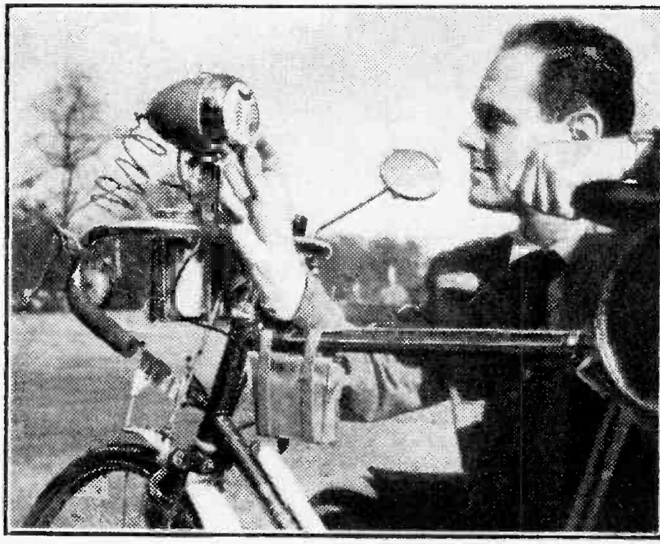
No South-east Service

THE BBC has stated that the commencement of operation of the Wrotham Hill V.H.F. transmitting station will not mean a new regional service for South-east England.

Contract from Thailand

PYE LIMITED have received a contract from Thailand for over £100,000 worth of telecommunications equipment, including a large quantity of new 60-watt H.F. sets.

The Thai police, who placed the order, have had a quantity of Pye V.H.F. radio-telephone gear in use for the past year.



Mr. Eric Braun, of Hornchurch, Essex, adjusts the bicycle radio receiver which kept him company on his recent 2,000-mile cycling tour of Europe.

Coming of Age

ON November 20th, in the Home Service, "In Town To-Night" celebrated its twenty-first birthday and 737th sound broadcast.

The first edition of the programme was broadcast on the night of Saturday, November 18th, 1933, with the late A. W. Hanson as producer. He was succeeded in 1936 by C. F. Meehan until Peter Duncan, the present producer, took over in the autumn of 1947.

Interference in Wales

AT a recent meeting of the South Wales and Monmouthshire branch of the Rural District Councils Association, it was suggested that a direct approach be made to the East German authorities in an attempt to rid the Welsh Home Service reception of interference.

No Personal Appearances

BBC radio announcers, most of whom earn approximately £1,000 a year, have been told that they will no longer be able to accept outside engagements that involve personal appearances.

No official reason has been given for the introduction of the new rule.

Northern Radio Show

CLOSED-CIRCUIT demonstrations of the new V.H.F. radio system to be employed eventually in this country will be given by leading manufacturers at the Northern Radio Show to be held at the City Hall, Manchester, from May 4th to 14th, under the auspices of the Radio Industries Council.

Valves Talk

A TRADE talk and film show was given recently by Mullard Limited, to members of the Isle of Man Radio Dealers' Association.

The evening's programme included a lecture on valves and their application, illustrated by Mullard's new film, "The Manufacture of Radio Valves," and a discussion on topics arising from questions put forward by members of the audience.

Record for August

THE Radio and Television Retailers' Association has announced that sales of radio receivers in August were the highest ever recorded for that month.

Obituary

THE death took place, in Canada, on November 7th, 1954, of Mr. A. H. Ginman, a former President of the Canadian Marconi Company. He was 79.

Mr. Ginman was born in Surrey on December 14th, 1874, and first joined the Marconi Company at the age of 27, working with Marconi himself. He retired in January, 1951.

AMPLIFIER DESIGN

10.—UNTUNED AMPLIFIERS—CONTINUED

By R. Hindle

(*Continued from page 754 December 1954 issue*)

A Series of Articles Dealing with the Theoretical Considerations of Amplifier Design, and Containing at a Later Stage Constructional Details of Various Types of Amplifier.

IN practice, two Dubilier 700Ω 70-watt dropper resistors in series are used. These are adjustable and so other chassis can later be run from the same droppers. An anode limiting resistor R3 is included in the rectifier circuit in accordance with the makers' recommendation to protect the valve.

Construction

The chassis, 7in. x 4in., is identical with that used for the A.C. version, and the drilling diagram for the components used in the prototype is given in Fig. 40. As before, the components should be obtained and checked to the diagram before drilling the chassis in case of slight deviations. Another point is that the small holes for fixing valveholders and electrolytic condensers are not shown. The best way is to drill the large hole (preferably using a punch) and then to insert the component and turn it round until the tags are in the relative positions as shown on the wiring diagram. Then the positions of the holding-down bolts can be marked through the holes in the component and subsequently drilled.

To help the less-experienced constructor the sequence of wiring is again given in Fig. 41, and as the wires are put on it is a good plan to mark them out either on the wiring diagram or on the circuit diagram.

1. Input socket to pin 1 (V1).
2. R1, 220 KΩ. From pin 1 (V1) to earth tag by input socket.
3. Pin 3 (V1) to pin 3 (V2).
4. Pin 4 (V1) to pin 3 power output socket.
5. Pin 6 (V1) to pin 5 (V1) to one primary tag of output transformer.
6. R2. 300Ω, C1. 50 μF } Both from pin 2 (V1) to earth tag.
7. Pin 4 power output socket to earth tag.
8. Pin 5 power output socket to furthest tag on electrolytic smoothing capacitor to other tag on primary of output transformer.
9. One side of smoothing choke to pin 5 of power output socket.
10. Other side of smoothing choke to nearest tag of electrolytic smoothing capacitor to tag 7 (V2).
11. R3, 150Ω. From tag 1 (V2) to tag 5 (V2).
12. Connect together the top tags of the two dropper resistances.
13. The lower *adjustable* tag on one dropper to pin 4 (V2).
14. The lower adjustable tag of other dropper to pin 1 (V2).
15. Mains lead to pin 1 (V2) and other side of mains to earth tag.

The remarks concerning the use of the amplifier for A.C. apply equally to this model except, of course, that as the heaters are in series the voltage amplifier will have to be connected to the universal output chassis before continuity of heater circuit can be tested, whereas the A.C. version output stage can be tested by itself before connecting the voltage amplifier to it.

No provision has been made for switching the mains in either version. This switch is most likely to be fitted to equipment to be used along with this amplifier, and the mains lead of the amplifier is then connected to the side of such a switch away from the mains. If used as an amplifier alone, a switch can be mounted in any convenient position and the amplifier mains lead connected via this to the mains supply. A particular word of warning should be given about the universal version, however. As usual with such equipment, the chassis is directly connected to the mains, and if practicable measures should be taken to ensure that the neutral side of the mains is always connected to chassis. The switch used in the mains lead in this case should be the two-pole type.

The amplifiers described will be very useful for a compact gramophone player and will have endless uses on the workbench. With the R.F. amplifiers later to be described they can be incorporated into complete receivers, or the reader may like to design

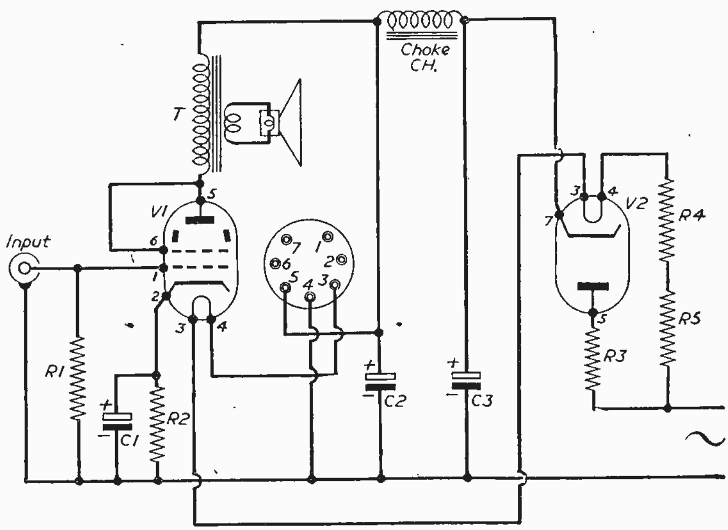


Fig. 39.—Complete circuit for a triode power amplifier—Universal mains version.

his own tuner to go with them. A compact switch-tuned unit would be particularly appropriate.

The universal mains version will require the dropper resistances to be adjusted to their correct value and in the first place the power amplifier and the voltage amplifier, without any other units, will be used. The required resistance, as we have seen, is 1,150 ohms, and the best way is to use an ohmmeter (or the resistance position of a multi-purpose meter) without the mains being connected, of course, across the dropper connections (i.e., between pin 1 and pin 4 of V2), whilst the lower adjustable contacts on the droppers are moved up the resistors. A final check should be made by reading the current flowing (which should be .15 amps), temporarily breaking one of the connections and inserting the meter there. A convenient point is at the link at the top of the resistors. This link can be removed and the ammeter connected in its place. If the constructor has not the necessary meters, no doubt the supplier of the resistors will adjust them to the appropriate value for him. It will be realised that if later more valves are added to the chain (as will be explained in subsequent articles), the positions of these taps will have to be readjusted.

Output Transformer

The miniature components such as are used for these amplifiers do not offer a great deal of choice in ratios, and we have seen that this is not very critical so long as the error, if any, is towards a larger load. The valves used want a load of 4,000 ohms, but the nearest ratio available matched the speaker to 5,000 ohms. This was used and was quite convenient, because 5,000 ohms is the correct load for the valve working as tetrode, and conversion was thereby made easier.

Tetrode and Pentode Output Stages

The ordinary tetrode is useless as a power output valve because the permissible anode voltage swing is limited by the kink in the valve characteristic where the anode voltage runs lower than the screen voltage. This kink was found to be a disadvantage often in R.F. amplifiers and the pentode was developed to avoid the kink for both applications. The advantage of the pentode from a power output point of view chiefly rested with its greater efficiency whereby a greater proportion of the power consumed from the H.T. supply was converted into audio power. It had also a greater sensitivity, i.e., it required a smaller input signal for a given power output than did the triode. The price that had to be paid for these advantages was a higher degree of distortion, particularly third harmonic distortion which is more disturbing to the ear than the second harmonic distortion given by the triode. The beam tetrode was later developed in which the secondary emission

LIST OF COMPONENTS FOR FIG. 36

R1—220 K (½w. Dubilier).
2—300 Ω (5w. wirewound Dubilier A11).
3, 4—150 Ω (½w. Dubilier).
C1—50 μF, 12 v. (Dubilier BR).
2—, 3— } 16-16 μF, 350 v. (Dubilier CT).
T1—Output TRF Elstone MO/T.
T2—Mains TRF, 6.3 v., 250-0-250 v. Elstone MT/MI.
CH—15H, 50 mA. Elstone SC/M.
V1—6AQ5. Brimar.
V2—6X4. Brimar.
3—Valveholders, B7G. McMurdo.
1—Coaxial socket. Aerialite.
4—Grommets.
1—Miniature plug for B7G base.
Mains flex.

COMPONENT LIST FOR FIG. 39

R1—220 K (½ w. Dubilier).
2—300 Ω (5 w. Wirewound Dubilier A1/1).
3—150 Ω (1 w. Dubilier).
4, 5—700 Ω (70 w. adjustable, with mounting rods, Dubilier, HYA).
C1—50 μF, 12 v. (Dubilier BR).
2—, 3— } 16-16 μF, 350 v. (Dubilier CT).
V1—19AQ5, Brimar.
2—35W4, Brimar.
T—Output transformer to match speaker to 5,000 Ω. Osmor.
CH—15H, 50mA. Elstone SC/M.
3—Valveholders, B7G. McMurdo.
4—Grommets.
1—Coaxial Plug and socket. Aerialite.
1—Miniature plug for B7G base. Elpreq.
Mains flex.

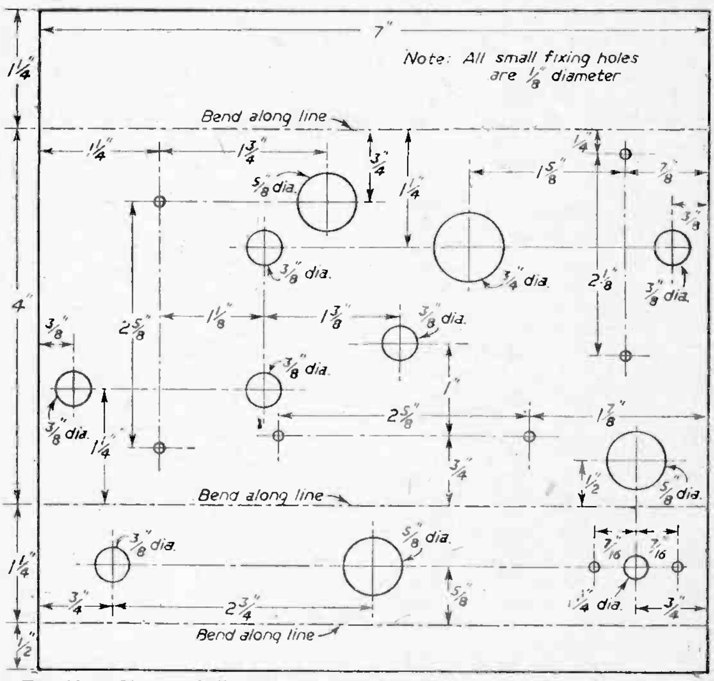


Fig. 40.—Chassis drilling and bending diagram for Fig. 36. Fig. 37 was the chassis data for Fig. 39.

from the anode that caused the objectionable kink in the characteristic of the straight tetrode was eliminated without resort to a third grid. This construction reduces the proportion of third harmonic as compared with the pentode and also allows the anode voltage excursion to go nearer the zero volts position.

Our choice of valve, the 6AQ5 (or the 19AQ5 for universal working) is a beam tetrode and the anode volts/anode current curves for tetrode connection are given in Fig. 42. It will be noticed that the slope of the curves is considerably less than was the case with a triode and it can be seen why the tetrode is looked upon as a more or less constant current device; its use in this connection is often found in timebase circuits. The curves for different grid voltages are seen to be less evenly spaced, giving rise to the increased distortion already mentioned.

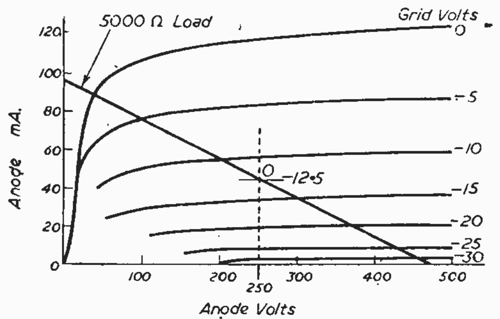


Fig. 42.—Characteristic of 6AQ5 tetrode connected.

A load line is needed again to help in the interpretation of the curves and the method is, as before, to plot the static point 0 on the 250 volt H.T. line where this cuts the curve for the grid bias to be applied —here we have taken the figure of —12.5 volts recommended in the Brimar data and at this point the anode current is 45 mA. The load specified for the tetrode condition is 5,000 ohms which, by Ohm's Law, is a slope of 5 volts to 1 mA. A peak current of 45 mA (from the signal and superimposed on the static state current) will run the total current down to zero and will be equivalent to a peak voltage swing of 5×45=225 volts, taking the anode up to 250+225 475 volts. The second point to be plotted, then, is 475 volts 0 mA, and the two points are joined together and the line extended to give the load line for 5,000 ohms. This appears in Fig. 42.

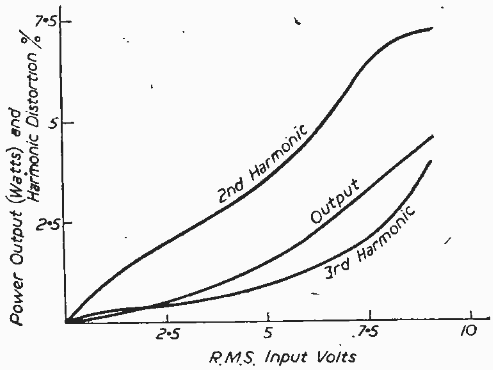


Fig. 43.—6AQ5 output harmonic distortion.

The makers rate this valve to give a maximum output of 4.5 watts with H.T. at 250 volts and Fig. 43 is interesting in showing how the output and the distortion (separate curves are given for second and third harmonic distortion) vary with the input signal. The input voltage is given here in R.M.S. values; these have to be multiplied by $\sqrt{2}$, of course, to give peak values. Nine volts R.M.S. is seen to be required to give the maximum output of 4.5 watts and this is equivalent to a 12.5 peak grid swing, i.e., running the grid down to zero volts. It is interesting to see that with this valve and for an output of 1 watt the third harmonic is well under 1 per cent.; second harmonic is higher at approaching 3 per cent. but this is not so distressing as third harmonic and, in fact, the valve is very satisfying for a simple amplifier. It is quite reasonable to talk of a power output of 1 watt because very rarely would this be exceeded for purposes for which this type of amplifier would be used. For instance, for domestic radio, only the loud passages of music would require more.

The analysis on the basis of Fig. 42 assumed a fixed bias and this is not quite true when the usual cathode bias resistor is used, for the voltage must change slightly. Fig. 43 is taken, however, with a cathode resistor and not with fixed bias and so represents the actual conditions of work. The difference is only very slight and consequently it is quite justifiable to work on the basis of fixed bias when considering the anode characteristics.

(To be continued)

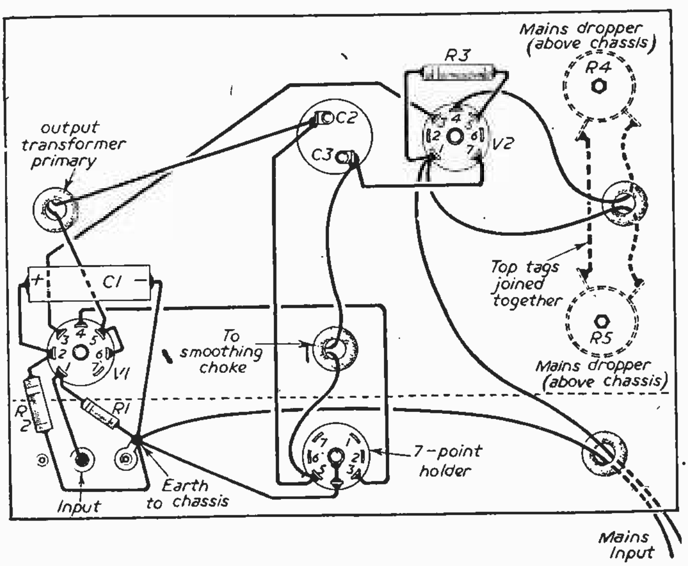
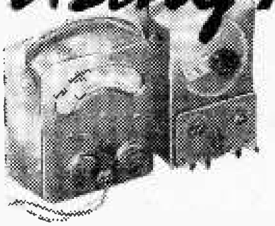
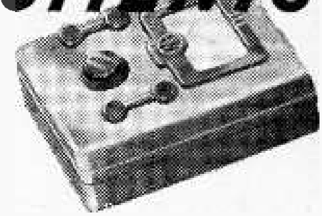


Fig. 41.—Wiring diagram of the arrangement shown in Fig. 39.

Using TEST INSTRUMENTS





Part 1 of a New Series of Articles Dealing with the Practical Application of Standard Test Equipment

By Gordon J. King, A.M.I.P.R.E.

THIS series of articles is mainly intended for the experimenter and constructor who, being in possession of either home-made or commercial test instruments, is desirous of reaping full benefit from them. From time to time in these pages constructional details are given on test gear that can be of immense value if properly used, although they might well represent boxes of mystery and potential sources of bewilderment to the experimenter if used without premeditation.

It is not here intended to discuss the merits or demerits of any particular make of instrument, nor dwell on the design considerations involved; our aim will be to focus attention primarily on how various pieces of test gear can best be used, and to bring to light any traps into which the unwary might be likely to stumble.

The Multi-range Meter

Nearly all constructors have a multi-range meter of some kind or other. In its simplest form it may consist merely of a moving-coil meter movement and a box of resistors of pre-computed values that can be arranged in series or in parallel with the movement to provide either current or voltage tests.

In its finished and polished form it is really no more, even though it boasts the added feature of a rotary switch, or a set of sockets, that can be readily used to select and introduce the desired resistor in series or in parallel with the movement according to the range setting.

Before we continue it will be as well to emphasize the fact that the meter movement itself is a current-operated device, and actually deflects in proportion to the current which flows through it. Therefore, when we set the range switch to a "volts" position and make an appropriate test, we are taking current from the circuit under test to provide energy for the deflection, but since the current flowing through the coil of the meter is precisely proportional to the voltage across the coil and associated resistance, the needle deflection is also proportional to the VOLTAGE across the coil, and as a consequence the meter scale can be calibrated directly in volts.

Either the milliammeter or the microammeter forms the basis of any multi-range instrument. The choice of the meter will be determined by the lowest reading that is likely to be required, and also, as we shall see later, on the desired sensitivity of the instrument on the volts range.

