RADIO BOOKS

Tape and Wire Recording. A selection of articles reprinted from the pages of *The Radio Constructor*, covering both the theory and practical applications. A really useful book on this latest development of the hobby.
4th Edition, 3/–. Postage 4d

Receivers, Preselectors and Converters. Practical articles, again reprinted from past issues of *The Radio Constructor*, which will prove of interest to many radio enthusiasts. 2/6. Postage 4d

TV Fault Finding. Profusely illustrated with photographs taken from a televisor screen depicting the faults under discussion, and containing a wealth of technical information, with circuits, enabling those faults to be eradicated.
5/–. Postage 5d

FM Tuner Units for Fringe and Local Area Reception. Including optional Tuning Indicator and circuit of Osram 912 Amplifier. 2/–. Postage 2d

The Argonaut AM/FM MW/VHF Tuner Receiver. Describing the construction, alignment, and other details of a high quality tuner (or complete receiver), together with map of present and projected coverage areas.
2/–. Postage 2d

Radio Amateur Operator's Handbook. An indispensable aid to the amateur transmitter and listener, containing all details of information which are constantly required. Prefix Lists, Zone Boundaries, Call Areas, Codes, and Mileage Tables, together with Maps and much other useful operating data. 1957/8 edition, 3/–. Postage 4d

Mercury Switched Tuned FM Tuner Unit. A stable unit employing automatic frequency control and a *ready built* front end. 2/–. Postage 2d

Radio Control for Model Ships, Boats and Aircraft, by F. C. Judd, G2BCX. A comprehensive work on this fascinating subject.
Standard edition 8/6. Postage 7d
Cloth bound edition 11/6. Postage 8d

The "Eavesdropper." A miniature transistor local station receiver. Complete constructional details of this pocket portable. 1/6. Postage 2d

Radio Control Mechanisms, by Raymond F. Stock. The only book dealing solely with this important part of radio control. 4/6. Postage 4d

All available from your local bookseller, or from

DATA PUBLICATIONS LTD

57 MAIDA VALE LONDON W9

Telegrams **Databux London** *Telephone* **CUNningham 6141** *(2 lines)*

Published in Great Britain by the Proprietors and Publishers
Data Publications Ltd 57 Maida Vale London W9
Printed by A Quick & Co Ltd Oxford House Clacton on Sea England
Obtainable abroad through the following Collets Subscription Service Continental Publishers & Distributors Ltd William Dawson & Sons Ltd *Australia and New Zealand* Gordon & Gotch Ltd *South Africa* Central News Agency *Holland* "Radio Electronica"
Registered for transmission by Magazine Post to Canada (including Newfoundland)

Cooper-Smith BPI High Fidelity Amplifier

VOLUME 11
NUMBER 5
DECEMBER
1957

The RADIO Constructor

RADIO · TELEVISION · AUDIO · ELECTRONICS

The Petite
4 Valve Battery Portable

Included in this issue
INEXPENSIVE IMPEDANCE COMPARATOR
BUILDING A FREQUENCY METER
CONTESSA TRANSISTOR PORTABLE, Part 2
MAYFAIR TURRET TELEVISOR, Part 4
SENSITIVE PROXIMITY DETECTOR

DATA Publications 1/9

THE MODERN BOOK CO

TV Fault Finding. A Data Publication. **5s.** *Postage 4d.*

Electronics Made Easy. Popular Mechanics. **6s.** *Postage 8d.*

The Radio Amateur Operator's Handbook. Data Publication. **3s.** *Postage 3d.*

Television Engineers' Pocket Book. By E. Molloy and J. P. Hawker. **10s. 6d.** *Postage 6d.*

An Introduction to the Cathode Ray Oscilloscope. By H. Carter. *12s. 6d. Postage 8d.*