Let us suppose that the movement in our multi-range meter has a full-scale deflection (f.s.d.) of 1 milliampere. To provide a f.s.d. on the 10 milliampere range, then, the movement will need to have in parallel with it a resistor to by-pass the extra 9 milliamperes, so that when the meter records 1 milliampere the current flowing will actually be 10 milliamperes.

In order to calculate the precise value of the shunt resistor—let us call it Rs—we shall first need to know the internal resistance of the meter movement, including any internal resistors. Usually this value is not very high, commonly in the region of 20 to 100 ohms—let us suppose that our meter has a resistance of 45 ohms.

Now on the 10 milliampere range 9 tenths (9 milliamperes) of the external circuit current must pass by way of Rs, and 1 tenth (1 milliampere) by the meter itself. This set-up is illustrated in Fig. 1, which shows the multi-range meter adjusted for 10 milliamperes within the dotted square, and an external circuit passing 10 milliamperes.

In this particular case one can quickly realise that Rs will need to be 5 ohms, since the meter resistance—

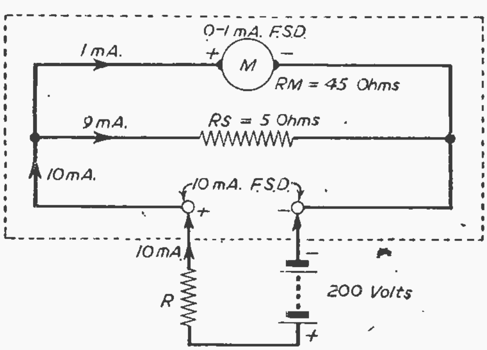


Fig. 1.—A multi-range meter (in dotted square) using a movement of 1 mA F.S.D. arranged to provide a F.S.D. of 10 mA.

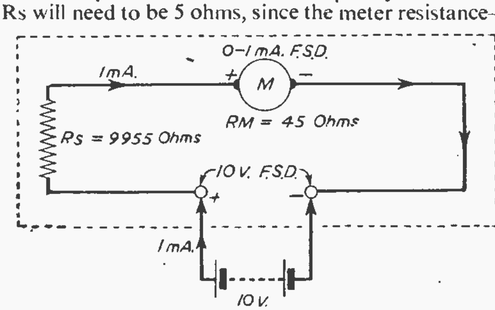


Fig. 2.—A multi-range meter using a movement of 1 mA F.S.D. arranged to provide a F.S.D. of 10 volts.

let us call this Rm—is 45 ohms. In less readily computed cases, however, the value for Rs can be acquired from the following formula, where n is the ratio by which the *current* range is to be extended:

Rs equals Rm/(n minus 1)..........(1)

Any number of current ranges—above 1 milliampere f.s.d.—can thus be given to the meter by introducing the corresponding value of Rs.

When our multi-range meter is set to a "volts" range, however, things are a little different, for now a resistor is introduced in SERIES with the meter movement. When it is set to, say, the 10 volts range it might well look like the circuit of Fig. 2.

We can clearly see, then, that the total resistance of the circuit (Rs plus Rm) must be of such a value that when connected across a 10-volt source—such as the battery shown—a current of 1 milliampere is permitted to flow through the meter movement to give rise to f.s.d. We can easily find the total resistance value from Ohms Law—for example, R (total) equals Voltage/Current equals 10/0.001 equals 10,000 ohms. 45 ohms of this value is, of course, contained in the meter itself, so subtracting this figure from 10,000 indicates that Rs possesses a value of 9,995 ohms.

The general formula used to calculate the value of the series resistor is as below:

Rs equals E/Im minus Rm.........(2)

where E is the f.s.d. voltage reading required, and Im is the f.s.d. reading of the meter movement in amperes.

Apart from measuring current and voltage, our multi-range meter will almost certainly have a switch position marked "ohms"—and also probably positions "ohms × 10," "ohms × 100," and etc. This switch position simply introduces a battery in series with a resistor and the meter as a means of testing continuity or measuring resistance. The meter, which on this range is directly calibrated in ohms, measures the current which a known voltage will drive through an unknown resistance. A variable resistor—marked "ohms adjust"—is also generally incorporated in the circuit and is so adjusted that the needle rests on "zero ohms" when the leads are shorted (see Fig. 3).

Since a moving-coil meter is incapable of measuring alternating current and voltage, a small metal rectifier is used to give the instrument an A.C. range, and thus make it universal in application. On the A.C. range, therefore, the appropriate scale may not be perfectly linear, since the scale must be calibrated with regard to the characteristics of the rectifier employed.

On A.C. current ranges measurement is often carried out through a current transformer housed within the instrument, or in some cases, particularly if high A.C. currents are to be measured, used external to the instrument. Such a feature reduces the inherent resistance of the instrument when set on A.C. current ranges.

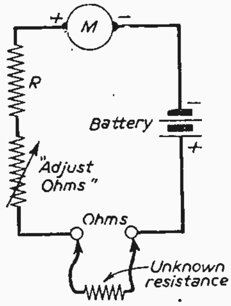
Voltage Testing

As we have already seen, the meter is strictly a current-operated device and needs to draw energy from the circuit under test to incite deflection. This is all very well provided the circuit is capable of supplying the additional current without its balance being disturbed.

Testing the voltage across the terminals of a H.T. battery or power-pack, for instance, by means of an ordinary voltmeter, will extract such little current from a large current-giving source that the battery or power-pack will be unaffected in supplying it.

For any power source to be able to supply considerable current means that the internal resistance of the source must be kept at a low value. A new H.T. battery, for example, has a very low internal resistance and is, therefore, able to permit the passage of a relatively large current—clearly, since the current is equal to the voltages divided by the resistance. As the battery ages, however, its internal resistance rises, the value of which, even when the battery is called upon to supply only a small current, gives rise to a considerable voltage-drop, and thus provokes a fall in the voltage appearing at its terminals.

Now let us look at this problem in a different way. Fig. 4 depicts two 1 megohm resistors (R1 and R2) connected across a voltage source, which has an internal resistance of negligible value as compared with the combined values of R1 and R2. We can thus rest assured that the actual terminal voltage of



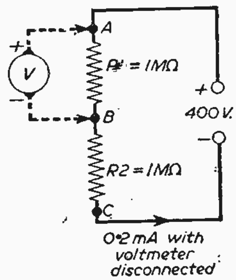


Fig. 3 (left).—Showing how a meter, calibrated in ohms, can be used to measure the current which a known voltage will drive through any unknown resistance. Fig. 4 (right).—The voltmeter V will not indicate the true voltage across R1.

the source appears between points A and C. Let this be 400 volts, then by employing Ohms Law (I equals V/R) we discover that a current of 0.2 milliampere is flowing through the series combination. It is obvious that, since R1 and R2 are of the same value, the same voltage will appear across each resistor. This will, of course, be half the supply voltage; or in other words, 200 volts will exist between points B and A, and B and C.

This we know as fact and can be readily proved by Ohms Law, but let us now endeavour to measure the voltage across, say, points A and B. We gaily set our multi-range meter to the 200 volts range, apply the prods to the circuit, only to find that we get but a glimmer of a deflection on the meter. We try another meter and most likely find that we get more or less the same results. We try switching to a lower voltage range, but even this hardly has any further effect on the needle deflection. We might or might not be mystified. If we are not, then we are aware of the shunting effect the internal resistance of the instrument has on the circuit under test.

(*To be continued*)

On Your Wavelength

BY THERMION

Car Radio

THE number of private cars in this country equipped with broadcast radio receivers has now passed the 250,000 mark. More than 500,000 car radio receivers have been produced by British manufacturers since the war and about half that quantity have been exported. Direct exports amount to 100,000 and about 150,000 have been exported fitted to cars. Production is running at about the rate of 8,000 sets a month, of which nearly 5,000 have sold at home, half of them to the public and half to car manufacturers. The present rate of production is thus higher than in any previous year except 1951. It is noteworthy that all cars coming from British factories to-day have special provision for fitting car radio or at least space for it.

At the recent Motor Show four manufacturers exhibited car radio receivers—E. K. Cole, Motorola, Pye and S. Smith and Sons. Their exhibits included a new receiver costing only £14, plus £5 16s. 8d. purchase tax, and this included fitting charges. It is an optional standard fitting in the Ford Popular and receives the BBC Home, Light and Third Programmes, in addition to many Continental stations. E. K. Cole offered instantaneous selection of three preset stations or normal tuning on medium and long waves on a set designed for cars of any make or year, and the prices range from £26 10s. to £28 15s. Motorola have marketed a telescopic aerial which emerges from its socket when the set is switched on and disappears when it is switched off. Strangely enough, car radio has never greatly interested amateurs, probably because of the special problems involved. In the first place, a car radio has to be heavily screened from the engine ignition and other electrical parts which might cause interference and output noises. Even screening the set by use of a metal cabinet is not sufficient entirely to eliminate interference. This has involved the production of special coils and circuits. There are, indeed, some almost insurmountable difficulties which arise when one commences the task of building a car radio. The size of the completed apparatus, decided by the space available, is an important factor. Miniature components are, of course, available, but the arrangement and spacing of these on the chassis is critical, if stray coupling between the stages is to be avoided.

A car radio is expected to operate off a very short aerial with a consequent loss of signal strength. This means that the set must be provided with a method of amplifying the received signal before it is passed on to the H.F. stage of the set. Although a tuned radio frequency circuit may be used the number of stages to be employed is limited to the H.F. section, due to interaction between them setting up oscillation. Thus the superhet is the only possible circuit to employ, as the number of stages is not limited. Here again, however, snags arise. Intermediate-frequency transformers have to be correctly aligned for their intended frequency or else trouble will arise with poor reception, and this involves the use of costly alignment equipment. The use of such equipment requires specialist knowledge. The construction of a car radio receiver is thus likely to be more costly in the long run than buying a commercial receiver. The power supply for a car radio is another big problem.

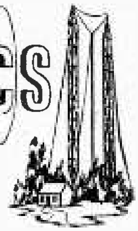
As far as running a domestic portable from the car battery is concerned, the volume would be inadequate to overcome the noise of all but the quietest of cars ; a frame aerial would not be satisfactory. A vibrator can be obtained which converts the 12 volts from the car battery to 90 volts H.T. and 1.5. volts or 7.5 volts L.T., as required, for about 25s., and an ordinary car aerial can be fitted. All sources of interference on a car will have to be suppressed as for a normal car radio.

One alternative is to modify one of the Government surplus American communication sets. The average commercial car radio uses a superhet circuit employing H.F. mixer, one or two I.F. stages, second detector, L.F. amplification and output stages. The construction of such a set is probably beyond the scope of most amateurs. It might be possible to evolve a simpler superhet circuit using mixer, I.F. and super regeneration, followed by starved grid pentodes and output stage. This, however, would not give good H.F. gain, but the L.F. gain would be considerable. Also, the background noise would be fairly high, but this would be offset by the engine noise anyway.

The average battery portable must have a frame aerial and this means that, as the car winds its way round our roads, fading will take place. One way out of the problem is to modify an A.C./D.C. set by changing the valves to 6 volt or 12 volt filament types, and deriving the H.T. from a motor generator or rotary transformer with 6 volt or 12 volt input and 230 volt 60 mA output.

In our January and February, 1951, issues we gave details of a car radio receiver which, readers have reported, has given very satisfactory results. I would, however, suggest some modifications. It was rather bulky by comparison with present-day standards. I think it should be constructed in three units—tuning control box, power pack and speaker. If smaller components, which are now more readily available on the market, such as B8A and B9A based valves are used in place of the more bulky octal-base type and a miniature two-gang condenser were substituted, the tuning control box could be compressed into a unit comparable in size to any ready-made receiver. I suggest also that the home-made coils be substituted where possible for proprietary coils.

TRANSMITTING TOPICS



MORE ON PI NETWORK TANKS

By O. J. Russell, B.Sc.(Hons.), A.Inst.P. (G3BHJ)

FROM correspondence received it is clear that Pi network tanks are a subject of supreme interest among the amateur fraternity. This is largely due to their excellent reputation as a cure for TVI troubles. A few further notes on the use and refinements of Pi network tank circuits may be of interest.

First, however, it must be made quite clear that a Pi network tank circuit by itself is no guarantee of a cure of either TVI or of the radiation of spurious frequencies. The Pi tank is a powerful aid in the reduction of TVI causing harmonics, and coupled with a little elementary assistance in the form of screening and coaxial line feeds, will generally secure immunity from TVI. However, a point of some importance is that while the Pi tank strongly discriminates against high-frequency harmonics, largely because of its capacity output, it does NOT necessarily by itself guard against "sub-harmonic" radiations. Thus, if the P.A. is on say 40 metres, and is driven by a doubler stage, an appreciable amount of 80 metre energy may find its way to the P.A. anode. This 80 metre R.F. will not be very much attenuated by the 40 metre Pi tank, and may indeed reach the aerial. This does often happen, and a strong signal may be radiated in some cases upon the next lowest band to the one actually being used. This state of affairs may be responsbile for the phenomenon of S9 plus signals on top-band calling "CQ Eighty Metres!" In fact, top-band stations have actually been heard calling stations who were radiating a strong fundamental of 80 metres and a strong "sub-harmonic" on 160 metres! In view of the strict control upon 160 metre emissions and the possibility of interference with vital services sharing that band, not to mention the possibility of radiation on frequencies outside the authorised amateur bands, it is essential that measures be taken to prevent the likelihood of such happenings.

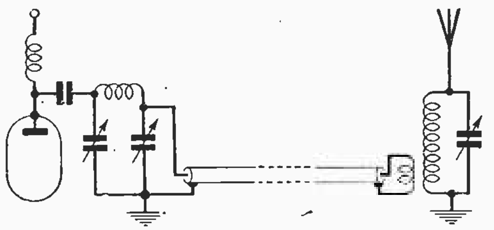


Fig. 1.—Link coupling the network to an aerial tuner.

Fortunately this is not a difficult matter. It is strongly urged that a Pi tank output never be coupled directly into an aerial. In all cases an auxiliary aerial tuner should be used. This should be coaxially linked to the output of the Pi tank as shown in Fig. 1. If this is done, the additional discrimination of the link and tuned circuits reduces spurious radiations, and in fact is essential if "sub-harmonic" radiation is to be avoided. A further specific against "sub-harmonics" is to drive the P.A. from a straight amplifier rather than from a doubler.

While the device has not caught on to any extent in this country, it should be noted that in the U.S.A. the use of the "Pi-L" tank circuit has been popularised as a measure to give an even better rejection of spurious frequencies than the straightforward Pi tank. It must be remembered that the use of high power and the general use of several alternative channels for TV, makes the TVI question in America much worse than at present over here. However, the institution of VHF FM broadcasts, and an alternative TV programme in this country will naturally intensify and complicate the TVI and interference problems facing the British amateur. Accordingly, more drastic measures then the straightforward Pi network may well become needed. As may be seen from Fig. 2, the "Pi-L" network consists of a straightforward Pi network feeding into an L network. By this means a further substantial reduction of high-frequency radiation is secured, although the effect upon "sub-harmonics" is not very great. Readers of an experimental turn of mind may care to experiment in this direction, although the "Pi-L" tank is naturally a complication if multi-band operation is desired.

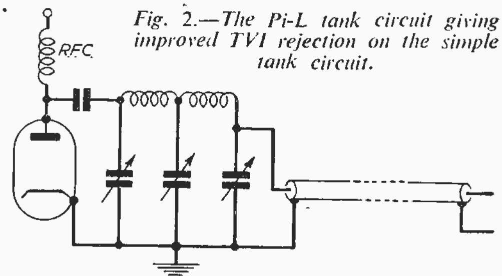


Fig. 2.—The Pi-L tank circuit giving improved TVI rejection on the simple tank circuit.

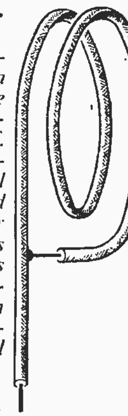


Fig. 3.—The "coaxial link" is a coupling coil made by coiling the coaxial cable itself. The inner connector of the coaxial is then connected directly to the outer metal sheath as shown. This gives an effective Faraday shielding which reduces TVI transfer to the aerial tuned circuit.

Some Dodges

However, before complex networks become necessary in the future, there are a number of dodges that may help in the reduction of TVI where a straightforward Pi tank link-coupled into an aerial tuning unit does not provide enough TVI reduction. One device capable of assisting in TVI reduction, is the "coaxial link," as shown in Fig. 3. In effect, this provides a Faraday shield for the link coil, and

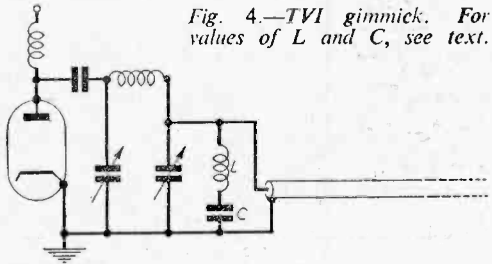


Fig. 4.—TVI gimmick. For values of L and C, see text.

virtually eliminates capacitive transfer of TVI harmonics from the link winding to the aerial loading or tuning coil. In the case of a tightly-coupled link coil of the unshielded variety, there may be an appreciable capacitative coupling to the aerial coil, which may suffice to transfer TVI causing harmonic frequencies to the aerial and hence into neighbouring TV receivers. The menace of TVI is highlighted by the recent report of TVI from a transistor top-band transmitter, so that the reader may rest assured that TVI is not necessarily cured by the application of just one measure! In fact, TVI is generally only to be cured by the application of several methods. The "coaxial link" therefore is a very useful weapon in the armoury of "anti-TVI" devices!

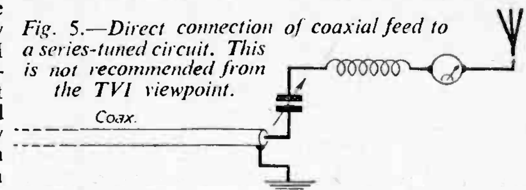


Fig. 5.—Direct connection of coaxial feed to a series-tuned circuit. This is not recommended from the TVI viewpoint.

A further device of proven merit in increasing the efficacy of Pi network tank circuits, is the "TVI Gimmick." In this case part of the output capacity of the tank circuit is a small capacitor say of 50 pF. This may be wired directly across the coaxial output socket. However, in flat defiance of the edict that "R.F. leads must be short," the lead to one side of the condenser consists of a few turns of wire of say ¼in. diameter made by coiling the lead round a suitable former such as a pencil. Four or five turns is a useful size to start with, at any rate for London area transmissions. For the higher frequency TV channel areas three or four turns only may be required. If a "grid dip" oscillator is handy, the "gimmick" is resonated to the local TV channel by squeezing or pulling apart the turns of the coiled lead. In fact, with a "grid dipper" the "as is" frequency of the "gimmick" may be measured, which will immediately indicate whether the coil needs adjustment. If the "dip" frequency is higher than the TV channel, the coil needs to be squeezed to bring up the inductance, or a slightly larger coil may be needed. If the "gimmick" "as is," tunes to too low a frequency, pull out the turns until it does resonate on the TV channel, or, if necessary, fit a smaller coil. Final adjustment may be made by watching the screen of a TV receiver, while squeezing the coil to adjust inductance. In the case of TVI, where a grid dipper is not available, the coil must be adjusted while watching the receiver for minimum TVI. The "gimmick" operates as a series resonant circuit for TVI frequencies, and effectively prevents them from being passed along the coaxial cable. The final line up of the "gimmick" is best carried out with the coaxial cable attached to the output socket, in order that the circuit be resonated under actual working conditions. Fig. 4 illustrates the "gimmick" connections.

Tuning Units

In view of the importance of using a suitable aerial tuning unit to back up the Pi network tank, it may be as well to review some of these. In the case of a simple series-tuning unit for loading up a wire in the Marconi fashion, Fig. 5, illustrates one way in which this is often done. The coaxial output link is taken directly into the series-tuned circuit.

In Fig. 6, is illustrated one way in which the parallel tuned version of Fig. 5 might be directly coupled by a tapped-in coaxial feeder to the Pi network output. Neither of these arrangements is to be recommended, as TVI frequencies might be directly transferred to the aerial. Such arrangements might, in fact, be satisfactory in a few cases in areas where the TV signal is strong enough to over-ride TV, or, in fact, might be just adequate on the lower frequency bands such as 160 metres and 80 metres where TVI is less pressing than upon the higher frequency bands. Accordingly the link coupled versions shown in Figs. 7 and 8 are recommended as the use of link coupling, particularly if of the "coaxially shielded" type of link coil, gives further discrimination against TVI.

In this connection of aerial coupling, the feeding of conventional centre-fed or end-fed aerials offers little difficulty. However, in some locations, especially where the shack is located at the top of a house, the question of long earth leads may arise. For Marconi-operated systems, the earth lead forms part of the

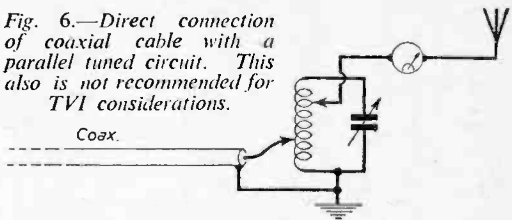


Fig. 6.—Direct connection of coaxial cable with a parallel tuned circuit. This also is not recommended for TVI considerations.

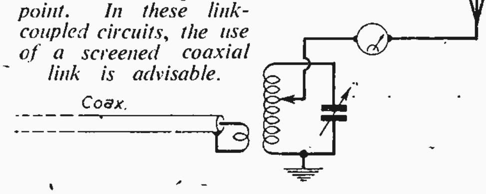
aerial, so that it is inadvisable to earth the transmitter to the lead used for the aerial return. Moreover, depending upon circumstances, it may be found that the earth lead may be dispensed with. In general the use of balanced two-wire centre-fed systems will be found more satisfactory than unbalanced systems wherever there is difficulty in obtaining a good, short earth lead. Balanced systems do not depend upon an efficient earth connection for correct operation, and may often work better without an earth lead at all in cases where a long earth lead or an inefficient earth is involved.

Novel Scheme

One interesting arrangement that has arisen as a result of correspondence, is the aerial shown in Fig. 9. This is a top length of 88ft. overall, including a 73ft. length outside, and a 15ft. length of lead in to the shack. While such a length might be fed directly from a Pi tank on some band by connecting directly to the coaxial output of the Pi network, this is not recommended. An earth lead of some 14ft. in length is also included. An odd length of wire of this amount offers some problems in feeding. On top band and on 80 metres, it can be loaded up as a Marconi with a series-tuned circuit. However, on 80 metres, it could also be loaded up fairly well with a parallel-tuned circuit. In fact, the top length could be either series- or parallel-tuned on 40 metres, 20 metres and 28 Mc/s and the earth lead would be needed at any rate for the series tuning connections. On 21 Mc/s the top definitely requires parallel tuning as it is four half wavelengths long, and the earth would probably not be required. This example is a further illustration of the fact that exact resonant lengths of wire are not necessarily required, provided that the tuning and feeding arrangements are correctly adjusted.

From the radiation viewpoint for simple single wire aerials, there is no advantage in an exact resonant length, provided that R.F. is effectively fed to the aerial. Resonant lengths merely happen to be easy to load in some cases. However, it is not generally realised that an aerial which "draws well" is usually far from resonant and its good "drawing" properties depend largely upon the impedance and reactance it presents to the coupling unit. In fact with feeder systems good "drawing" properties are usually the hallmark of a high standing-wave ratio. This point is raised, as it is generally considered a bad thing to have a high standing-wave ratio on feeders. However, a feeder of the open wire resonant type with a high standing-wave ratio may be more efficient than some coaxial cables correctly matched. This may not please the purists, but it is also a fact that radiation from a balanced open wire line has little to do with the standing-wave ratio. It is unbalance that is responsible for excessive radiation. Coaxial cable may not be free from radiation, in fact

Fig. 8.—Link coupling of the parallel tuned circuit is advantageous from the TVI standpoint. In these link-coupled circuits, the use of a screened coaxial link is advisable.



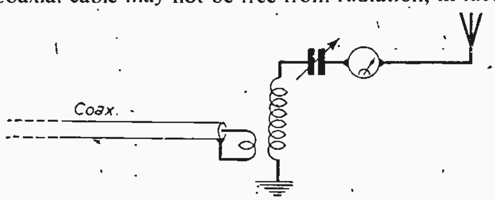


Fig. 7.—Link coupling of the series-tuned circuit offers advantages from the TVI standpoint.

the practice of feeding a dipole with coaxial usually ensures that the outer cable sheath carries a sizeable amount of R.F. and the cable certainly radiates!

The significance of the above observations is that radiating feeders may carry TVI interference close to TV aerials, so that a further source of trouble may be apparent. It is unfortunately true that the dogmatic acceptance of legends and fallacies may obscure the solution of TVI problems. Therefore, do not assume that resonant open wire feeders are necessarily potent radiators. Moreover, do not assume that coaxial feeders are free from radiation. If the outer sheath carries R.F. it will inevitably radiate.

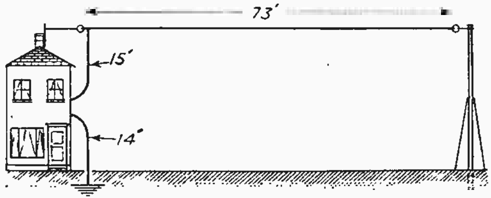


Fig. 9.—A problem aerial that can be fed from a tuning network link coupled to a Pi tank transmitter. 1.8 Mc/s: Use series-tuned aerial circuit. 3.5 Mc/s, 7.0 Mc/s, 14 Mc/s, 28 Mc/s: Use either series or parallel tuning. 21 Mc/s: Use parallel tuning.

If a dipole is to be fed from coaxial cable, ensure that a balance to unbalance transformer is used at the dipole, so that the possibility of R.F. travelling backwards over the outside of the sheath is minimised.

Finally, if you are troubled with TVI, and have turned to a Pi network tank circuit as a relief, arm yourself with a few essential instruments to check TVI emissions. One such item is a grid dip oscillator which will enable valuable measurements and observations to be made. In the absence of a sensitive receiver covering the TV channels, a TVI "sniffer" should be acquired, borrowed or made. This consists of a couple of R.F. stages tunable over the TV channels together with a crystal diode detector and microammeter. The sniffer will locate leaks of R.A. from screens, leaks around the transmitter cabinet, TVI R.F. transferred out of the transmitter and the presence of TVI harmonics at the aerial coupler, on the coaxial sheath and on the aerial itself. The adjustment of trap circuits, TVI "gimmicks," and link suppressors is greatly facilitated by these two indispensable aids. Without them the use of a Pi network to eliminate TVI is little more than a pious gesture of faith. With them the elimination of TVI is made a very much more certain proceeding.

Earth Connection

While from an R.F. point of view the use of an earth connection may be optional, it is certainly not so from two important points. Audio equipment such as a modulator may definitely need an earth connection for one thing. For another, it is essential that an earth be available so that aerials when not in use may be earthed to avoid the accumulation of static, and also in the presence of thunder storms. Even a small aerial can collect a dangerous charge in thundery weather, Therefore, do not neglect the provision of the best and heaviest and most direct earth connection possible. In any case, gear, particularly expensive receivers, may be badly damaged from the effects of induced static charges. An earthed aerial by dissipating static charges may in fact prevent a discharge of lightning striking the neighbourhood.

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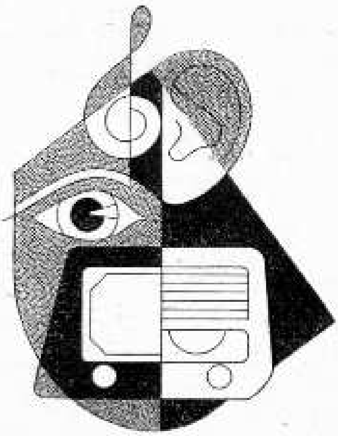

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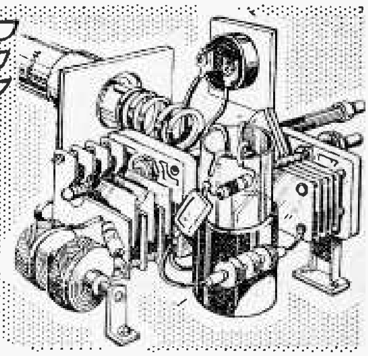

BUILDING COMMUNICATIONS RECEIVERS

2.—THE INTERMEDIATE-FREQUENCY STAGES

(*Continued from page 630, October issue*)

THOUGH the I.F. stages of a simple communications receiver may not differ greatly from general receiver design, there will usually be a number of added features, while larger receivers may employ very complex circuits. Additional sensitivity and selectivity will normally be required, with high gain, often manually controlled, and variable selectivity. Because no variable tuning is required, the I.F. stages of a receiver lend themselves well to modification. If space is available, there is usually little difficulty in adding one or more extra I.F. stages to an existing receiver, or making other changes. Such alterations can greatly improve sensitivity and selectivity, though the overall performance of a receiver is not, of course, wholly governed by the I.F. amplifier section.

Fig. 1 shows a circuit which is typical of many of the smaller communications type receiver, and which is capable of giving excellent results. (Though the popular 6K7 valve type is indicated, any other variable-mu R.F. pentode type can be employed.) This circuit is very straightforward, the only departure from general receiver design being in the provision of an I.F. gain or sensitivity control. A 50 K potentiometer is used for this, operating in the first I.F. stage. If both I.F. stages are to be controlled, the potentiometer may be common to both cathode circuits. In some cases A.V.C. is not applied to the stage thus controlled, the I.F. transformer secondary being returned directly to the H.T.—line.

Such a circuit may give high gain for the number of valves employed. The transformers may be air-cored, with pre-set trimmers; or, alternatively, dust-cored types with adjustable cores. The latter are more general, in view of their small size and high efficiency. For general purposes, an intermediate frequency of 465 kc/s is satisfactory, and enables readily obtainable "unit" signal-frequency and oscillator coils to be used in R.F. and F.C. stages, for all bands.

As each I.F. transformer will be contained within its own screening can, stability may easily be maintained. Grid and anode leads should be short and direct, and may be screened. If the valves are of the clear glass type, they should be contained within screening cans. The detector is of ordinary type, and a double-diode-triode is equally suitable.

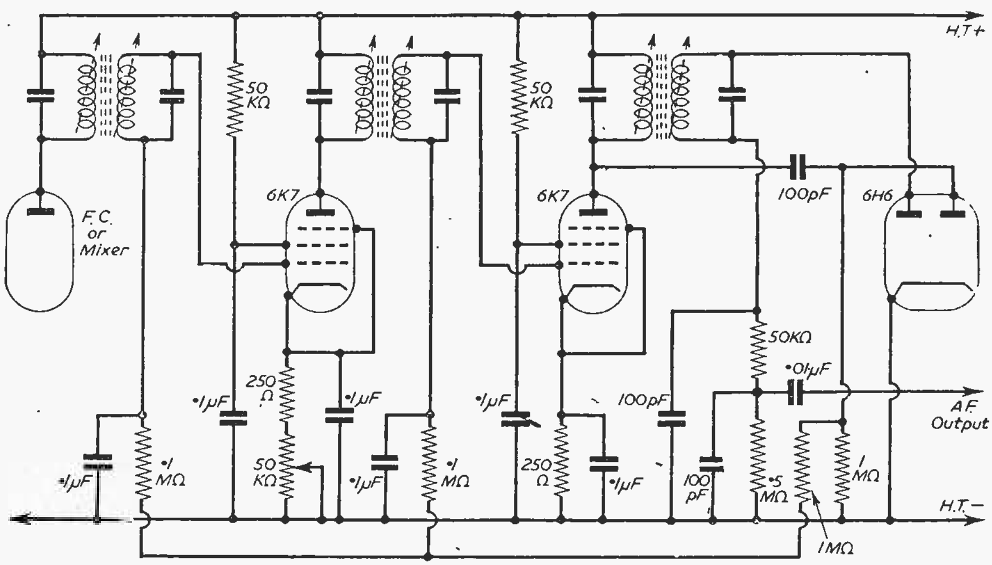

Fig. 1.—A two-stage I.F. amplifier.

Alternatively, a grid-leak triode type detector circuit can be used, in the interests of added sensitivity, a diode being retained for A.V.C. When I.C.W. reception is desired, the A.V.C. may be rendered inoperative by using an "A.V.C. IN," "A.V.C. OUT" switch. An on/off switch wired between A.V.C. line and H.T.—line constitutes the simplest form of this.

Further Types of Coupling

Though a circuit such as that in Fig. 1 is capable of excellent general results, selectivity is not sufficient when powerful transmitters are employing frequencies adjacent to that of the desired station. Selectivity can be increased by reducing the degree of coupling between the I.F. coils, or by employing more stages, or stages offering increased selectivity. The latter methods lend themselves most readily to amateur construction, and a simple yet effective circuit enabling the number of I.F. transformers to be increased to five is shown in Fig. 2. Here, cathode, screen-grid and other power-supply circuits are omitted for clarity, and may be as shown in Fig. 1.

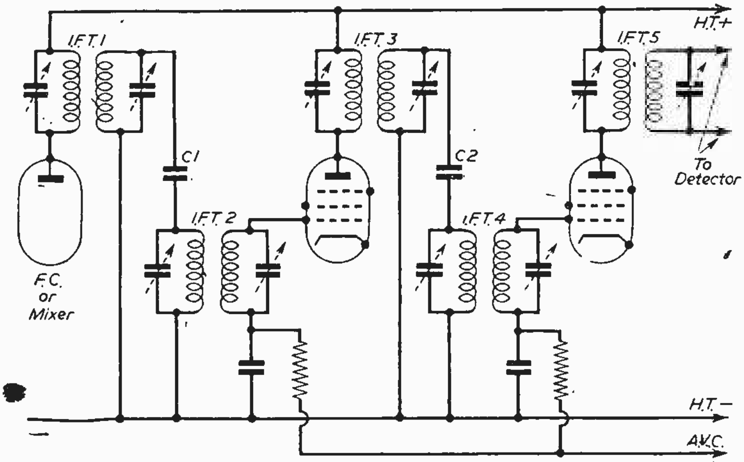

Fig. 2.—Top capacity I.F. coupling.

This circuit uses five transformers of the same frequency, either air- or dust-cored, the first pair being coupled by C1 and the second pair by C2. These condensers should be of very low capacity and may be fixed, pre-set, or fully variable. As the capacity is reduced, selectivity is increased, but signal strength is reduced. If variable condensers are not fitted, one or more stages may be coupled by a range of fixed or pre-set condensers, selected by means of a rotary switch. This gives a simple form of variable selectivity control. Suitable capacity values are from 2 to 25 pF. Each transformer is individually screened, coupling being by means of C1 and C2 only. If desired, only one coupling of this type may be used, resulting in four I.F. transformers in all.

A method which employs a common impedance for bottom-end coupling is shown at "A" in Fig. 3, C1 governing the degree of coupling. Here, the degree of coupling is reduced as the value of C1 is increased, and the condenser is of relatively large value—about .0005 to .05 μF. The greatest advantage of the circuit lies in the ease with which very loose coupling can be obtained.

At "B" in Fig. 3, two small windings provide coupling between the first and second I.F. coils, these being in separate cans or otherwise arranged so that no direct inductive coupling between them can arise. For such coils, one winding of an I.F. transformer may be used. The degree of coupling will govern signal strength and selectivity, and may be reduced by increasing the distance between I.F. coils and coupling windings, or by reducing the number of turns on the latter. If such coupling windings are to be made, about 15 to 30 turns can be used.

Variable Selectivity Controls

With the sharpest possible tuning which is obtainable when a selective I.F. amplifier is used, general tuning is very difficult, while the quality of speech seriously deteriorates. While "single signal" operation is desirable in congested frequency bands, a much lower degree of selectivity is adequate for general tuning, and much simplifies operation. Those degrees of selectivity which make exact spot-tuning

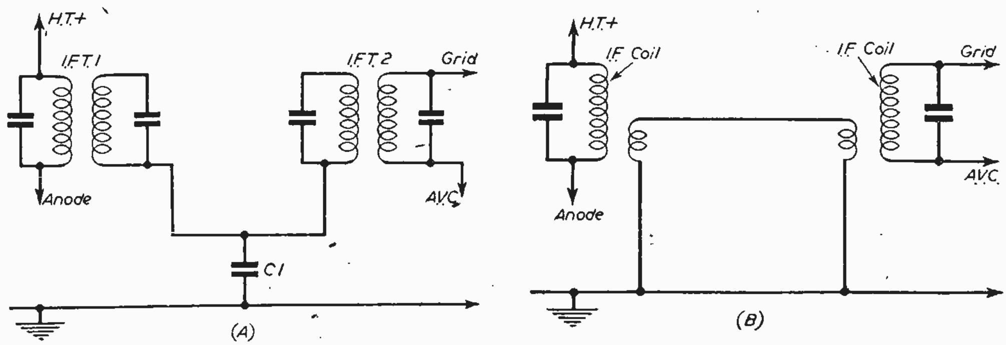

Fig. 3.—Two further types of coupling used in I.F. stages.

of any transmitter essential are best reserved for use solely when conditions require.

As mentioned, variable selectivity is possible with the circuit in Fig. 2 by adjusting the capacity of C1 or C2, or both. This also applies to the circuits in Fig. 3. With that at " B " a variable-selectivity control may readily be arranged by using coupling windings with one or two tappings, the number of turns being selected by means of a rotary switch. As the number of turns is reduced, selectivity will increase.

In other cases it may be more feasible to cut out some stages of the I.F. amplifier, and a circuit enabling this to be done is shown in Fig. 4. Here the degreee of selectivity at the " Sharp Tuning" switch position will depend primarily upon the values of C1 and C4, and may be very high. At the " Medium " switch position, two I.F. transformers are eliminated, and selectivity is to some extent adjustable by changing the capacity of C2. At the " Flat " position, both top-capacity coupled I.F. stages are cut out, and the degree of selectivity obtained is that usual with the standard superhet circuit with one I.F. stage and two I.F. transformers. If the top-capacity couplings are loose, the overall gain may remain reasonably uniform for all settings of the selectivity switch.

When a large number of I.F. transformers are employed, correct alignment is very necessary. With such selective circuits, signals may be greatly weakened, or become inaudible, if one stage is incorrectly trimmed. With the selectivity control (if used) at maximum, all the I.F. transformers should be peaked so that any further adjustment to any trimmer or core only reduces volume. This will be the normal operating setting, except when the selectivity and gain are sufficiently high to enable a " flat-topped " response to be obtained by *slightly* staggering the exact frequencies to which the I.F. transformers are set.

When several I.F. stages are used, a good layout, with adequate screening, becomes necessary. Any instability by back-coupling through the H.T. circuits may be avoided by decoupling each stage, as shown in Fig. 4. Provision for manual control of I.F. gain, and for rendering the A.V.C. inoperative, will usually be included, as explained, in conjunction with the features in Figs. 2, 3 and 4.

Crystal Filter

A circuit for this will be given next month (Fig. 5) and it employs a 465 kc/s quartz crystal. (If an I.F. other than 465 kc/s is employed, the frequency of the crystal would be chosen accordingly.) Such circuits permit of a very high degree of selectivity, though adequate selectivity can be secured without the use of a crystal. Its main advantage lies in providing high selectivity without making a large number of I.F. transformers necessary.

C1 should be about 2 to 20 pF, and is fully variable, being a phasing control able to operate because the secondary of the I.F. transformer is centre-tapped. If such a tap is not available, and cannot be provided, a " butterfly " condenser may be used for trimming the I.F. secondary, the rotor being wired to earth. C2 is the coupling condenser, and may be fixed, pre-set, or variable, as already described.

The characteristics of crystals of this type are such that gain is high at the exact crystal frequency, but very low at other frequencies so that side-band interference is eliminated. The effect had upon side-bands is to some extent controllable by adjusting C1, but the selectivity will normally be too high for speech reception. This difficulty is most simply over-come by the fitting of a " Crystal In," " Crystal Out " switch, which may be an on/off switch wired in parallel with C1.

Double Superhets.

In the next issue, double superhets will be dealt with.

(To be continued)

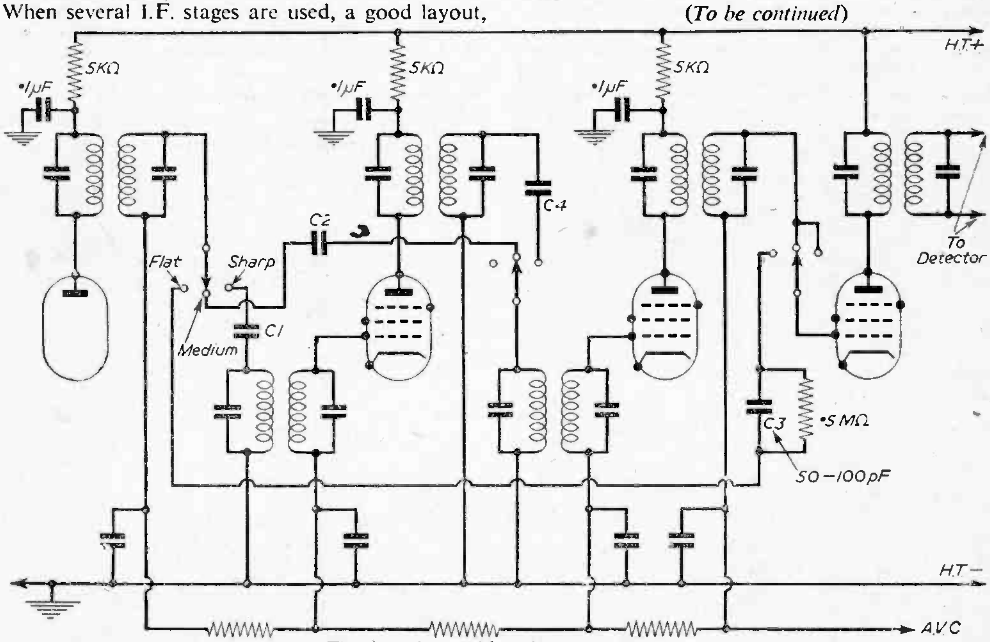

Fig. 4.—A variable-selectivity circuit

Surplus Bolometer Indicators

DETAILS OF COMPONENTS AVAILABLE ON THE SURPLUS MARKET

By E. G. Bulley

THESE tubes have a pure tungsten filament which is kept as straight as possible and is welded to two leads which are sealed to a glass envelope. The diameter of the filaments is extremely small and is usually in the order of one half of a thousandth of an inch. One will, therefore, appreciate the fragility of such tubes. The leads to which the filament is secured are sometimes " dumet " or some similar alloy which matches the coefficient of expansion of the glass envelope. Such indicators are, however, exhausted to a high degree of vacuum. This is essential to prevent ionisation occurring during the actual use of the tube. This point will be appreciated by the reader when he realises that such indicators are designed for use in or near R.F. fields. A typical Bolometer indicator is shown in Fig. 1, and for the interest of the reader the approximate dimensions are given so that he can appreciate their size.