Understanding Hi-Fi Circuits. By N. H. Crowhurst. **23s.** *Postage 1s.*

FM Radio Servicing Handbook. By G. J. King. **25s.** *Postage 1s.*

Fun with Radio. By G. Davey. **10s. 6d.** *Postage 8d.*

Transistors and Crystal Diodes. By B. R. Bettridge. New Ed. **5s.** *Postage 4d.*

Transistor Techniques. Gernsback Library. **12s.** *Postage 8d.*

High Quality Sound Reproduction. Circuits designed by Mullards. **3s. 6d.** *Postage 4d.*

Rapid TV Repair. By G. W. Heath. **23s.** *Postage 1s.*

High Fidelity. By G. A. Briggs. **12s. 6d.** *Postage 1s.*

Radio Valve Data. "W.W." **5s.** *Postage 8d.*

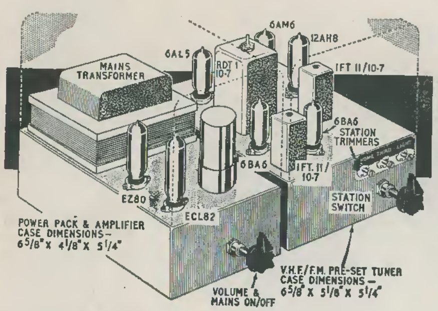
We have the Finest Selection of British and American Radio Books in the country

Complete catalogue **6d.**

19-23 PRAED STREET (Dept RC) LONDON W2

Telephone PADdington 4185

INTRODUCING THE COMBINED POWER PACK AND AMPLIFIER FOR THE 'MAXI-Q' PRE-SET OR VARIABLE FM TUNER WHICH NOW OFFERS YOU A COMPLETE RECEIVER



Full constructional details, point-to-point wiring diagrams and alignment instructions for building the **"MAXI-Q" COMBINED POWER PACK AND AMPLIFIER, PRE-SET FM TUNER** and also the **VARIABLE TUNED** version are given in Technical Bulletin DTB.8, **1/6**

POWER PACK AND AMPLIFIER. This unit consists of Mains Transformer, EZ80 and ECL82 valves, Volume Control complete with mains on/off switch and is housed in a gold-finished case. Power supplies available for any tuner—Heater 1.5 amps at 6.3V. H.T. from 220V at 50mA to 265V at 20mA. The unit is available completely wired and ready for use at **£5 . 10 . 0**, plus 2/6 carriage or available in kit form at **£5.**

PRE-SET FM TUNER. Completely punched chassis, screens and bronze-finished cover, **19/–.** Station Indicator Plate, **1/1.** Three-position switch, **4/3.** Station Condenser Trimmers, 3-9pF, **2/–**

RATIO DISCRIMINATOR TRANSFORMER, RDT 1–10.7 Mc/s. Secondary winding of bifilar construction, iron dust core tuning, polystyrene former, silver mica condensers. Can size $1\frac{3}{8}$" sq. x $2\frac{1}{2}$" high, **12/6. I.F. TRANSFORMER,** IFT.11–10·7 Mc/s. Miniature i.f. of nominal frequency 10.7 Mc/s. The "Q" of each winding is 90 and the coupling critical. Can size $\frac{13}{16}$" sq. x $1\frac{7}{8}$" high, **6/6. COILS, TYPE L1, T1** and **T2.** Specially designed for use in this unit, are wound on polystyrene formers complete with iron dust core tuning, **3/11** each. **THE "MAXI-Q" PRE-SET FM TUNER** is available completely wired, assembled, valved and housed in a sturdily made gold-finished cover at **£8 . 11 . 5,** plus **£3 . 8 . 7** P.T.=**£12. VARIABLE FM TUNER** completely assembled at **£7 . 17 . 2,** plus **£3 . 2 . 10** P.T.=**£11** (carriage 3/–, terms c.w.o.). **GENERAL CATALOGUE** covering technical information on full range of components, **1/–**, post free.