An important rating of such tubes is what is termed the cold resistance. This applies to the filament, and is the resistance of the filament at a current value of something like 2 or 3 mA, the value naturally depending upon the tube type.

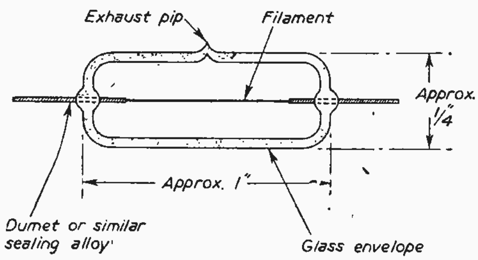

Fig. 1.—A typical Bolometer tube.

Such filaments, however, dissipate only milliwatts, and in actual operation they glow a very dull red.

Another important factor when using such tubes is that of the air temperature surrounding the glass envelope. Too high or too low a temperature will undoubtedly affect the characteristics of the tube, and it is essential, therefore, that the tube should be operated at or within the limits of the temperature rating of the tube in question.

Application

The application of these indicators is for the measurement of small radio frequency currents or power, and they are, therefore, used in laboratories engaged on research or development.

A basic laboratory bridge circuit in which a Bolometer tube is used is shown in Fig. 3, and is more or less an adaptation of the Wheatstone bridge. The latter is shown in Fig. 2, but is given only for reasons of comparison and will not be discussed in this article. However, for the convenience of the reader the Bolometer bridge will be explained, but before proceeding it is interesting to note that both bridge circuits are more or less the same, with the exception that R1 in the Wheatstone bridge is replaced by a Bolometer tube in the other circuit shown in Fig. 3.

To operate such an instrument one must first balance the bridge circuit. This must be done by first ensuring that the instrument is not coupled or connected to an R.F. source. The actual balancing is accomplished by adjusting VR1 and noting the results on the milliammeter marked M. When this instrument is connected to an R.F. source R.F. current will flow through the Bolometer tube (BT) and in so doing the cold resistance of the filament alters and the bridge becomes unbalanced. This unbalancing effect can be seen on the milliammeter; a record or mental note should then be made on the amount of deflection that is shown on the meter. The instrument should then be disconnected from the R.F. source and a known direct current injected in its place until a similar meter deflection is recorded. The latter reading does, therefore, give an indication of the amount of R.F. current that has been generated. Nevertheless, one must ensure, as in all bridge circuits, that the D.C. voltage across the bridge is constant at all times, that is to say, the current passing through the bridge must be the same when both sets of readings are taken.

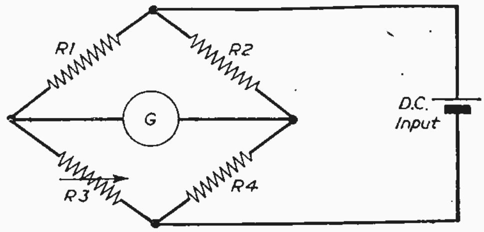

Fig. 2.—Basic Wheatstone bridge.

An important point to remember when experimenting with R.F., however small, is the prevention of R.F. being fed into parts of a circuit where it is not required. R.F. chokes must be included on either side of the indicator tube and should be as low a resistance as possible, otherwise the bridge will be unbalanced.

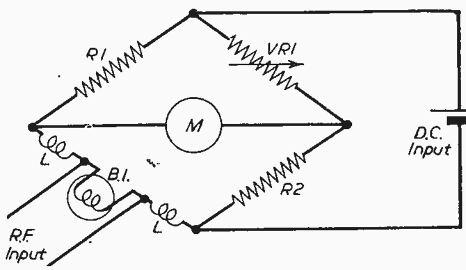

Fig. 3.—A basic laboratory bridge circuit using a Bolometer tube.

Radio Component Show, 1955

GROSVENOR HOUSE, APRIL 19TH TO 21ST

AS a result of a ballot for space in the Radio Component Show, 131 stands have been allotted and 11 more will be allotted shortly, a record total. A preliminary list of exhibitors shows seven newcomers to the exhibition. The Ministry of Supply will again be exhibiting although no stand is yet allotted.

An innovation this year is that instead of circulating admission tickets, application cards will be issued, one to be filled in and forwarded by each intending visitor, in return for which he will receive a ticket if his application is approved. Prospective overseas visitors, however, will receive their tickets as in previous years without application.

Considerable overseas interest in the exhibition is again expected, the exports of British radio and electronic components in the first nine months of 1954 having shown an increase in value of 30 per cent. as compared with 1953.

The full title of the exhibition is the Twelfth Annual Private Exhibition of British Components, Valves and Test Gear for the Radio, Television, Electronic and Telecommunication Industries. It is organised by the Radio and Electronic Component Manufacturers' Federation, 22, Surrey Street, Strand, London, W.C.2.

Member Firm	*Stand No.*
A.B. Metal Products, Ltd.	41
Advance Components, Ltd.	30
Aerialite, Ltd.	85
*A.K. Fans, Ltd.	123
Richard Allan Radio, Ltd.	8
Antiference, Ltd.	56
Associated Electronic Engineers, Ltd.	92
Associated Technical Manufacturers, Ltd.	88
Automatic Coil Winder and Electrical Equipment Co.	72
Bakelite, Ltd.	127
Belling & Lee, Ltd.	16
Sydney S. Bird & Sons, Ltd.	53
Geo. Bray & Co., Ltd.	109
British Electric Resistance Co., Ltd.	35
British Insulated Callenders Cables, Ltd.	57
British Mechanical Productions, Ltd.	76
British Moulded Plastics, Ltd.	2
British Physical Laboratories, Ltd.	78
A. F. Bulgin & Co., Ltd.	70
Bullers, Ltd.	1
Carr Fastener Co., Ltd.	75
H. Clarke & Co. (Manchester), Ltd.	116
Collaro, Ltd.	10
Colvern, Ltd.	55
Connollys (Blackley), Ltd.	9
Cosmocord, Ltd.	79
Creators, Ltd.	105
Daly (Condensers), Ltd.	100
Dawe Instruments, Ltd.	73
Thomas De La Rue & Co., Ltd. (Plastics Division)	83
Diamond H. Switches, Ltd.	6
Dubilier Condenser Co. (1925), Ltd.	45
Duratube & Wire, Ltd.	52
Edison Swan Electric Co., Ltd.	42
Egen Electric, Ltd.	37
Electro Acoustic Industries, Ltd.	40
Electronic Components	108
Electrothermal Engineering, Ltd.	120
H. J. Enthoven & Sons, Ltd.	58
Erg Industrial Corporation, Ltd.	119
Erie Resistor, Ltd.	29
Ever Ready Co. (Great Britain), Ltd.	125
Ferranti, Ltd.	44
Fine Wires, Ltd.	114
Garrard Engineering & Manufacturing Co., Ltd.	64
Goldring Manufacturing Co. (Great Britain), Ltd.	17
Goodmans Industries, Ltd.	47
Gresham Transformers, Ltd.	21
Guest Keen and Nettlefolds, Ltd.	115
Hallam, Sleigh & Cheston, Ltd.	117
Hassett & Harper, Ltd.	141
Hellermann, Ltd.	89
W. T. Henley's Telegraph Works Co., Ltd.	136
A. H. Hunt (Capacitors), Ltd.	23
Igranic Electric Co., Ltd.	12
Alfred Imhof, Ltd.	25
*Insulating Components & Materials, Ltd.	122
Jackson Bros. (London), Ltd.	74
J. Beam Aerials, Ltd.	80
Langley London, Ltd.	130
London Electrical Manufacturing Co., Ltd.	36
London Electric Wire Co. and Smiths, Ltd.	61
Long & Hambly, Ltd.	31
Magnetic & Electrical Alloys, Ltd.	110
*Mallory Batteries, Ltd.	97
Marrison & Catherall, Ltd.	132
McMurdo Instrument Co., Ltd.	39
Micanite & Insulators Co., Ltd.	101
*Minnesota Mining & Manufacturing Co., Ltd.	126
Morganite Resistors, Ltd.	15
Mullard, Ltd.	65
Mullard Overseas, Ltd.	94
Mullard (Valves), Ltd.	95
Multicore Solders, Ltd.	69
Murex, Ltd.	137
Mycalex Co., Ltd.	3
James Neill & Co. (Sheffield), Ltd.	90
N.S.F., Ltd.	49
Painton & Co., Ltd.	46
Parmeko, Ltd.	27
Partridge Transformers, Ltd.	24

Member Firm	Stand No.
Plessey Co., Ltd.	67
Plessey International, Ltd.	68
Radio Instruments, Ltd.	84
Reliance Electrical Wire Co., Ltd.	26
Reproducers & Amplifiers, Ltd.	32
Reslosound, Ltd.	50
Rola Celestion, Ltd.	77
Ross Courtney & Co., Ltd.	104
Salford Electrical Instruments, Ltd.	34
*Joseph Sankey & Sons, Ltd.	128
Geo. L. Scott & Co., Ltd.	118
Simmonds Aerocessories, Ltd.	140
F. D. Sims, Ltd.	133
Spear Engineering, Ltd.	121
Stability Radio Components, Ltd.	51
Standard Insulator Co., Ltd.	142
Standard Telephones & Cables, Ltd.	62
Standard Telephones & Cables, Ltd. (Valves)	5
Static Condenser Co., Ltd.	112
Steatite & Porcelain Products, Ltd.	38
Stocko (Metal Works), Ltd.	131
Stratton & Co., Ltd.	60
Suflex, Ltd.	48
Swift, Levick & Sons, Ltd.	139
H. D. Symons & Co., Ltd.	113
Taylor Electrical Instruments, Ltd.	19
Telcon-Magnetic Cores, Ltd.	111
Telegraph Condenser Co., Ltd.	54
Telegraph Construction & Maintenance Co., Ltd.	66
Telephone Manufacturing Co., Ltd.	33
Thermo-Plastics, Ltd.	11
Transradio, Ltd.	124
Truvox, Ltd.	28
Geo. Tucker Eyelet Co., Ltd.	81
Tufnol, Ltd.	129
Vactite Wire Co., Ltd.	
Vitavox, Ltd.	7
Walter Instruments, Ltd.	86
Wego Condenser Co., Ltd.	18
Welwyn Electrical Laboratories, Ltd.	63
Westinghouse Brake & Signal Co., Ltd.	22
Weymouth Radio Manufacturing Co., Ltd.	13
Whiteley Electrical Radio Co., Ltd.	14
*Henry Wiggin and Co., Ltd.	138
Wimbledon Engineering Co., Ltd.	87
Wingrove & Rogers, Ltd.	59
Wireless Telephone Co., Ltd.	71
Woden Transformer Co., Ltd.	20
Wright & Weaire, Ltd.	82
*Zenith Electric Co., Ltd.	4

* New exhibitors.

News from the Clubs

NEWARK AND DISTRICT AMATEUR RADIO SOCIETY

Hon. Sec.: Mr. R. Clayton, 160, Wolsey Road, Newark, or Mr. G. Bark (G3ITG), 7, Park Crescent, Newark, who is the hon. publicity officer.

THE club continues its winter programme with a meeting on Sunday, December 5th, at the "Northern Hotel" (7 p.m.) with a talk on "Valve-voltmeters," by A. Hall. There will be practical demonstrations accompanying this. Arrangements for the Christmas Social Evening are in the hands of the committee, and members look forward to a very enjoyable evening at the "Northern Hotel." New members are always welcome and may contact the club secretary.

NOTICE FOR CLUB SECRETARIES

Each issue is published about the 7th of the month preceding the date of issue. Copy goes to Press about the 14th of the month preceding the publication date. Copy should, therefore, be received by us not later than the 9th of the month. Example: Copy received by the 9th February will be included (if space is available) in the April issue which is published on or about March 7th.

SOUTHEND AND DISTRICT RADIO SOCIETY

Hon. Sec.: J. H. Barrance, M.B.E. (G3BUJ), 49, Swanage Road, Southend-on-Sea, Essex. Telephone: 68545.

MR. K. F. CRISPIN, technical adviser to the Society, gave a talk on the "Function of Crystals in Modern Apparatus" at a recent meeting. Mr. Crispin pointed out that crystals, which were the only known means of detecting radio signals in the early days, and which later were replaced by valves, have now become adjuncts to valves. By new angles of cut and new methods of mounting, the natural quartz crystal can be made to produce oscillations of pre-determined frequencies; depending chiefly on the thinness to which the crystal has been ground. These frequencies are extremely accurate and reliable.

LEICESTER RADIO SOCIETY

Hon. Sec.: W. N. Wibberley, 21, Pauline Avenue, Belgrave, Leicester.

THE Annual General Meeting of the Society was held in the Club Room at "Holly Bush Hotel," Belgrave Gate, Leicester, on October 11th. After receiving a report from the hon. secretary and the hon. treasurer, which showed both an increase in membership and finance over the past year, the election of officers of the Society followed.

For the year 1954/1955 the following were elected:

Hon. Founder President (in recognition of 25 years unbroken service to the Society): L. Ridgeway (G2RI); *President*: R. Frisby (G2CFC); *Chairman of Meetings*: W. McQueen (G3DVP); *Hon. Secretary*: W. N. Wibberley; *Hon. Treasurer*: D. Hoff (G3AWM).

A new committee of five members was elected, and the programme of the first session fixed.

On Sunday, December 12th, an inter-Society contest has been arranged with the Derby Radio Society on the Top Band, and it is hoped that all Midland stations will take part.

Transistor Experimental Group.—All members have been taking part in experimental transmissions and new equipment has been developed by G3CCA and preliminary tests have been carried out.

WARRINGTON AND DISTRICT RADIO SOCIETY (G3CKR)

Hon. Sec.: G. H. Flood, 32, Capesthorne Road, Orford, Warrington, Lancs.

RECENT lectures have been on "Radio Control for Models," with a demonstration of Mr. W. Sanson's home-constructed motor launch, and an example of the G.P.O. "Two-Motion Type Selector Unit," by Mr. A. Pearson. A visit to a local automatic exchange is being arranged.

COVENTRY AMATEUR RADIO SOCIETY

Hon. Sec.: J. H. Whitby, 11, St. Patrick's Road, Coventry.

AT the Annual General Meeting held on September 27th, 1954, the following officers were elected:

President: L. Gardner (G5GR); *Chairman*: D. W. Harries (G3RF); *Secretary*: J. H. Whitby (G3HDB); *Treasurer*: K. Barber (G3HDP).

TORBAY AMATEUR RADIO SOCIETY

Hon. Sec.: L. H. Webber (G3GDW), 43, Lime Tree Walk, Newton Abbot.

IN the absence of the chairman (G2GK), the October meeting was held under the chairmanship of the hon. Secretary (G3GDW).

A hearty welcome was extended to ZC4GT, who is home on leave, and who was making enquiries as to the full list of countries whose amateurs are licensed to work on Top Band. G3GDW gave a short account of the recent Low Power Field Day in which he took part.

A discussion followed, on the possibility of a Social Supper being held—some time in the New Year—for members and their ladies. Further information to follow.

The TV Interference Committee of the Society—recently formed under the leadership of G3AVF, has reported that it has successfully co-operated with the authorities in the case of complaints of T.V.I. against one of the members.

Any visitors to the district are always welcome.

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Model PC/3
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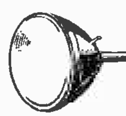

VCR 517C 6½in. picture. This tube is a replacement for the VCR97 and VCR517. Guaranteed full size picture. **PRICE, 35/-.** Plus 2/6 pkg., carr., ins. **VCR 516** 9in. Blue picture. Heater Volts 4. Anode 4 Kv., in Manufacturer's original Carton. Plus 5/- pkg., carr., ins. PRICE, £1.19.6.

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A VALVE TESTER

A COMPREHENSIVE TEST UNIT WHICH MAY BE USED ALONE OR IN CONJUNCTION WITH AN OSCILLOSCOPE

By R. Wilkinson

(Concluded from page 717 December issue)

THE next item required is :—

2. Mains Transformer. A discarded standard type mains transformer should be obtained with a sound primary winding. All secondary windings are removed, noting the turns/volt ratio for the L.T. windings removed. Secondary windings required are then wound over the old primary, using the turns/volt ratio obtained. Anode/screen winding should be wound first, followed by the grid winding and then the filament. Use waxed paper taken from a Mansbridge type condenser for insulation between layers. In choosing the gauge of wire the space available should be considered, attempting to fill the space if possible with active windings and necessary insulation. 34 s.w.g. enamel wire should suffice for anode/screen windings and the grid 15 volt supply. The L.T. windings should be 20 s.w.g. for 6.3 volt and below, 28 s.w.g. for 16 down to 6.3 volt, and 32 s.w.g. for 50 down to 16 volt winding.

3. Pin-connecting Panel. This consists of six horizontal brass strips, representing anode, screen, grid, cathode and two filament circuits connected to the tester. Mounted over these strips and insulated from them are nine vertical strips, representing pins 1 to 9, wired to the valve bases, and a tenth connected to the top cap socket. At each point where a horizontal and a vertical strip cross holes are drilled through, the bottom holes being tapped 6 B.A. and holes in the vertical strips and insulation drilled 6 B.A. clear. Suitable connections can thus be made to the valve to be tested by inserting shorting terminals into the panel, making the required circuit connections. The diagrams give the principal dimensions of a suitable panel. The six horizontal strips should be ¼in. thick, to allow about six threads for good connection. The vertical strips are brass and are shaped and slotted into the middle paxolin panel to prevent sideways movement and resultant shorts between adjacent strips. All paxolin panels should be 3/32in. thick. Shorting terminals are made from a short length of 6 B.A. threaded rod, using top terminals from old type valves, and 6 B.A. nut or collar to complete.

4. Rectifier. Any half-wave selenium rectifier rated at about 50 mA can be dismantled and its elements rearranged to form a bridge. Two rectifier elements are required for each arm, and three extra connection tags are necessary. The tightness of the clamping nuts is not critical.

5. Switches. All switches should be of the

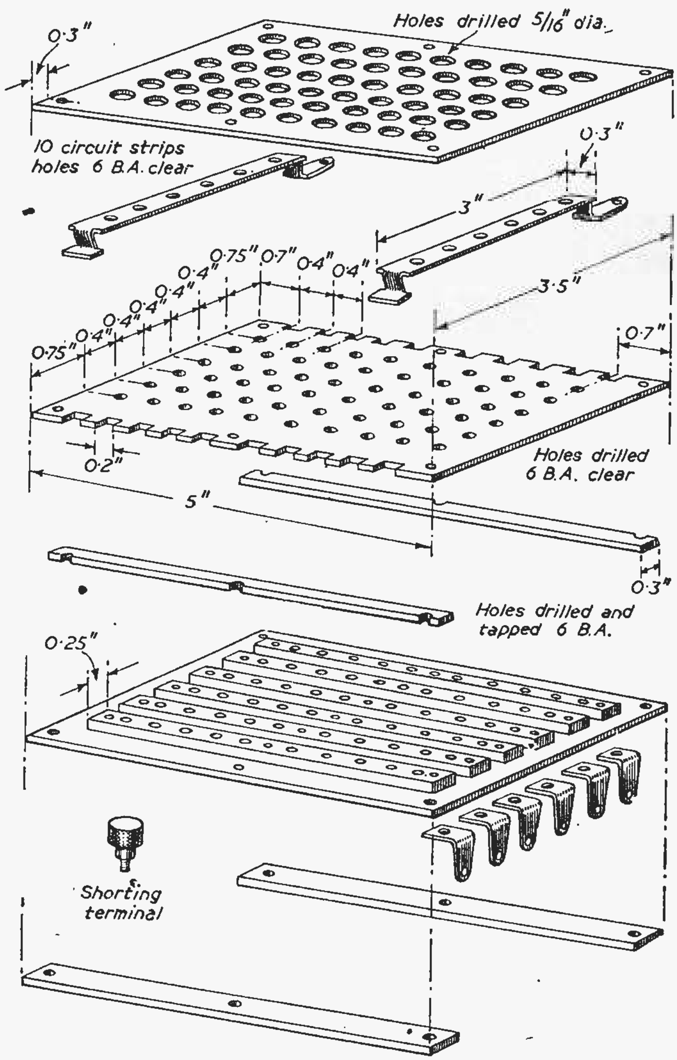


Fig. 7.—Details of the pin-connecting panel.

type which has "break before make" action.