TRADING TERMS for direct postal orders, c.w.o., plus appropriate postal charge

DENCO (CLACTON) LTD (DEPT. R.C.) **357/9 OLD ROAD CLACTON-ON-SEA ESSEX**

"Bleep, bleep" for BRIMAR

who as always

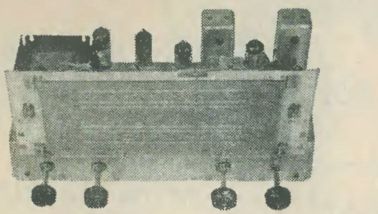
got there first!

Reproduction of an advertisement by BRIMAR in December, 1955

Standard Telephones and Cables Limited

(Reg. Office Connaught House 63 Aldwych London WC2)

FOOTSCRAY SIDCUP KENT *Footscray* 3333



1957 RADIOGRAM CHASSIS

THREE WAVEBANDS — FIVE VALVES
S.W. 16 m.–50 m. — LATEST MULLARD
M.W. 200 m.–550 m. — ECH42, EF41, EBC41,
L.W. 800 m.–2,000 m. — EL41, EZ40

12 month Guarantee. A.C. 200/250V, 4-way switch. Short-Medium-Long-Gram. A.V.C. and negative feed-back. 4.2 watts. Chassis 13½″ x 5½″ x 2½″. Glass dial 10″ x 4½″ horizontal or vertical available. 2 pilot lamps. Four knobs, walnut or ivory, aligned and calibrated. Chassis isolated from mains. Immediate Delivery

BRAND NEW £10.10.0 Carr. 4/6

TERMS: Deposit **£5 . 5 . 0** and 6 monthly payments of **£1.**
MATCHED SPEAKERS 8″ 17/6, 10″ 25/–, 12″ 30/–

Recommended for above Chassis

R.C.S. SCOOP

HIGH FIDELITY AUTOCHANGER

COLLARO 1957 MODEL RC456

For 7″, 10″, 12″ Records 16, 33, 45, 78 r.p.m.

4 SPEEDS — 10 RECORDS
WITH STUDIO "O" PICK-UP
BRAND NEW IN MAKER'S BOXES

OUR PRICE £9.15.0 Post free

Terms: Deposit £5.5.0 and 6 monthly payments of £1

B.S.R. MONARCH 4-SPEED AUTOMATIC RECORD CHANGERS

1957 MODELS

Brand new and fully guaranteed 12 months
NOT JOB LINE REJECT STOCK

Designed to play 16, 33, 45, 78 r.p.m. Records 7″, 10″, 12″. Lightweight Xtal pick-up, turnover head, two separate sapphire styli, for standard and L.P.

OUR PRICE £8.15.0 each. Post free

Terms: Deposit **£5** and 5 monthly payments of **£1.**
CUT OUT BOARD 14″ x 12½″, 6/–.

COLLARO 4-speed Motor and Turntable with selecting switch for 16, 33, 45 and 78 r.p.m. records, 200-250V a.c. 50 c.p.s. Also **HIGH FIDELITY** Lightweight Pick-up with Acos Xtal turnover head, separate sapphire stylus for L.P. and standard records. **SPECIAL OFFER £4 . 12 . 6,** post 2/6. 14″ x 12½″ Cut Out Board 6/–

AMPLIFIER/PORTABLE RECORD PLAYER CABINET. Size 17½″ x 13½″ x 7″, Motor Board 16½″ x 12½″. Space for any Single Record Player, Twin Speakers and Amplifier, etc. **Bargain price 45/–** Supplied Cut Out for above motor if required

I.F. TRANSFORMERS 7/6 pair
465 kc/s slug tuning miniature can 2½″ x 1″ x 1″. High Q and good band width. By Pye Radio. Data sheet supplied.
Wearite M800 I.F. transformers 465 kc/s, **12/6** pair
Wearite 550 I.F. transformers 465 kc/s, **12/6** pair

NEW AND ENLARGED SHOWROOMS NOW OPEN

C.R.T. ISOLATION TRANSFORMERS

For Cathode Ray Tubes having heater-cathode short circuit and for C.R. Tubes with falling emission.
Type A. Low leakage windings. Ratio 1:1.25 giving a 25% boost on secondary: 2V, 4V, 6.3V, 10.3V, 13.3V, **10/6** each; ditto with mains primaries, **12/6** each. All with tag panel and solder tags.
Type B. Mains input 220/240V. Low Capacity. Multi Output 2, 4, 6.3, 7.3, 10 and 13V. Input has two aps which increase output volts by 25% and 50% respectively. This transformer is suitable for all cathode ray tubes. With tag panel, **21/–** each. Ditto for 6 volt tubes, only **17/6** each.
Type C. Low capacity wound transformer for use with 2V tubes with falling emission. Input 220/240V. Output 2-2¼-2½-2¾-3V at 2A, **17/6** each.
All isolation transformers are individually boxed, labelled and clearly marked with relevant data.
NOTE.—It is essential to use mains primary types with TV receivers having series connected heaters.

RESISTORS. Preferred values. 20% 10 ohms to 10 meg, ¼W **4d.**, ½W **4d.**, 1W **6d.**, 1½W **8d.**, 2W **1/–**
HIGH STABILITY. ½W 1%, **2/–.** All preferred values 100 ohms to 10 meg. Ditto 10%, **6d.** each

WIRE-WOUND RESISTORS
25 ohms–10,000 ohms
5 watt **1/3**
10 watt **1/6**
15 watt **2/–**
15,000 ohms–50,000 ohms, 5W, **1/9**; 10W, **2/3**

WIRE-WOUND POTS. Pre-set min. TV type. Knurled slotted knob. All values 25 ohms to 30 K, **3/–** each. 50K, **4/–**. Ditto Carbon Track 50K to 2 Meg, **3/–**
3W Lab. Colvern, etc. Standard size Pots., 2¼″ Spindle high grade. All values, 100 ohms to 50K, **5/6**; 100K, **6/6**
W/W EXT. SPEAKER CONTROL 10Ω, **3/–**
O/P TRANSFORMERS. Heavy duty 50mA, **4/6.** Multi-ratio push-pull, **6/6.** Miniature 3V4, etc., **4/6.** Small pentode **4/6.** Hygrade push-pull 7 watts, **15/6**
L.F. CHOKES 15/10H 60/65mA, **5/–**; 25/20H, 100/120mA, **11/6**; 20/15H, 120/150mA, **12/6**; 5H, 250mA, **15/–**. **MAINS TRANS.** 350-0-350, 80mA, 6.3V tapped 4V 4A 5V tapped 4V 2A, ditto 250-0-250 80mA, etc., **22/6**

CRYSTAL MIKE INSERT by Acos
Precision engineered. Size only 1⅜″ x 3/16″. Bargain. Price **6/6** — No transformer required

HEATER TRANS. Tapped 200/250V 6.3V 1½A, **7/6**
ALADDIN FORMERS and cores. ¼″ **8d.**; ⅜″ **10d.**
0.3″ FORMERS 5937/8 and cans TV1/2. ¾″ sq. x 2⅛″ and ⅝″ sq. x 1¾″, **2/–** complete with cores
SLOW MOTION DRIVES. Epicyclic ratio 6:1, **2/3**
TYANA. Midget Soldering Iron. 200/220V or 230/250V, **16/9.** **SOLON MIDGET IRON,** 25W, **24/–**
MAINS DROPPERS. 3″ x 1¼″. Three adj. sliders, 0.3A 750 ohms, **4/3**; 0.2A 1,000 ohms, **4/3**
LINE CORD. 0.3A 60 ohms per foot, 0.2A 100 ohms per foot, 2-way, **6d.** per foot; 3-way **7d.** per foot
MIKE TRANSF. 50:1, **3/9**; 100:1, Potted **10/6**
LOUDSPEAKERS. P.M. 3 ohm. 2¼″ square, **17/6** 5″ R.A. **17/6,** 7″ x 4″ Goodmans **21/–,** 3½″ sq. Elac, **21/–,** 8″ Plessey **19/6,** 6½″ Goodmans **18/6,** 10″ R.A. **30/–,** 12″ Plessey **30/–,** 8″ M.E. 2.5K field tapped, o.p. transformer **24/6.** 15 ohm Plessey 10W 12″ with Tweeter **97/6**
CRYSTAL DIODES. G.E.C. **2/–**; GEX34 **4/–**;
40 CIRCUITS FOR GERMANIUM DIODES, 3/–
CRYSTAL SET, complete kit **12/6.** Construction book **1/–.** **TUNING AND REACTION COND.** 100pF, 300pF, 500pF, **3/6** each, solid dielectric
H.R. HEADPHONES 4,000 ohms, brand new, **16/6** pr
SWITCH CLEANER Fluid, squirt spout, **4/3** tin
TWIN GANG CONDENSERS. 365pF, miniature, 1⅞″ x 1½″ x 1⅜″, **10/–**. 0.0005 standard with trimmers, **9/–**; less trimmers, **8/–**. Midget **7/6**; 50pF single, **2/6**