Panel dimensions and layout of components are shown in the diagrams, ample space being provided for the storage of test leads and adapters. Suitable brackets must be made to support the 1.5 battery, rectifier and VR1. Graduated dials for switch positions, etc., are easily made from clear Perspex, cut to shape and painted, black on the back and white on the front. Graduations can then be marked with a scriber, the white paint removed revealing the black backing. The panel should be painted grey on which the white dials and black meter case and knobs contrast. Meter shunts are adjusted to give correct f.s.d. for the appropriate ranges, checking each against an accurate milliameter.

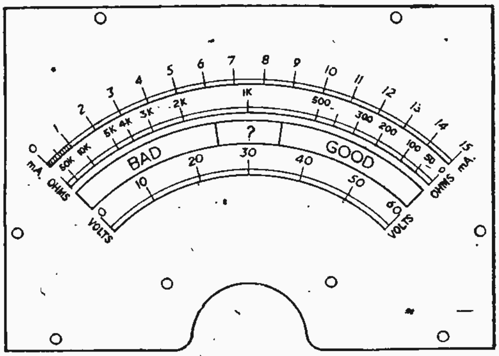


Fig. 8 (*right*).—*Details of the scale.*

Walkie-talkies for Gasholder Inspections

TESTS have recently been carried out by Mr. L. C. Grant, a leading consulting engineer in Liverpool, to find out how walkie-talkies could be used for the inspection of gasholders. Subsequent to these tests the consulting engineer has ordered equipment, and the following report on its use has been sent by a Pye representative who was present.

"Following a recent request by a leading north western gas consulting engineer, who required communications from inside gasholders for the purpose of maintenance and suchlike, a series of tests was carried out using the standard Pye battery-powered transportable, together with a standard walkie-talkie.

"The transportable 'Reporter' was set up approximately 50ft. away from the gasholder at ground level, working on frequencies of 85.875 Mc/s and 72.375 Mc/s. Tests were then made and two-way communication loud and clear was established to the walkie-talkie, working on similar frequencies to the transportable.

"At this stage one of the Gas Board engineers was fitted up with the walkie-talkie and made his way up the side of the gasholder, maintaining communication at intervals, loud and clear signals being received at all points up the side and on top of the gasholder. The engineer having descended to ground level, a second series of tests was made.

"The engineer entered the gasholder through a steel door into the airlock, which was then shut and secured, fully readable signals being obtained loud and clear. During the progress of the engineer into the airlock, a running commentary was given on his actions and every syllable was fully readable.

"The engineer passed through the second door of the airlock into the gasholder proper, closing this door behind him and again maintaining fully readable signals with those outside. Various instructions were passed to the engineer, who was by this time established on a raft which was floating inside the gasholder, and the engineer was instructed to pole this raft to various positions in and around the interior of the gasholder. At all times fully readable, full strength signals were obtained.

"It should be noted that the gasholder used for these tests was under repair and was filled with compressed air, no breathing apparatus being needed.

Britain's Sapphire Needle Industry

IN the middle of the biggest-ever boom in the gramophone record industry throughout the world, Britain has cornered the market in the now universally used sapphire needles (called "styli" in the trade).

What was formerly a monopoly of the Swiss has been stolen by a London engineering firm, Sapphire Bearings Limited, with a process for the automatic manufacture of these minute styli, which is being hailed as a "miracle of engineering." Britain has switched from being an importer to the world's largest exporter of these styli—and this firm holds export orders calling for deliveries at more than 100,000 styli per week.

The plant is now being doubled in size to cope with increased export demand and by June (1955) output will be at the rate of 20 million a year; worth £750,000. This achievement has been accomplished in a factory not much bigger than a large drawing room. The whole year's output would just fill a pint mug!

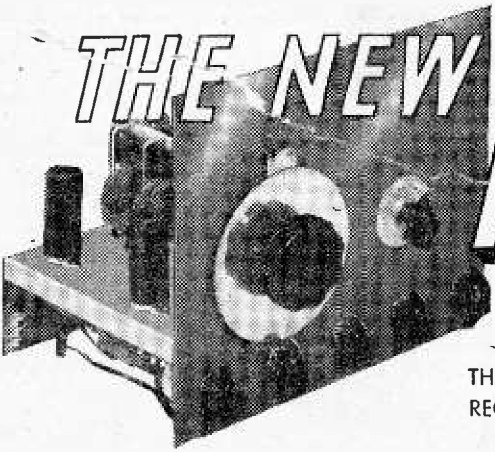
Fifty workpeople now work round the clock in this baby factory in London's Bow Road, living in a microscopic world. The finished stylus is less than one-twentieth of an inch long and one fiftieth of an inch in diameter.

It is necessary to polish a cone a mere fifteen-thousandths of an inch long, and then turn the pointed tip into a spherical shape accurate to within one-hundred thousandth of an inch of true sphericity. This has to be done not ONCE—but 40,000 times a day.

With British sales of gramophone records alone reaching an all-record level of 40 million a year, and with British manufacture of record players now well over one million a year, the demand for sapphire styli is rising by leaps and bounds.

With the advent of the long play record—with its tiny grooves measuring 325 to the inch—the old steel needle proved too soft to use. It wore out long before it traversed one tenth of the record.

The search for harder materials finally led to sapphire, the second hardest known material (diamond being hardest), because of its durability and high polish. Now sapphire is used universally in commercial gramophone pick-ups, with diamond styli used in only the luxury gramophones.



THE NEW Fury Four

THE LATEST VERSION OF OUR POPULAR TWO-R.F. RECEIVER, WHICH IS FULLY ADAPTABLE FOR MANY PURPOSES

(*Continued from page 735 December issue.*)

AN ECC83 should not be used for V.3 in view of the distortion which may result from the very much increased gain of this particular type of valve. Normal R.C. coupling is used between the A.F. stage and the output pentode, and all the preceding anode circuits are adequately decoupled. The output from the pentode is taken to a loudspeaker through the usual transformer and it will be noted that this is not included on the chassis. It should be placed at any convenient part of the cabinet which is finally chosen for the receiver, and then, if the special tone-control circuit is used, the leads to the speaker will be included in the final feed-back loop. It will be seen that the tone control forms a more or less normal feed-back circuit, and if included the earth connection should be removed from the junction of the bias resistor and condenser of the first A.F. valve and a 56 ohm resistor connected in place of it.

Cabinet Design

As already mentioned, the receiver may be made up in any desired form, and if included in a radiogram cabinet the on/off switch may be included on the side of the cabinet, or may be part of the R.F. or A.F. volume control. It would be in the latter position if the receiver is mounted in a small table-type cabinet, or it may be omitted entirely and the ordinary house switch used at the point into which the receiver is plugged. It will be seen, therefore, that there are a number of points which must first be decided before the components are purchased, and the component list which is included below the circuit on page 734 gives the parts which we used and does not include the on/off switch, but does include all the other parts. Knobs have been specified for all the controls, but if, for instance, the first R.F. stage is omitted, then the R.F. gain control will not be required, which will be one knob less, and so on. No attempt should be made to use condensers other than those specified for the aerial and earth isolating condensers, and for the .05 across the mains transformer. In the case of all the other parts the physical size plays an important part in the layout, and for this reason any departure may lead to trouble due to modifications in the layout or wiring.

Construction

Having fully described the circuit and the principles underlying the design, we may now proceed to the actual constructional work. Firstly, the chassis will be standard type, no matter which of the

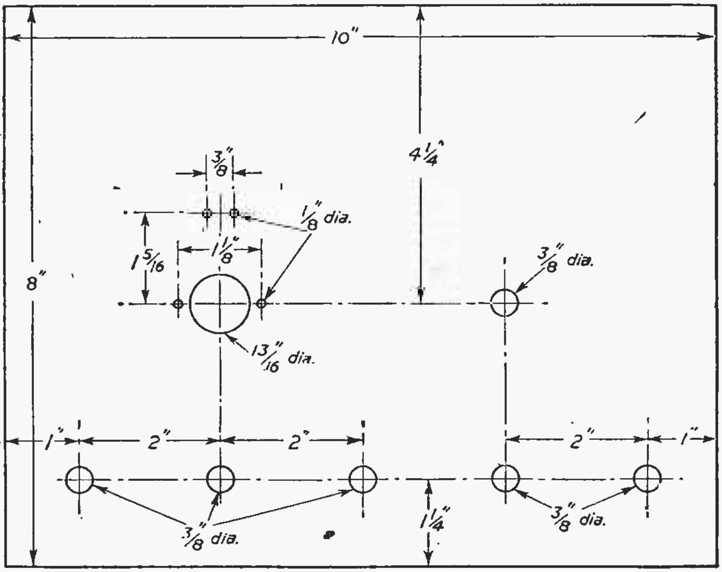


Fig. 2.—Panel drilling details. See special note on p. 32 under 'Warning'

alternatives the constructor decides to build. The original which we used was a standard Denco model, measuring 10in. by 6in. with 2½in. runners. If it is desired to construct this at home a square foot of aluminium of 16 s.w.g. should be used. The full drilling and bending data is given in Fig. 6 on page 34, and it will be noted that the sides are merely ½in. projections. If a thinner gauge of metal is employed these should be the full 2½in. and should be provided with a turnover which may be bolted to the front and rear runners to provide rigidity. As already mentioned, there are a number of alternatives in the circuit and the final design will govern the panel layout, shown for the full circuit, in Fig. 2 on page 31. This provides for the special slow-motion drive specified and the full range of controls. If any of these are to be omitted, the appropriate hole will of course not be drilled. When drilling the holes in the front runner of the chassis, care should be taken to see that they line up with those in the panel, and some constructors may prefer to drill the panel first and place it in position on the front runner of the chassis, using a bolt at each end, and then drill the chassis runner.

Warning

It should be emphasised at this point that the receiver does not utilise an isolating mains transformer, and by reason of this the chassis is " live " to one side of the mains. Consequently, a metal panel must not be employed. All of the specified volume and tone controls are provided with metal cases which

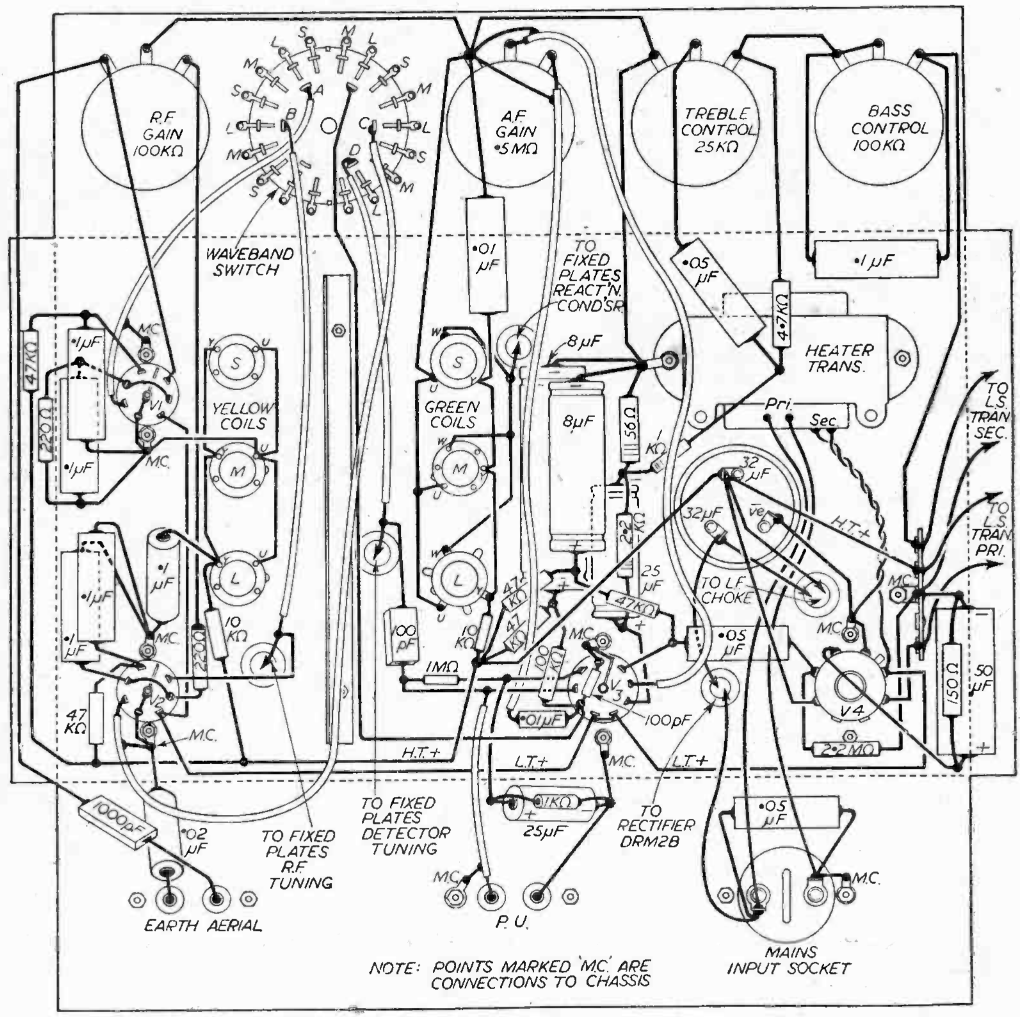


Fig. 3.—Wiring details. Note that for clarity only part of the coil wiring is shown, the remainder being given in Fig. 4.

will automatically be "earthed" when the lock nuts are tightened. This is essential for screening the components. The lock nuts will, therefore, also be "live," and the knobs which have been specified have a centre portion which will effectively cover these, whilst at the same time the grub screws are deeply recessed. The main slow-motion drive is isolated

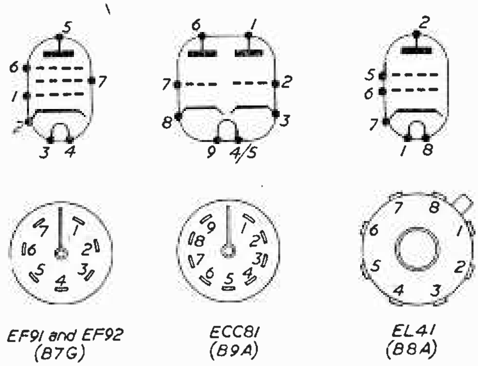


Fig. 5.—Valve base data.

from the tuning condenser by the special coupler, and the reaction condenser also has the dial attached to a "live" lock-nut. In the event of a metal panel being used, therefore, it would be difficult to isolate the lock-nut of this component so that the small dial is not actually in contact with the panel. These precautions will be obvious to those who are familiar with A.C./D.C. types of receivers but are emphasised for those who may not be aware of the risks of this type of equipment. All the precautions are, of course, rendered unnecessary if a paxolin, Perspex or similar material is used for the panel. A thin panel of wood will be adopted by many, stained and polished to match a cabinet, or as an alternative a standard mains transformer with a 250 volt secondary, in addition to the 6.3 volt winding may be employed, and this will effectively isolate the receiver.

All the holes shown in the chassis will be needed for the full circuit, and it would probably be preferable to drill all of these even if only part of the receiver is to be used. For instance, three holes are shown for the two sets of coils, although if only the medium- or long-wave coil is to be used, two of the holes will not be needed. It would be simpler to drill all at the beginning, and then if at a later date it is decided to add a coil or make any other modification the hole will be ready.

Coil Screening

One further piece of aluminium is needed to provide a screen between the two sets of coils. This strip should be as deep as the chassis (2½in.) and have a ½in. turnover along one edge. Its length is 5in. and the bent-over edge should be drilled with two holes, and if it is desired to use the wave-change switch this should be fitted to the front runner and then the screen placed as close to the switch as possible, before the holes are marked through to the chassis. The screen actually screens the projecting lugs of the switch and then leaves sufficient room between the rear runner and the screen for some of the wiring. Even if only one range is to be employed, this screen will still be necessary in the interests of stability. A special flexible coupler is specified for connecting the slow-motion drive to the variable condenser as it may be found that even with the measurements given the spindles may not be in exact line and the flexible coupler will take care of any discrepancy.

Mount the valveholders and other parts as shown in the wiring diagram (Fig. 3), making certain to get the valveholders round the right way. As a guidance the separating point between pins 1 and 7, 1 and 9 and 1 and 8 for the different valveholders has been shown in the wiring diagram, and in Fig. 5 we give a view of the underside of the valveholders and the various electrodes of the different valves. If the set is not to be used for record reproduction the pick-up socket strip will be omitted.

Wiring

The receiver is now ready for wiring and one can follow either the theoretical circuit given last month or the wiring diagram in Fig. 3. Note the fact that the latter is for the *full* circuit and, therefore, any omissions decided upon will affect the wiring. In this connection the tone-control network is taken back to the bias resistor for the second half of the double-triode. If the network is omitted a wire must be connected from the nearest earthing tag to the *negative* end of the 25μF condenser across which is connected the 2.2 KΩ resistor. This is shown as a solid line in the theoretical circuit, but it is, of course,

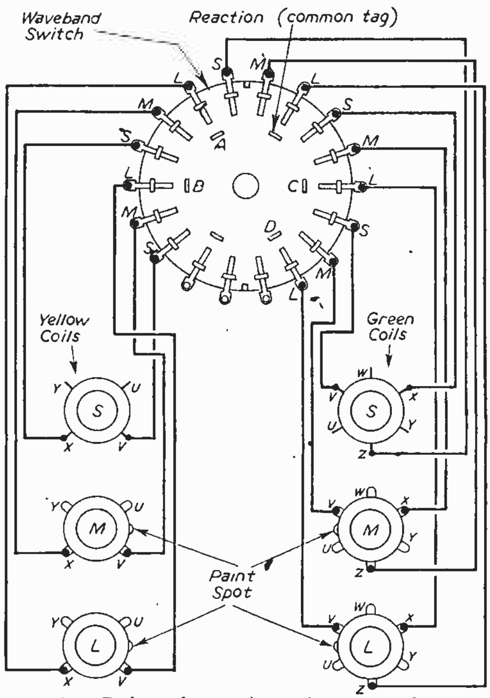


Fig. 4.—Coil and switch wiring—not shown in Fig. 3.

omitted if the tone-control network is fitted, and as the wiring diagram shows the tone controls in circuit this lead is automatically left out. It will also be noted in the wiring that the anode lead is joined to one of the switch arms, and the three reaction windings are taken to three of the contacts on the switch. This was omitted in the theoretical circuit given last month.

It should also be mentioned again that there is no on/off switch in the receiver. If the set is to be built as it stands, then the A.F. gain control should be of the type having a double-pole on/off switch fitted, and then the two leads from the rear of the mains input socket would be taken to one pair of contacts on the switch, and the other pair of contacts would be joined to the primary of the mains transformer. As an alternative, a length of twin flexible mains lead may be attached to the input socket and taken to a double-pole switch conveniently sited on the cabinet or installation and a similar length of twin lead taken from the primary of the mains transformer to the remaining contacts on the switch. If an isolating mains transformer is fitted, the switch need only be of the single-pole type.

Coil Switching

To facilitate wiring of the coils and switch a separate diagram is given in Fig. 4 on page 33, and this indicates a fixed layout of the connecting points on the coils. In actual fact, some short-wave coils are provided with wire ends to the coils only and in this connection the maker's leaflet which is supplied with each coil should be carefully studied. As already mentioned, coils may be selected for any desired waveband and although the connecting points are standardised the actual layout may be slightly different. The leads shown on the wiring diagram in hollow form (as distinct from the solid leads generally employed) are to represent standard 80 ohm coaxial cable as used for television aerial lead-in. This should be bared and cut with the minimum of

(*Continued on page* 42)

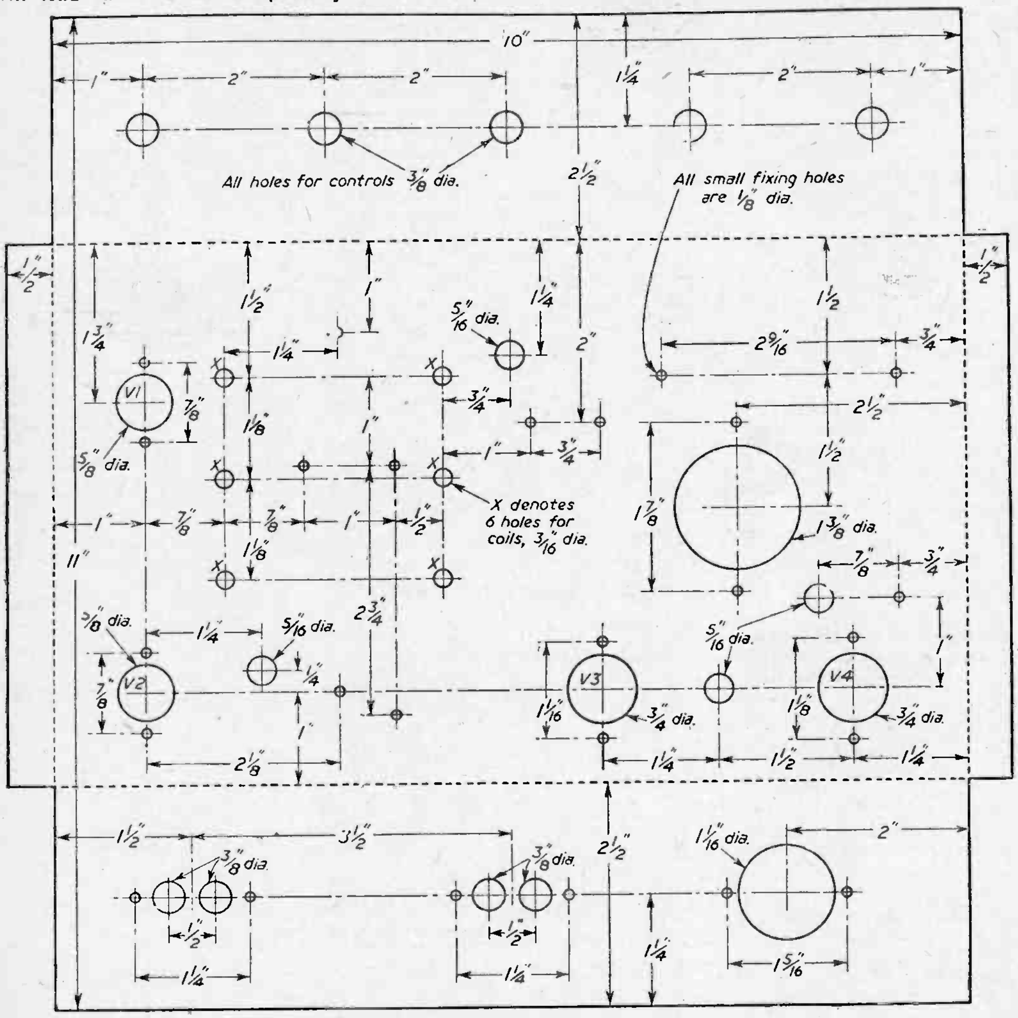
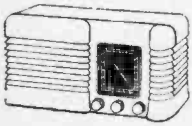


Fig. 6.—Chassis drilling and bending details.

GET ON THE BEAM!



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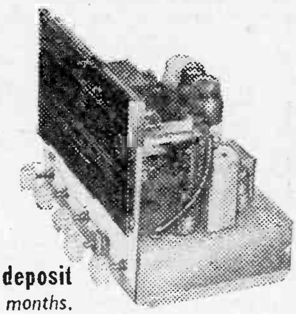

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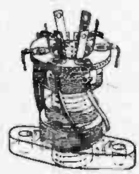

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The Beginner's Guide to Radio

The Twenty-first Article of a Series Explaining the Fundamentals of Radio Transmission and Reception. This Month Mains Valves and Practice are Dealt With.

By F. J. CAMM

THE resistance should be screwed down on to a flat piece of wood covered with white paper. Mark out a scale on the paper, dividing up the length of the resistance into 10 equal parts, so that each division represents a resistance of 1,000 Ω. This provides a temporary and inexpensive variable resistance. Now take the bared end of a lead as shown in Fig. 91 and press it on to the resistance at the first mark nearest the meter terminal, representing a resistance of 1,000 Ω. Take a note of the meter reading, and take similar readings of all the other markings on the resistance scale, and make a small table of them as below:

Anode volts = 100 Grid bias = 1.6

Resistance (ohms)	Current (milliamp)	Valve output (milliwatts)
1,000	8.0	64
2,000	7.0	98
3,000	6.2	115
4,000	5.8	134
5,000	5.2	136
6,000	4.8	138
7,000	4.5	141
8,000	4.2	140
9,000	3.8	130
10,000	3.5	123

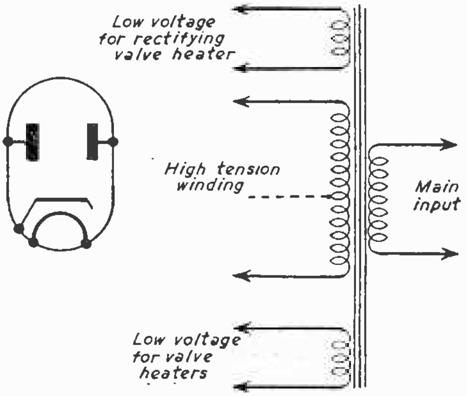


Fig. 93.—Theoretical circuit of a mains transformer and a full-wave rectifier.

These figures will, of course, only provide data for the first two columns, and we must calculate from these two columns the figures for the third column.

The watts absorbed by the resistance equals resistance multiplied by the square of the current. For example, the first reading is 8, the square is 8×8, which equals 64; multiplying this by $1,000 = 64,000\ \Omega$; but this must be divided again by 1,000 to bring it to milliwatts (1,000 milliwatts equals 1 watt), so the answer is 64 milliwatts, which is put down in the third column. The second line will be:

$$\frac{7^2 \times 2000}{1000} = \frac{49 \times 2000}{1000} = 98 \text{ milliwatts.}$$

and so on for all the other readings. If you can use a slide rule you can read off all the answers direct; otherwise you must calculate them.

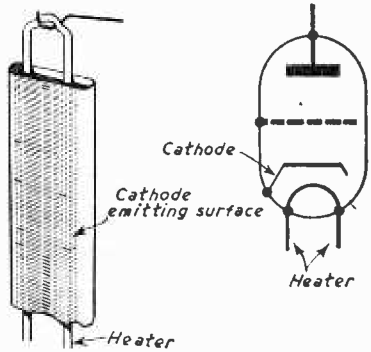


Fig. 94.—An indirectly-heated cathode and the elements of an indirectly-heated valve.

The next step is to plot a graph representative of milliwatts for any value of resistance. Mark the milliwatts scale on the left of the squared paper and the resistance scale at the foot (Fig. 92); using the figures of the table (yours will, of course, be a different set of figures), trace the pencil up the vertical line representing a resistance of 1,000 Ω and make a dot where it intersects the 64 milliamp line. Repeat this for all the other values and then connect the points with a free-hand curve. Almost certainly you will not be able to draw a smooth curve touching all the dots. This is probably due to inaccuracy in your reading, but a curve which "averages" the dots will give the approximate mean of all the results. The highest point on this curve represents the highest or optimum of the valve under the conditions of this test. In the graph it is shown that the optimum is at about 7,000 Ω, and this should be the impedance (impedance is the resistance plus the inductance) of the speaker.

Knowing the optimum load for the valve, on referring to your table you will find that at this load the current is, say, 4.5 milliamps. By connecting up the milliameter in series with the speaker while it is working, if the meter reads 4.5 milliamps, the speaker is right. The figure 4.5 will probably be different in your case and is only given here as an example.

When two or more speakers of the moving-coil type are to be operated from one receiver it is often found most satisfactory to use a single output transformer to feed them all. In that case the speaker speech coils should be of similar impedance, when they may be connected in parallel. The transformer ratio should naturally be selected to match the combined impedance of all the speakers added together.

Mains Valves

Hitherto, I have chiefly dealt with battery sets and battery valves. When a set, however, is intended for operation on the mains, different types of valve are needed, and although the fundamental principle is the same, the methods of heating the filament vary. In a battery the filament or cathode is connected directly to the low-tension source of supply—the accumulator. Most mains valves to-day, however, have *indirectly-heated* cathodes, which means that the emitting surface is not directly connected to the supply. There are of course valves with directly heated filaments, and in this respect they are similar to ordinary battery-operated valves. The emitting surface in the latter case is a wire coated as already described, and it may be heated by a raw alternating current supply. An indirectly-heated valve is indicated in Fig. 94.

In a mains receiver, the alternating current from the mains is connected to the heater, and surrounding this is the cathode.

Consequently, a mains power section must be included, and this is the main difference between a battery receiver and mains receiver. The power pack for an alternating current receiver consists of a mains transformer to convert the voltage of the mains supply to a desired value, which may be 250, 350, 500 volts or even higher, and a low-tension supply—usually of 6.3 volts, to heat the cathodes.

Most mains valves to-day are designed for 6.3 volt working, and it is necessary therefore to recapitulate to some extent the principle of the transformer. It is an instrument for stepping up or stepping down an A.C. voltage, in this case for the purpose of feeding the heaters and anodes of the valves. Alternating current is extremely valuable as a basis of design of mains receivers, because the voltage can be changed to any required figure with the greatest ease, whilst it is, of course, impossible to step up D.C. All that is needed in the case of A.C. is a step-up or a step-down transformer. As we have seen earlier a transformer consists essentially of an iron core on which are placed the primary and secondary windings. The type of core most frequently used for small transformers is that consisting of U and T shaped stalloy stampings. The T fits inside the U, forming a semi-solid core with two "windows" and a central limb upon which the windings are placed.

The number of turns per volt for both primary and secondary windings depends upon the cross-sectional area of the winding limb and the frequency of the mains supply. For example, if the area is 1 sq. in., and the frequency 50 cycles, 8 turns should be allowed for every volt. If the area is half this, the number of turns must be doubled and vice versa. On the other hand, if the frequency is doubled, the turns should be halved and vice versa.

This rule is invariable, and is the basis of all mains transformer design.

In order to ascertain the most suitable size of stamping, it is necessary to know the power, in watts, which the transformer has to handle. For example, assume that the transformer has to supply 20 volts at 2 amperes; the wattage would be 20 multiplied by 2, or 40 watts, assuming an efficiency of 100 per cent. But as the actual efficiency is only about 80 per cent., it is necessary to increase the valve by about 25 per cent., which gives the power to be handled as 50 watts.

(To be continued)

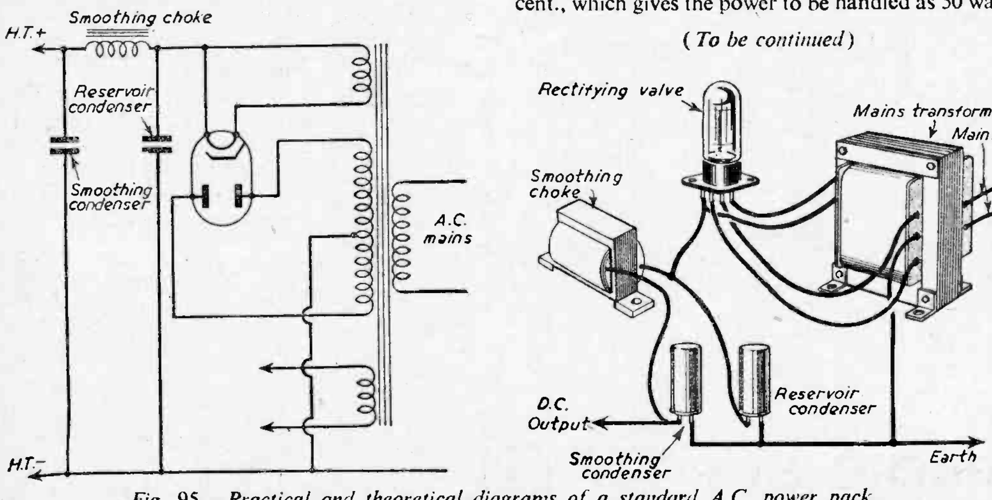
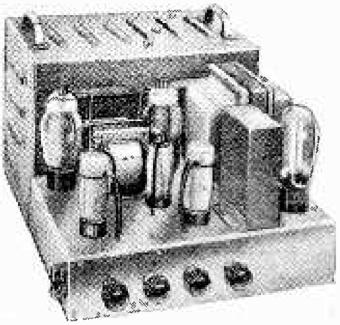


Fig. 95.—Practical and theoretical diagrams of a standard A.C. power pack.

R.S.C. A4 HI-FIDELITY 25 WATT AMPLIFIER



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Low-Cost HI-FI

MODIFYING EXISTING RECEIVERS AND EQUIPMENT FOR BETTER REPRODUCTION AT MINIMUM COST

By W. J. Delaney

MANY readers are interested in modern hi-fidelity equipment, but on the grounds of expense, or that they already own a receiver, are unable to take advantage of the idea. Dual speakers, cross-over networks, and specially designed cabinets are the main features of modern hi-fi equipment, but when one already has a favourite receiver (in either a table or console cabinet), it is not thought desirable to scrap it and build a completely new outfit. At the same time, the feeling remains that perhaps a modern arrangement might sound so much better that it would be worth while, and the user is left in doubt when receiving a musical programme, as to whether a hi-fidelity installation would sound so much different. Actually the user of an ordinary commercial or home-made installation can often do quite a lot in the way of improving things, without undue expense, and in many cases with the minimum of labour. First, what is actually meant by hi-fi ? The term covers quite a wide field, and what to one listener is hi-fidelity might be considered by another as too harsh or too deep. In most cases the term is applied to reproduction of a much wider range of tone than is normal with a standard type of receiver. This means that there is more top and more bass than in the average case and, therefore, any improvement must be in the form of accentuated treble or bass, if the circuitry is not to be modified.

Improved Top

The average receiver utilises a medium or small type of speaker which is very good for the higher frequencies but usually lacking in bass. There should thus be little difficulty so far as concerns the top, but this *appears* to be lacking in most receivers for two or three reasons. First, the position of the loudspeaker is generally too low. If a console type of cabinet is employed, the speaker will be a foot or so from the floor, and one has only to bend down so that the ear is on a level with the speaker to note the improved top-note response. The reason for this is that the higher frequencies are directed more or less in a straight line from the diaphragm, and do not radiate in the same manner as the low frequencies. If, therefore, the speaker can be directed upwards to the level at which the ears normally are found (depending, of course, on the particular chair and listening point), the improvement will be noted immediately. If there is no gramophone turntable in the equipment the front of the cabinet may be raised from the floor, tipping back the cabinet and effecting the desired tilting of the speaker. In the case of a table model, the receiver may be placed on some extra packing to bring it to the desired level, and neither of these modifications calls for any constructional work. Where the equipment is home-made, or access may easily be gained to the interior, the speaker itself may be tilted by placing some packing at the top, after loosening the holding screws (Fig. 2). Where a receiver gives a boomy effect as a result of undue cabinet resonance, this idea will remove the boom whilst at the same time improving the upper register. Alternatively, the speaker may be removed and placed in quite a small cabinet placed on a special shelf to give the desired height and direction. The effects of modern cabinet design may here be roughly obtained by making the cabinet of fairly stout wood, with a close-fitting back, and packing the cabinet with kapok or similar material to deaden any resonance. An alternative is to mount the speaker on a small triangular board and fit this to the top corner of the room so that it is directed downwards toward the normal listening point. (Fig. 3).

Improved Bass

All the ideas just mentioned aim at improving the *effect* of top-note response, although they do not actually improve the response. To effect the latter some circuit changes must be made, and in many cases it will be noted that there is a top-note cut fitted to the output circuits, usually a fixed condenser across the speaker or output transformer, and it may be found that this may be removed—generally to be

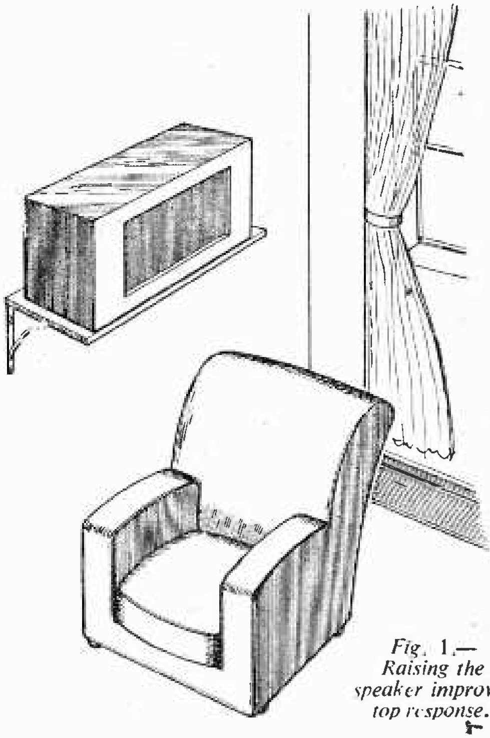
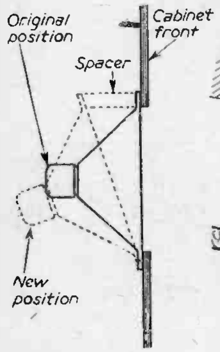
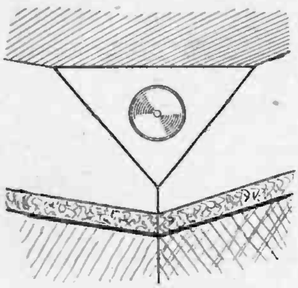


Fig. 1.—Raising the speaker improves top response.

accompanied by some change to strengthen the lower frequencies. Usually, this can only be effected by changes in circuit values or in the actual valves, etc., but the simplest change would be to use larger capacity coupling condenser(s) in the L.F. circuits. Most standard receivers will have condensers of .01 to .05μF, and this may in most cases be increased to .1μF, any larger capacity, whilst perhaps giving improved bass response, involving the risk of grid choking due to a grid leak of too high a value. Some measure of improvement might also be effected in a simple manner by removing any bias by-pass condensers which may be fitted—again, the change involving the risk of instability in some circuits. No changes should be made which might affect the H.T. current drain as these may result in instability, and this means that anode-load resistors and bias resistors must not be touched. Neither must a valve be changed for one of lower impedance, in an endeavour to obtain improved bass response—unless the extra current can be handled by the power pack which is fitted.



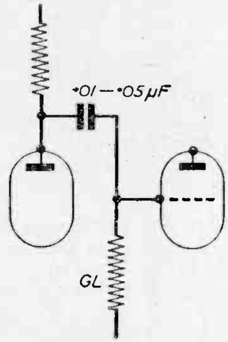


Corner of Walls and Ceiling

Fig. 2 (left).—Tilting a speaker to improve " top."
Fig. 3 (right).—Mounting the speaker in a corner to provide better baffling.

Tone Controls

Where any or all of the above-mentioned changes are made, and it is felt that the result, whilst it is an improvement on some types of music, is not desirable on others, an adjustable tone control will become necessary. In fact, in many cases the reader may desire to fit such a device to an existing receiver, and the simplest form of this is shown in Fig. 5. It consists merely of a fixed condenser and a variable resistor joined between the anode of the output valve and the chassis line. If there is already a fixed condenser across this point, or across the output transformer primary, it should, of course, be removed. The values will have to be found by experiment to suit the particular tastes of the listener, but condenser C should be between .01μF and .1μF and the variable a 5,000 or 10,000 ohms component. This only cuts the upper frequencies, but if these have been improved by one of the first methods described this will be found desirable on some items, and if the values chosen result in severe cutting the effect of bass boosting will be obtained by comparison. There is no effective way of controlling bass without drastic changes in circuitry, and if such changes are contemplated it would be preferable to build a new amplifier to take advantage of all the resources of modern tone control and improved quality.



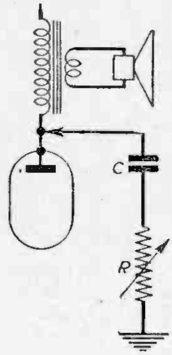


Fig. 4 (left).—Increasing the grid condenser will improve " bass " but the grid leak may restrict the range of adjustment possible.

Fig. 5 (right).—A simple tone control.

THE FURY FOUR

(*Continued from page 34*)

bare wire at the end for connection and if there is any risk of the braiding not being effectively soldered a short piece of Scotch tape or a Hellesen's rubber sleeve should be put over the end to guard against short-circuits. Earth these leads at one end only. The two leads to the tuning condenser are shown in similar form but not with earth points. In the original model these leads were merely inserted in insulated sleeving, but in some layouts there may be a risk of instability and, therefore, these two leads also may be of coaxial cable. It will be found desirable to attach these leads to the variable condenser before this is mounted and the leads should then be pushed down through the grommets and the other ends finally cut off as required. Note particularly that the two condensers specified for isolating the aerial and earth must be of the voltage rating specified.

Testing

Insert the valves in the sockets making sure that the EF91 is nearest the panel, plug into the mains and switch on. All controls should be turned fully anti-clockwise which will result in the variable condenser and reaction control being at minimum and all other controls backed right off. Turn the wave-change switch to the medium waves if the three coils are of the long, medium and short type or otherwise set it to the medium-wave band. Turn the R.F. gain about half on, turn up the A.F. gain until a rushing noise can be heard in the loudspeaker, and then rotate the main tuning knob until a signal is heard. Turn this to its loudest point and then adjust R.F. gain to the lowest position consistent with adequate signal strength when the A.F. gain is nearly full on.

These two controls need adjusting together, the R.F. gain to avoid overloading in the case of a powerful local station and also to provide adequate selectivity. The A.F. gain is similarly used to avoid overloading the EL41 on loud signals from either radio or pick-up.

The reaction control should be used when receiving C.W. or for boosting very weak signals. It will, of course, affect tuning slightly.