SUPERHET COIL PACK 27/6
Miniature size 2½″ x 2¾″ x 1½″. High Q dust cored coils. Short, Med., Long. Gram. switching with connection diagram and circuit. 465 kc/s i.f.

Aluminium Chassis. 18 s.w.g. Plan, undrilled, with 4 sides, riveted corners and lattice fixing holes, with 2½″ sides. 7″ x 4″, **4/6**; 9″ x 6″, **5/9**; 11″ x 7″ **6/9**; 13″ x 9″, **8/6**; 14″ x 11″, **10/6**; 15″ x 14″, **12/6**; 18″ x 16″ x 3″, **16/6**

Volume Controls

Midget size
Long spindles. Guaranteed 1 year. All values 10,000 ohms to 2 Meg.

No. S2	S.P.Sw.	D.P.Sw.
3/–	4/–	4/9

Linear or Log Tracks

80 Ω Coaxial cable

Semi-air spaced Polythene insulated ¼″ dia. stranded core. Ideal Band III **9d.** yd. Losses cut 50%.

FRINGE QUALITY
Air-spaced Coaxial **1/6** yd

Co-axial Plugs 1/– — **Double Socket** 1/3
Sockets 1/– — **Outlet Boxes** 4/6
Balanced Twin Feeder per yd, **6d.** 80Ω or 300Ω
Twin Screened Balanced Feeder, 1/– yd, 80 ohms
Trimmers. Ceramic, 30, 50, 70pF, **9d.**; 100pF, 150pF, **1/3**; 250pF, **1/6**; 600pF, 750pF, **1/9.** Philips **1/–** each
BLACK CRACKLE PAINT. Air drying, **3/–** tin
P.V.C. CONN. WIRE, 10 colours, single or stranded, **2d.** yd. Sleeving 1, 2 mm **2d.,** 2, 3 mm **3d.,** 6 mm **5d.** yd
5″ RADIO SCREWDRIVERS, 6d. each
NEON MAINS TESTER SCREWDRIVERS, 5/3
MULTICORE SOLDER, 60/40, 18 s.w.g., **3d.,** 16 s.w.g., **4d.** yd; ¼lb **2/6**
Sentercel Rectifiers. E.H.T. Type Fly-back. Voltages: K3/25 2kV, **5/–**; K3/40 3.2kV, **7/–**; K3/45 3.6kV, **7/6**; K3/50V 4kV, **8/–**; K3/100 8kV, **14/6**
50 cps voltage 30% of above ratings
Mains Type RM1, 125V 60mA, **5/–**; RM2 100mA, **6/–**; RM3 120mA, **8/–**; RM4 250V 275mA, **16/–**; RM5, **20/–**
Miniature Contact Cooled Rectifiers. 250V 50mA, **8/6**; 250V 85mA, **9/6.** **Selenium Rect.** 300V 85mA, **7/6**
Coils. Wearite "P" type, **3/–** each. Osmor Midget "Q" type adj. dust core, from **4/–** each. All ranges
Teletron. L. & Med. T.R.F., with reaction, **3/6**
Ferrite Rod Aerials. M.W., **8/9**; M. & L., **12/6**
T.R.F. Coils A/HF, **7/–** pair. **H.F. Chokes, 2/6**