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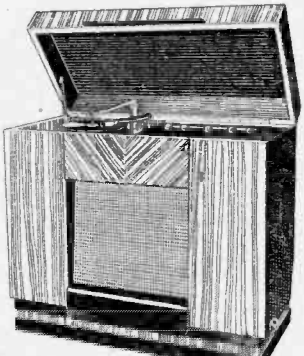

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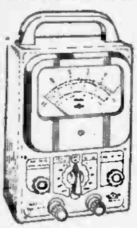

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The 6CH6 for Audio

USING A VIDEO OUTPUT PENTODE FOR NORMAL AUDIO WORKING

By S. A. Money

THE majority of amateur radio constructors when faced with the prospect of building an audio output stage almost immediately think in terms of the 6V6 or some similar valve. Whilst the 6V6 makes an excellent output stage, there are other valves which can give an equal if not better performance, although not specifically designed for this purpose. Such a valve is the Brimar 6CH6.

The 6CH6 is a pentode designed for use in video amplifiers and similar applications. When used in these circuits it is important that the valve should have a high mutual conductance. In the case of the 6CH6 the phenomenal value of 12 mA/V has been attained. Such a high slope implies the use of a larger cathode, and this in its turn requires a larger amount of heater power. The heater of the 6CH6 consumes 0.75 amps at 6.3 volts, almost twice as much as a 6V6. An interesting point about this valve is that the peak cathode current, under pulsed operation, is no less than 1.5 amps.

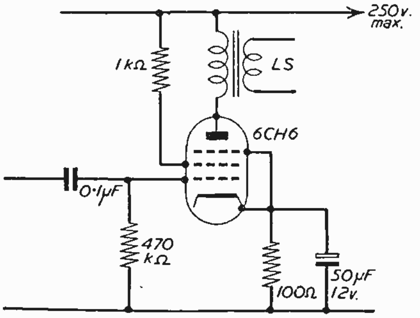

Fig. 1.—A single-ended stage.

Construction is of the modern all-glass type on a B9A "noval" base. The overall dimensions are 2½in. high and ⅞in. diameter. Despite its small physical size the valve has a maximum anode dissipation of 12 watts. The small size and high power dissipation cause the valve to run quite hot. In fact, the bulb temperature under normal running conditions may well be in the region of 200 deg. F. Apparently this is quite in order since the manufacturers quote a maximum safe bulb temperature far in excess of this figure.

What is the advantage of using such a valve for an audio output stage? Since the valve has a short grid base and a high slope, it requires a smaller input signal for the production of a given output power. This means that it is possible to drive the output stage directly from a diode detector.

Single-ended Operation

Let us first consider the normal single valve output stage as used in the majority of domestic radio receivers. This usually consists of a pentode operating under Class A conditions. A circuit suitable for use with the 6CH6 is as shown in Fig. 1. It will be noticed that the cathode bias resistor is of somewhat lower value than usual. This is due to the short grid base of the valve, only 4.5 volts of bias being required instead of the more usual 13 volts.

The speaker transformer must be arranged to present an anode load of 6,000 ohms. This gives a ratio of about 40 : 1 if a three-ohm speaker is being used. The power output is 3 watts with harmonic content of around 8 per cent. This compares favourably with the 6V6, which gives an output of 4.5 watts with 8 per cent. distortion.

The input signal required at the grid for maximum output is only 3.5 volts peak. Such a signal would be available at the detector of an average radio receiver. This enables us to drive the output stage direct from the detector, thus saving a stage of A.F. amplification.

The 6CH6 can be substituted for a 6V6 simply by changing the valveholder and reducing the cathode resistor to 100 ohms. A point which must be watched, however, is the value of anode voltage used. The valve is designed to take 40 mA of anode current at 250 volts, under which conditions the anode will dissipate 10 watts. This is almost the maximum rating, and if the voltage were increased to, say, 300 volts the anode dissipation becomes excessive, causing overheating and possible damage to the valve. Most radio receivers have an H.T. rail of 200 to 250 volts, but in some circuits using the 6V6 an H.T. line of 300 volts or more is used. In such cases the voltage must be reduced if a 6CH6 is to be substituted.

A Bedside Radio

Owing to its high sensitivity, the 6CH6 can be used to make a novel single-valve receiver. The valve is made to work as a combined detector and power amplifier. A normal reacting detector circuit is used, with the exception that a loudspeaker transformer is connected into the anode circuit. On local stations an output of some ½ to 1 watt can be obtained, giving ample volume from a 5in. loudspeaker. By adding a metal rectifier for the H.T. supply this could be made into an ideal receiver for use as a bedside radio.

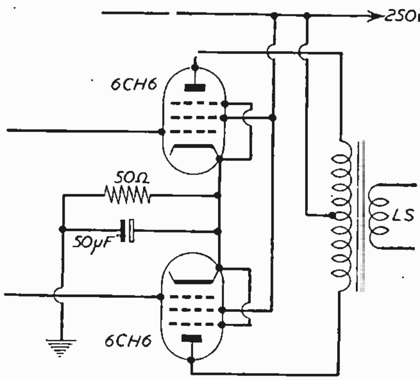

Fig. 2.—A push-pull stage.

Push-pull Operation

For those people who like to have more power from their amplifiers, push-pull operation can be adopted. The circuit for a pair of 6CH6's in Class A push-pull is given in Fig. 2. The bias resistor is again lower than usual for the same reason as before.

The anode-to-anode load presented to the valves should be 9,000 ohms. Taking again the case of a 3-ohm loudspeaker, the transformer ratio will need to be 55 : 1. The output obtained from this circuit would be about 8 watts with a harmonic distortion of 7 per cent. This should give ample volume for a large room or small hall. If still more power is required, the valves can be run in Class AB1, in which case an output of some 12 watts should be obtainable.

No input circuit has been shown on the diagram, since either a transformer or a phase-splitting stage can be used. The grid-to-grid input required in either case will be 9 volts peak for Class A operation. For Class AB1 operation an input of 15 volts peak will be needed. It is not advisable to run the valves in AB2, where grid current flows, since the permissible grid dissipation of these valves is small.

Operation as a Triode

The 6CH6 can be used as a triode by connecting the screen-grid to the anode through a 100-ohm resistor. For Class A single-ended operation the anode circuit must be matched to an impedance of 4,000 ohms. Output is much lower than for the pentode, being only 0.8 watt with 4 per cent. harmonic distortion. The input voltage must also be raised to 4.5 volts peak.

A Cascaded Twin-triode R.C.-coupled Amplifier/Mixer

THE circuit shown in Fig. 1 utilises a 12AT7 double-triode with the two halves individually operated as negative feedback triode amplifiers, each with an approximate voltage gain of 18.5. The signal at the *a* anode is fed into the opposite grid via the .01μF coupling capacitor, and the final output is taken from *b*-section anode. Since both amplifiers have the same gain, the overall voltage gain of the cascaded pair is the square of the composite gains (i.e., approximately 340).

At the same time a second signal can be injected into the *b*-grid to appear at the output (gain 18.5) mixed with the signal originated at the first grid. Thus the circuit has a wide variety of practical applications, some of which are "straight" amplification and mixing or monitoring amplifiers.

The immediately obvious use is a twin-channel mixing pre-amplifier wherein the microphone channel is fed via an appropriate input transformer to the *a*-grid and simultaneously the gram. channel put in at the *b*-grid, the resultant mixed signal, appearing at the second anode, being taken to the main amplifier. This has been successfully tried by the writer, the 270 KΩ grid leaks being replaced by 470 MΩ potentiometers. On the microphone channel the secondary of a 100 : 1 input transformer was connected straight across the potentiometer, and on the gramophone channel the pick-up output was similarly connected, with the addition of a 220 kΩ resistor between the wiper and the *b*-input, to avoid shorting out the microphone signal when the gramophone gain was turned to zero. Using this arrangement, gains of approximately 1,800 and 18 were obtained on the microphone and gramophone channels respectively.

A large value of grid-stopper is used to discourage parasitic oscillations, but even so care is required to keep all leads as short and direct as possible.

Increased Gain

The gain of the circuit could be increased, if desired, by using higher anode loads, or by putting 50 to 100 μF by-pass capacitors across the cathode-loads (i.e., removing negative feedback). The writer, however, experienced serious instability troubles on attempting this, apart from which microphony and overload distortion inhibit excessive gain values.

A further application would be to increase the cathode-load on the second half to 47 kΩ, and take an additional output lead from this cathode, as shown in the circuit of Fig. 2. Also the coupling-capacitor, grid-stopper and grid-leak are dispensed with and the first anode D.C.-coupled to the second grid. Hence the second half can function either as a cathode-follower, giving a low-impedance output to earth, or as a cathode-anode follower phase-splitter giving a paraphase signal across the two outputs for use in push-pull driving circuits.

It should be noted that the gain of a cathode-follower cannot exceed unity and so the maximum gain of the two last-mentioned circuits cannot exceed 18.5.

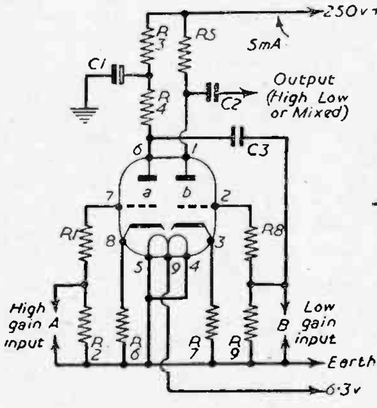

Fig. 1.—Main circuit.

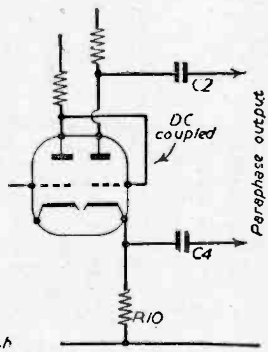

Fig. 2.—A modification.

R1, R8	27 KΩ	(½ watt.)
R2, R9	270 KΩ	(½ watt.)
R3, R4, R5, R10	47 KΩ	(½ watt.)
R6, R7	1 KΩ	(½ watt.)
C1	Electrolytic 8μF. ...	(350 v. wkg.)
C2, C3, C4	0.01μF.	(350 v. wkg.)

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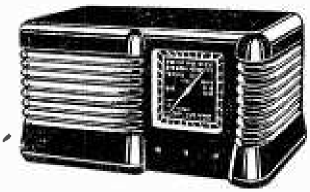

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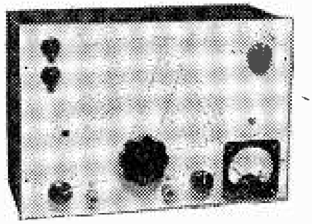

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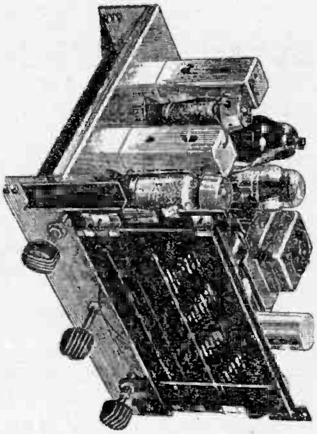

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Oscillatory Circuits

AN EXPLANATION OF THE WORKING OF THE VALVE AS AN OSCILLATOR

By F. E. Apps

OSCILLATORS can be said to be in two different classes. One is the type that is required to give large power output such as R.F. heating apparatus or transmitters, and the other is the type that gives stable frequency output with very little power output. The latter is used in superheterodyne receivers. Continuous oscillations can be set up in an oscillatory circuit in several ways. They are the H.F. Goldschmidt generator, the Poulsen arc, the thermionic valve and the Rochelle salt crystal, and including, of course, the latest device, the two-point contact transistor. The Goldschmidt generator and the Poulsen arc are now obsolete. For the purpose of this article we will deal with the thermionic valve and its circuit or circuits.

For a circuit to be in a state of oscillation it is necessary to have two parts of the circuit capable of storing energy and passing this energy from one part to another at the natural frequency of the circuit. These two parts of a circuit are the inductance, which stores energy by means of its magnetic field, and the condenser, which also stores energy in its electrostatic field. In Fig. 1 we see an oscillatory circuit in combination with a three-electrode valve. When the D.C. voltage to the anode is made anode current commences to flow through L1, which is magnetically coupled with L2, so that as the anode current increases an increase of flux from L1 cuts across L2. This induces a voltage in L2 which is applied between the grid and cathode of the valve. Oscillation of the grid circuit will now take place at its natural frequency. This will cause the grid of the valve to vary its potential from positive to negative, and thus cause fluctuations of the electron stream, thus varying the anode current of the valve at the frequency of the grid circuit. Now if the coupling of L1 L2 is sufficiently close the effect of the varying potential of the grid circuit upon the anode current, and the alteration of anode current through L1 upon the grid circuit via L2, will, if correctly arranged, cause the circuit automatically to fall into oscillation at the frequency of the grid circuit, and oscillations will be maintained.

Maintenance of Oscillations

Oscillations will be maintained only when the power fed back is equal to or greater than the power dissipated in the circuit. This can be expressed as follows:—

When the anode coil supplies energy in phase with the oscillatory current in the circuit — Energy introduced into the LC circuit $= (wMI_a)I$ watts.

Net loss of energy in LC circuit is at the rate of

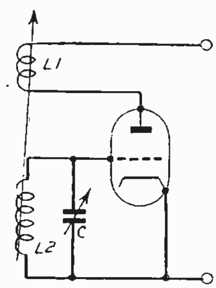
$$I^2R-(\omega MI_a)I \text{ watts}=I^2\left(R-\frac{Mgm}{C}\right) \text{ since } Vg=\frac{1}{\omega C}.$$

This shows that when M is equal or greater than CR/gm oscillations will be continuous.

The foregoing, with Fig. 1, applies only to small oscillators where large power is not required. When a large output, as for a transmitter, is required the circuit is then modified as Fig. 2. It will be noticed in this case that the feed-back coil is in the grid circuit, so that more power can be drawn from the oscillatory circuit which is in the anode lead. The action of the two circuits is very similar. On switching on the H.T. a shock is given to the circuit by the slight change in current, and oscillations are set up. To maintain the oscillations the coupling between the two coils must be such as to allow the grid/cathode voltage variations to supply enough power to make good losses through damping.

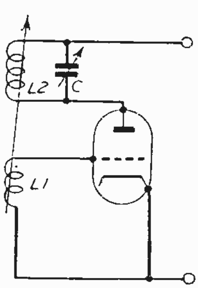
The Hartley Oscillator

Generation of oscillations is possible when the oscillatory grid voltage Vg is more than 90 deg. out of phase with the anode oscillatory voltage Va. Also the energy supplied to the oscillatory circuit must be in the correct phase and be sufficient to overcome the losses through damping. The action is as follows (see Fig. 3). The oscillation set up in the tuned circuit produces an oscillatory voltage across that part of the coil which is between grid and cathode. Now for self oscillation this voltage must be in antiphase to the anode/cathode voltage, i.e., the voltage across that part of the coil between anode and cathode. In Fig. 3 it will be noticed that this is



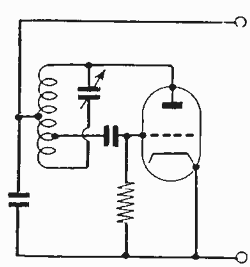
TUNED GRID FEEDBACK

Fig. 1.



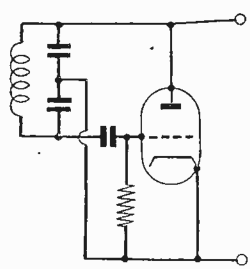
TUNED ANODE

Fig. 2.



HARTLEY

Fig. 3.



COLPITTS

Fig. 4.

Some standard oscillator circuits.

done by connecting the cathode to a point on the coil between the points connected to anode and grid. This point is obviously always at an intermediate potential between the anode and grid points. Thus, if at any instant the anode point on coil is positive to the cathode point, then the grid point must be negative to the cathode point at the same instant, and so the voltages from anode to cathode and grid to cathode are always in opposite directions. The grid condenser and grid leak are to isolate the grid from the H.T., and to produce an automatic negative bias for the valve so as to increase its efficiency.

The Colpitts Oscillator

The Colpitts oscillator, Fig. 4, is similar in action to the Hartley. The circuit differs from the Hartley in that the grid excitation is direct capacitive, whereas the Hartley is direct inductive. When an oscillatory voltage is developed across the tuned circuit the cathode potential is intermediate between the anode and grid potentials, Va and Vg are in antiphase and the circuit is self-oscillatory.

When the circuit is used on high frequencies it is found sufficient to place the LC circuit between anode and grid and rely upon the inter-electrode capacity of the valve to provide grid excitation.

Frequency Variation

Now although the frequency at which a valve will oscillate may be stated as

$$f = \frac{10^6}{2\pi\sqrt{LC}}$$

this is, in fact, not exactly the truth because frequency also depends on the valve constants ra and gm. It also depends upon the LC values of any circuits coupled to the oscillatory circuit, and the inter-electrode capacities of the valve. Unless all these remain constant frequency variation will occur.

(To be continued)

Portable Lifeboat Radio

THE Marconi International Marine Communication Co., Ltd., now has in production a new portable radio transmitter and receiver for use in ships' lifeboats. Known as the "Salvita," it is completely self-contained and watertight and will float after having been thrown into the sea from the deck of a ship in distress.

As long ago as 1931 the Marconi Marine Co. designed and produced a small portable transmitter for use in small boats, such as the dories used in line-fishing on the Newfoundland Banks, where sudden fog so often hid the dories from their parent craft.

The new "Salvita," descendant of these earlier sets, meets the requirements of the latest G.P.O. specification for this type of equipment, and has successfully undergone most stringent tests simulating the worst conditions likely to be encountered at sea anywhere in the world.

A specimen "Salvita" was operated while being continuously shaken on a special vibrating table. Then followed a bump test during which it was subjected to 500 jolting bumps at the rate of one per second with a free drop of 1in., after which it still functioned perfectly. Its next ordeal, under dry-heat conditions, consisted of 10 hours in a temperature of 70 deg. C., followed by two hours of continuous working at 55 deg. C.

Perhaps the most dramatic test to which the "Salvita" was subjected was the 30ft. drop test in which the set was actually thrown from a height of 30ft. into water, and operated at full efficiency after it had surfaced and been recovered.

The "Salvita" is housed in a cylindrical case a little over 2ft. in height and painted bright yellow for easy recognition in water, and is fitted with stout carrying handles which are also used to pass lashings round to hold the "Salvita" steady for operation. The upper portion of the case contains a medium- and short-wave transmitter and medium-wave receiver, all the operating controls being placed on the circular top panel and covered by a watertight lid when not in use. The transmitter, which is crystal-controlled, can be switched to either 500 kc/s or 8,364 kc/s.

New Hi-fi Recording Tape

E.M.I., who were the first to institute immediately after the war the new technique of magnetic tape-recording for all "His Master's Voice," Columbia and Parlophone records also pioneered the manufacture of the tape itself, and their plant, at Hayes, is the largest and most up-to-date production unit in the country.

They now introduce a new high-quality recording tape for professional or general use; the same tape, in fact, which is used in the studios for the initial recordings for all "His Master's Voice," Columbia and Parlophone discs, as well as for the recently-released "His Master's Voice" and Columbia tape records.

Outstanding features of the new Emitape are high sensitivity, marked anti-static characteristic, and freedom from curl—the latter ensuring uniform and close contact with the head and, therefore, uniformity in recording and reproduction. In addition, the P.V.C. base used instead of cellulose acetate gives high tensile strength (7½ lbs. per ¼in. width) and yield point (4½ lbs. per ¼in. width); very low elastic elongation (less than 0.5 per cent. at 1 lb. load, 15 secs. application) and longitudinal temperature co-efficient (4×10^{-5} per degree F); negligible humidity expansion.

Sensitivity is considerably higher than previous tapes (9 dB above H50 tape); the print signal is at least 60 dB below the test signal after close contact for five minutes; the basic unweighted noise from a properly erased tape is at least 65 dB below peak recording level, and modulation noise at least 50 dB below peak modulation at 2 per cent. total harmonics.

Prices

Typical prices are: 5in., double-sided, plastic spool, with 600ft. of tape—type 88 at **£1.1.0**, and type 77 at **£1.10.0**; 7in. spools (1,200ft.) cost **£1.15.0** and **£2.8.0**, respectively.

A comprehensive range of editing and jointing accessories are also available.

Emitape is marketed by E.M.I. Sales and Service, Ltd. (Recording Equipment Division), Hayes, Middlesex.

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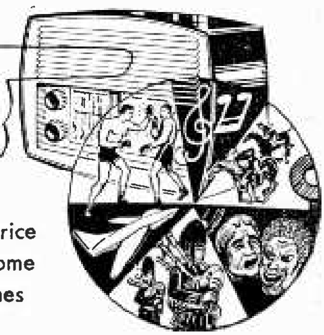


Our Critic, Maurice Reeve, Reviews Some Recent Programmes

Oscar Wilde Centenary

THE centenary of the birth of Oscar Wilde was honoured by an excellent production of his " An Ideal Husband," which probably ranks a long way behind " The Importance of Being Earnest " as second of his four major dramatic works. The play itself is based on a clever enough, if too period, a story and it glitters with some of the master's choicest epigrams. " To love oneself is to start a lifelong romance," and " I always pass on good advice. It's the only thing to do with it. It's never any use to anyone," are two that remained in my memory. But the situations, particularly the bracelet and the eavesdropping ones, are contrived with frightful artificiality and the play lacks the spontaneity and virtuosity of the immortal " Importance," in which the continuity of thought and purpose never flag for an instant.

The piece was brilliantly handled and given all the necessary period brashness and cynicism by Janet Burnell, Ursula Howells, Dorothy Primrose, Malcolm Keen, Monica Gray, Christine Bocca, Michael Ingrams, Richard Bebb and others.

Other Plays

The implications of our reactions to learning that our father had been hanged for murder formed the basis of a most interesting play, " A Question of Fact," by Wynyard Browne, in *Saturday Night Theatre*. Angela Baddeley played the part of the mother who reveals the secret, and another as well, with great éclat and verve. This was the role in which Gladys Cooper was so successful in the stage production last winter. Patrick Barr brought out all the horror and pathos of his ancestry and Joan Hart backed him up nobly as his wife.

The *Curtain Up* series of thrillers were of varying vintages. Best of the lot, I thought, was " The Brothers " by Rex Reinits. At least it had a purpose, in addition to setting out to merely excite. The compassion of Stephen Wayne, a police officer, for his worse than ne'er-do-well brother Larry gave the otherwise fairly normal thriller a moral tone and a quality absent from most plays of this genre. The scamp Larry was engagingly played by Richard Bebb and his higher-minded brother excellently handled by Hamilton Dyce. Sheila Burrell made much of an undeservingly forgiven wife.

" Fever Bark " was a laborious effort at telling, in documentary form, the story of the discovery and development of quinine. There didn't seem to be anything like enough interesting material to hold one for fifty-five minutes. I hope we are not given a similar type of programme dealing with castor oil !

As Forecast

The 8 a.m. weather forecast one Monday contained the following sentence : " Only a moderate drying day can be expected." This seems to me to be the most practical and sensible justification I have ever heard contained in one of these plaguy nuisances. Also, on that particular morning, it was exactly correct. But, on second thoughts, I wonder if the British housewife was being assisted in what must be one of her most arduous duties ? Or did it relate to the harvest or something quite different ? Anyhow, be that as it may, if she did take it as being for her especial benefit, she must have found it very useful.

" Any Answers " is Freddy Grisewood's postscript to his " Any Questions " programme and seems to be the substitute, half as long, to " Dear Sir." In it, listeners send in their comments on what they have heard the previous Friday. Is your answer really necessary ?

Gilbert Harding has commenced a bi-weekly series of 15-minute interviews with famous people who would seem to be " in town to-night," though, in reality, interviewer and subject may be many miles apart. The BBC welcomes suggestions for interview-ees. The first two I heard were very urbane and pleasant. Mr. Harding is, of course, a past-master at this sort of thing, and given suitable subjects for interviewing the new feature should prove a popular success.

A Question of Time

An interesting, if saddening, reflection on the relative estimation in which the public holds the various avocations and pursuits of mankind was recently provided by the time allotted to two consecutive items. I say " in which the public holds " advisedly because, although it was not consulted beforehand as to how much time it would like given to each of the subjects, any more than it was asked whether it even wanted the subjects at all, the BBC, having chosen them, was doubtless perfectly correct in apportioning to each the duration it did.

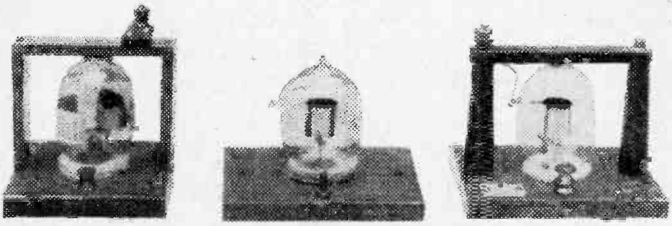
The two items were, first, 15 minutes to " A Great Management," the story of the Vedrenne-Barker management at the Court Theatre, London, commencing in 1904, followed by 45 minutes of " A Man and his Music," a personal tribute to the late Carroll Gibbons.

Now, the Vedrenne-Barker era at the Court was probably the most famous managerial enterprise in the history of the British theatre. Amongst its achievements were the first productions of some of Shaw's finest works. In any case, the theatre is a not unimportant part of our national life affecting our prestige and standing among the nations. On the other hand, Mr. Carroll Gibbons and his music was, well, just Mr. Carroll Gibbons and his music. What would you do, chums ?

50th Anniversary of the Invention of the Thermionic Valve

SIR AMBROSE FLEMING, whose birthday anniversary was on November 28th, reporting on his experiments in a personal letter to Marconi, remarked in conclusion, "I have not mentioned this to anyone yet as it may become very useful." Just how useful it was to become the future had yet to reveal.

His immediate objective had been to find a more sensitive and reliable method whereby the high-frequency alternations of the feeble current in a receiving aerial could be rectified, or caused to flow in one direction only, so that the current might be capable of operating instruments such as an ordinary galvanometer, whereby the strength of the signal could be measured with accuracy.



Some early production models of the Fleming diode, forerunner of the valve of to-day.

Recalling the results of experiments which he had made some years before when associated with the original Edison Electric Light Co. of London, Fleming saw that in them lay a possible solution of his problem. These investigations had concerned the passage of electric currents through rarefied gases. It had been noted that if two electrodes were separated in a partial vacuum and one of them such as a carbon filament was made hot, current would flow across the space between them provided that the potential of the cold electrode was made positive in relation to that of the hot one. If the polarities of the electrodes were reversed no ordinary voltage would cause any current to flow at all.

Nothing was known of electrons in those days, and it had been assumed that the current was conveyed by particles of negatively charged carbon thrown off from the incandescent filament. In 1899, however, Sir J. J. Thompson had proved that it was, in fact, particles of "disembodied electricity" unassociated with matter in atomic form and far smaller than any atoms.

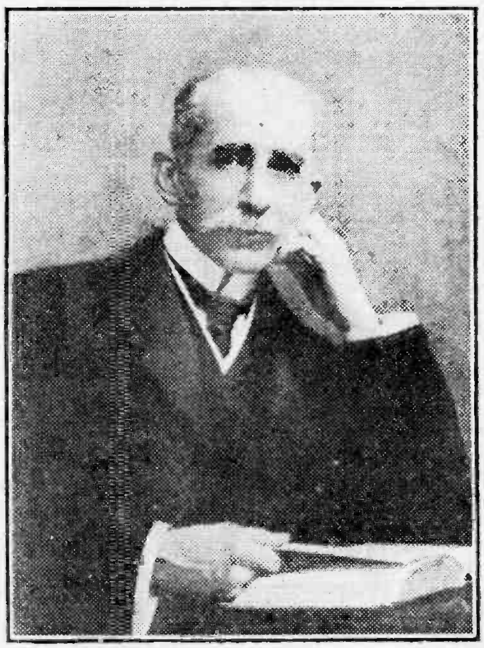
Fleming connected up one of his old experimental bulbs, with its hot and cold electrodes, in a receiver circuit using a mirror galvanometer as an indicator. At the other side of the room he pressed the key of his little spark transmitter and the spot of light reflected from the mirror of his galvanometer leapt across the scale to proclaim the immediate success of the world's first wireless valve. That was in November, 1904.

Biographical Notes

Sir Ambrose Fleming, F.R.S., was born near Lancaster on November 29th, 1849. He was brought to London at the age of five years. At 14 he went to University College School, which was then conducted in a wing of the College in Gower Street. Decided on engineering as a career, at age of 17, and worked for B.Sc. degree in the University of London by private evening study while helping to maintain himself by taking a post as clerk on the Stock Exchange. He was one of the only two in the First Class in the degree list of 1870, when not quite 21 years old. Took post of Science Master at Rossall College, and, after 18 months, entered the Science Schools just established in South Kensington, studying for three years under Dr. Frankland. In 1881 he was appointed Professor of Physics and Mathematics at University College, Nottingham, soon, however taking a post as scientific adviser to the Edison Electric Light Company.

He took a leading part in the design of the powerful transmitting equipment at Poldhu, Cornwall, which Marconi was preparing for his successful attempt to span the Atlantic by wireless in 1901. He continued to lecture until nearly 90 years of age.

He died in his 96th year on April 18th, 1945, at Sidmouth, where he had spent in retirement the last few years of his intensely active life.



Sir John Ambrose Fleming, M.A., D.Sc., F.R.S.

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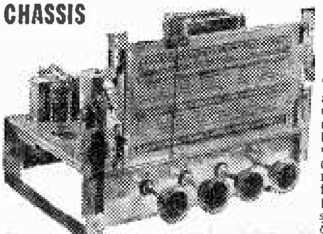

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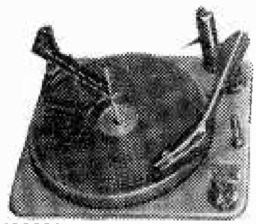

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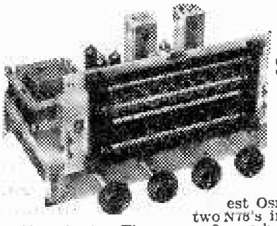

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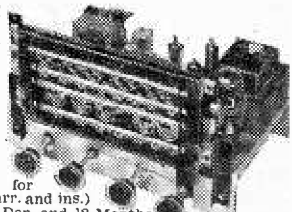

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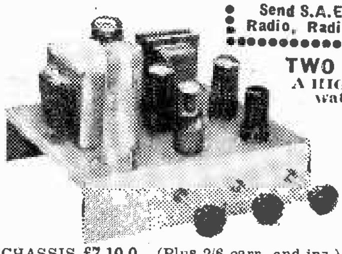

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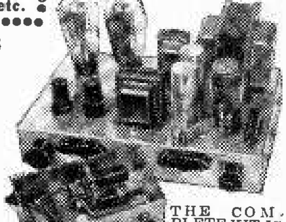

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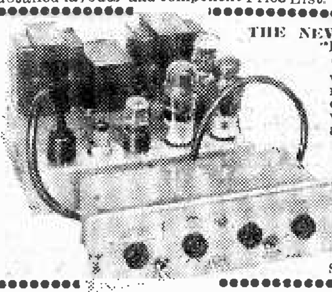

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Open to Discussion

Amplifier Design

SIR,—I hope that Mr. R. Hindle will deal fully with "Cathode Follower" Output before completing his series of articles.

After trying this and doing my best to compare it with the very latest speakers and amplifiers, I think it is *still* unsurpassed for quality.

Example: A Williamson Amplifier, using 6V6 output valves in pull-push (instead of KT66) and with 250 volts (instead of 450) circuit unchanged. Considerable volume, probably 6 to 8 watts.

I cut the cathode connections and took one to each end of an 84s. size sectionally-wound output transformer. Heaters to separate mains transformer. Anodes to H.T. provided with a pair each of resistors (33K and 10K were used). Centre of output transformer to earth. Speaker 15 ohms. (No alterations to output transformer.)

Violins sound like violins—not tin whistles: and so on. Speaker, by the way, was the fairly new one —"Cambric" cone, 10in., price about £4.

Earlier experiment with a small amplifier (2 6J5's and a 6V6) led me to think that provided the output transformer primary provides suitable cathode resistance, very excellent quality can be obtained without unduly expensive equipment. I use no tone control, and do not pen-in my speakers, but do mount on a baffle.

I may say that when the pull-push amplifier was changed over to cathode output, the first trial occurred on a Sunday evening when Mr. Charles Mackerras was conducting the BBC Concert Orchestra. His orchestra played, as we then thought, so magnificently that we wanted to sit down and write our appreciation. The next Sunday I had changed the amplifier back to ordinary anode output and—believe it or not—the contrast was so considerable when compared with the memory of the previous superb performance that I had to switch off and cut the cathodes again, reverting to cathode output. There is nothing to touch it yet for violins. But, the volume must be kept down. Only up to about 2 watts from a 10 watt amplifier; and with a small amplifier, which can sound very beautiful, the volume must be kept well down to perhaps a ¼ watt. The clarity, however, is amazing. Using the superhet part of a 17-year-old eight-valver (output removed) the reproduction was even clearer (if possible) than anything I have heard using a crystal detector, and seemed to be of better quality, particularly with violins, but, of course, the "Cambric" (is it?) speaker would contribute to this. Earlier speakers had a "clouding" effect on reproduction, just as bass knobs on a volume control do—they should be called "smother" controls on most sets. (They certainly do not produce "bass," but only some electronic deepness, which is not "bass.")

You will appreciate, therefore, that I would like some knowledgeable observations on the use of "Cathode Follower" Output; and also would like to have the observations of transformer manufacturers on suitable transformers, and valves, and volts for use with certain transformers.

It is true that if the secondary (one side only) of an output transformer is connected to the cathode-earth of an output valve, the programme can be heard—but badly. I think that a suitable transformer could be cheaply produced, and the only question would be the resistance value of the wire used in the primary, to suit a certain anode voltage. Wide latitude is permissible in matching. 20 to 1 and 30 to 1 might perhaps give equally good results from same circuit, but I would not of course assert this.

Thanking you and PRACTICAL WIRELESS for many happy hours, and with final advice to those who may have read "Experimental Circuits" not to include the intervalve transformer as therein suggested, if they try this output.—O. G. KERSLAKE (Orpington).

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying surplus equipment. We cannot supply alternative details for receivers described in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. If a postal reply is required a stamped and addressed envelope must be enclosed with the coupon from page iii of cover.

A Variable H.T. Unit

SIR,—I was interested to read the above article by Mr. Stewart in the current issue but feel that he dismisses too lightly the certainty of short-circuiting windings of the transformer at several settings of the three switches, especially as the connections can easily be arranged to avoid it.

The problem of switching the three windings is merely that of arranging the circuit to give three

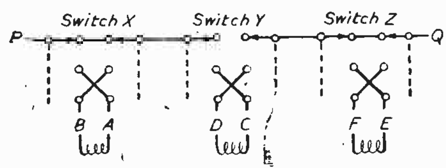

Fig. 1

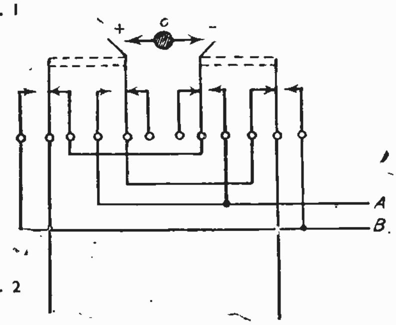

Fig. 2

Mr. d'Assis-Fonseca's switching suggestion.

different connections to each, as follows :—

1. Winding bypassed.
2. Winding connected in circuit aiding.
3. Winding connected in circuit opposing.

With each winding switched in this manner the three switches are then connected in series. Fig. 1 shows the arrangement.

Many wafer switches bridge adjacent contacts during transit and this is undesirable with almost any switching arrangement. Using the switches specified in the above article a dead position can be left between working contacts, thus avoiding bridging the latter.

As an alternative to wafer switches any non-bridging three-position switch can be used, such as the Post Office lever-type telephone key found on some service equipment and readily available at the disposal stores. Two changeover spring sets are needed on each side of the key and Fig. 2 shows typical wiring of one such key.—H. D'ASSIS-FONSECA (New Barnet).

For the Deaf

SIR,—I thought that the following might perhaps suggest an article in your excellent publication which would interest quite a lot of your readers.

An elderly relative of mine is deaf, and, although wearing his National Health deaf aid, does not appear to be able to hear my Hi-fi Radiogram very well. To avoid driving the rest of the household to distraction while he was staying with us, I plugged in a single 4,000 ohm earpiece in place of the audio amplifier into the R.F. feeder unit, holding the earpiece to his deaf aid with a rubber band, when he could hear very well indeed.

It seems to me, however, that this is a wasteful method and it might be possible to plug his D.A. earpiece into the R.F. feeder unit direct, with suitable matching arrangements.

Then came another snag. When he returned to his room where he has no radio (and his landlady does not approve of aerials or wires around the place) he feels lost without it and wants me to try to fix him up with a small set which he can take around with him. Cost is a real problem as he would need something very sensitive in this area to cover the medium Regional and long wave Light programmes. He has A.C. mains and it might be possible for him to use them. A superhet seems necessary as he would be fogged if he had to operate reaction to get a satisfactory sensitivity, and would most likely run it oscillating without knowing it.

Perhaps, at some future date, you will be able to include an article on these lines.

Also, we see plenty of 5- and 6-valve A.C. designs for receivers, but I feel that a good D.C./A.C. 6-valve job would be appreciated. The R.F. stage would give that little bit extra. We poor creatures on D.C., and positive earthed at that, are still tearing our hair and making unavailing requests to be changed over to A.C. when we will be able to construct gear to your articles without limit.—E. W. LARK (Lowestoft).

Modern One-valver

SIR,—As a beginner in wireless construction, and as perhaps other beginners may be interested, I have built your "Modern One-valver" published in PRACTICAL WIRELESS, No. 552, of October, 1952, but used a miniature 1T4 valve in place of 1N5 as specified.

In addition, I have wound my own coil of 6 turns on a 1in. tube for short-wave reception, and deleted the wave-change switching. The aerial coil was interwound on the same former using the same number of turns as for the tuning coil. Selectivity is good using the reaction just under oscillation point. The battery used is a Vidor L5504 of 69 volts H.T. with 1½ volts L.T.

One of the first stations received was Radio Sweden on about 30 metres, and plenty of other stations were available. This arrangement makes a good and inexpensive receiver for any beginner interested in short-wave working.—H. DRANSFIELD (Luton).

"What is Hi-fi?"

SIR,—Your contributor "Grid Current," in his article "What Is Hi-fi?" in your December issue, is described as a critic. This he certainly is, and some of his comments are to the point, but I feel that he misses it when he describes the emphasis on the reproduction of the higher frequencies in present-day "High Fidelity" equipment as "curious" because, as he says, the similar extension of the lower frequency range in the past was not described as "High Fidelity."

The extension of the bass frequencies without a corresponding extension of the treble resulted in unbalanced reproduction which, despite the satisfaction of the enthusiasts in their technical achievement, did not give pleasing results. Present-day equipment extends both the bass and the treble ranges, giving a balanced reproduction which when properly used can give very pleasing and indeed inspiring results on music. Your contributor must not tar all Hi-fi enthusiasts with the same brush because some of those that he has come into contact with have been more interested in their achievement in extending their treble range than in maintaining a balance.

That this question of balance is of more importance than that of extended range is evident from the undoubted fact that many wireless receivers have a limited range falling off at perhaps 100 cycles in the bass and 6,000 in the treble, as compared with 50 to 12,000 or an even wider range with present Hi-fi equipment, and yet give very pleasing results. As he says, when the lower frequencies only were extended the result was "bangs, thumps and resonant booms."—S. T. PINDER (Weston-super-Mare).

P.S.—Had he said *over*-emphasis I would have agreed with him.

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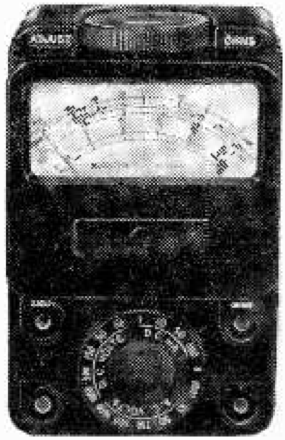

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0-10	0-50	0-10	0-200,000 ohms
0-50	0-250	0-50	These ranges can be extended by using external battery.
0-250	0-500	0-500	
0-500	0-1,000		
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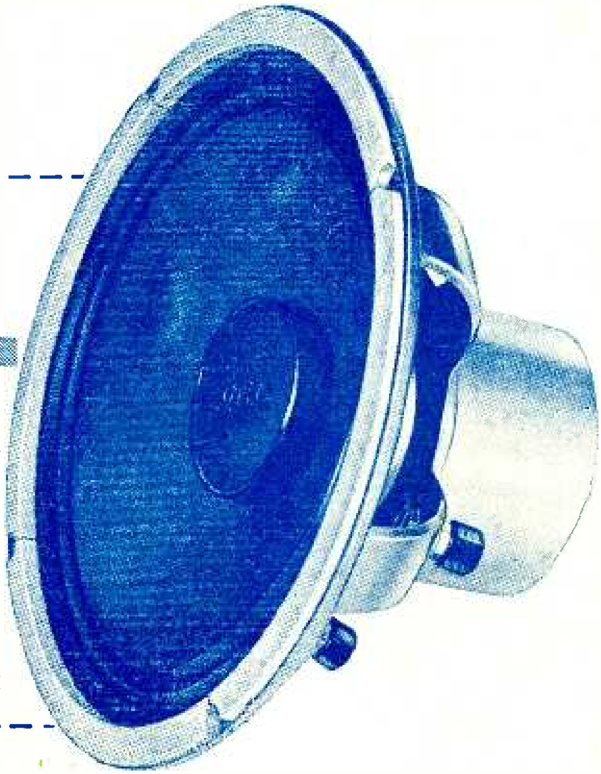

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