HANDY VOLTMETERS

2″ Twin Range 0–25V, 0–250V d.c. with leads and Leather case, **12/6** each

Condensers. New stock. 0.001μF 7kV T.C.C., **5/6**; ditto 20kV, **9/6**; 100pF to 500pF Micas, **6d.**; Tubular 500V 0.001 to 0.01μF, **9d.**; 0.05, 0.1, **1/–**; 0.25, **1/6**; 0.5, **1/9**; 0.1/350V, **9d.**; 0.1/600V, **1/3**; 0.1/2,000V, **4/–**
Ceramic Condensers. 500V 0.3pF to 0.01μF, **10d.**
Silver Mica 10% 5pF to 500pF, **1/–**; 600pF to 3,000pF, **1/3**; Close tolerance, (plus or minus 1pF), 1.5pF to 47pF, **1/6**; ditto 1% 50pF to 815pF, **1/9**; 1000pF to 5000pF **2/–**.

NEW ELECTROLYTICS. FAMOUS MAKES

TUBULAR		TUBULAR		CAN TYPES	
1/350V	2/–	100/25V	3/–	8+16/450V	5/–
2/450V	2/3	8+8/500V	6/–	16+16/500V	6/–
4/450V	2/–	16+16/500V	6/–	6,000μF 6V	6/6
8/450V	2/3	**CAN TYPES**		32+32/350V	4/6
8/500V	2/9	Clips	3d.	32+32/450V	6/6
16/450V	3/6	16/450V	3/6	64+120/275V	7/6
16/500V	4/–	32/350V	4/–	60+100/350V	11/6
32/450V	5/6	64/350V	5/6	100+200/275V	
25/25V	1/9	100/275V	5/6		10/6
50/25V	1/9	50+50/350V	7/–	1,000+1,000/6V	
50/50V	2/–	500/12V	3/–		6/6

Full Wave Bridge Selenium Rectifiers. 2, 6 or 12V 1½A, **8/9**; 2A, **11/3**; 4A, **17/6**
Charger Transformers. Tapped Input 200/250V for charging at 2, 6 or 12V 1½A, **15/6**; 2A, **17/6**; 4A, **22/6**

12/6 PURETONE RECORDING TAPE
1,200ft on standard 7″ metal reels.
Spare reels 5″ metal, **1/6**; 7″ metal, **2/3**
FERROVOICE 1,200ft Plastic Tape, **25/–**

CHAMPION (VHF) FM TUNER

88 to 96 Mc/s
5 MULLARD VALVES and SUPERHET TUNING HEART

Maroon and cream receiver styled cabinet 6″ x 12″ x 6″. Features: This is a self-powered 200/250V a.c. VHF (FM) Adaptor with operating and servicing data, and a screened lead for connection to pick-up sockets of any radio, radiogram or amplifier.

Brand new with 12 months guarantee. List price **16 gns. Our price 10 gns.,** carr. 4/6

BBC Beginners I valve radio kit in stock

JASON FM TUNER COIL SET, 26/–. H.F. coil, aerial coil, oscillator coil, two i.f. transformers 10.7 Mc/s, detector transformer and heater choke. Circuit and component book using four 6AM6, **2/–.** J.B. Chassis and dial, **19/6.** Complete kit, **£5.18.6.** With Jason superior calibrated dial, **£6.15.0.**

Wavechange Switches. 2 p 2-way, 3 p 2-way, short spindle, **2/6**; 5 p 4-way 2 wafer, long spindle, **6/6**; 2 p 6-way, 4 p 2-way, 4 p 3-way, long spindle, **3/6**; 3 p 4-way, 1 p 12-way, long spindle, **3/6**; Wave change "MAKITS," 1 wafer, **8/6**; 2 wafer, **12/6**; 3 wafer, **16/–**; 4 wafer, **19/6**; 5 wafer, **23/–**; 6 wafer, **26/6**
Toggle Switches, s.p. **2/–**, d.p. **3/6**, d.p.d.t. **4/–**
Morse Keys, good quality, **2/6**

Knobs, Gold Engraved. Walnut or Ivory. 1⅝″ diam., **1/6** each. 'Focus,' 'Contrast,' 'Brilliance,' 'Brilliance-On/Off,' 'On-Off,' 'Volume,' 'Volt-On/Off,' 'Tone,' 'Tuning,' 'Treble,' 'Bass,' 'Wave-change,' 'Radio-Gram,' 'S.M.L.-Gram,' 'Record-Play,' 'Brightness.' Ditto, not engraved, **1/–**

Valveholders. Pax. int. oct, **4d.** EF50, EA50, **6d.** B12A, CRT, **1/3.** Eng. and Amer. 4. 5, 6, 7 and 9 pin, **1/–** MOULDED Mazda and int. oct, **6d.,** B7G, B8A, B8G, B9A, **9d.** B7G with can, **1/6.** VCR97, **2/6.** B9A with can, **2/6.** **Ceramic,** EF50, B7G, B9A int. oct., **1/–.** B7G with can, **1/9**; B9A with can, **2/9**
Speaker Fret. Gold cloth, 17″ x 25″, **5/–**; 25″ x 35″, **10/–.** Expanded metal, silver, 15¾″ x 9½″, **2/–** each;
Tygan. 4′ 6″ wide, **10/–** ft; 2′ 3″ wide, **5/–** ft.
TV Fault Finding. Data Publications. **5/–** each
Radio Valve Guide. Books 1, 2 or 3, **5/–** each

All Boxed VALVES New & Guaranteed

1R5	8/6	6K8	8/6	EABC80	8/6	EZ81	11/6
1S5	8/6	6L6	10/6	EB91	6/6	EI148	1/6
1T4	8/6	6Q7	10/6	EBC33	8/6	HABC80	12/6
3S4	8/6	6SA7	7/6	EBC41	10/6	HVR2A	7/6
3V4	8/6	6SN7	8/6	EBF80	8/6	MU14	10/6
5U4	8/6	6V6G	7/6	ECC84	12/6	P61	6/6
5Y3	8/6	6V6GT	8/6	ECF80	10/6	PCC84	12/6
5Z4	10/6	6X4	7/6	ECF82	10/6	PCF80	10/6
6AM6	8/6	6X5	7/6	ECH42	10/6	PCF82	10/6
6B8	5/6	7S7	8/6	ECL80	8/6	PCL82	10/6
6BE6	7/6	12A6	7/6	ECL82	12/6	PEN25	6/6
6BH6	10/6	12AH8	10/6	EF39	7/6	PL82	10/6
6BW6	8/6	12AT7	10/6	EF41	10/6	PY80	10/6
6BW7	8/6	12AU7	10/6	EF50	5/6	PY81	10/6
6CH6	10/6	12AX7	10/6	Equip.		PY82	10/6
6D6	7/6	12BE6	10/6	EF50	8/6	SP61	5/6
6F6	7/6	12BH7	10/6	Sylv.		UBC41	8/6
6H6	3/6	12K7	8/6	EF80	10/6	UCH42	8/6
6J5	6/6	12Q7	8/6	EF92	5/6	UF41	8/6
6J6	7/6	35Z4	10/6	EL32	5/6	UL41	8/6
6J7	8/6	80	8/6	EL84	10/6	UY41	8/6
6K6	6/6	954	1/6	EY51	11/6	U22	10/6
6K7	5/6	EA50	1/6	EZ40	10/6	X79	10/6

A Merry Christmas to all readers of "The Radio Constructor" Please post Christmas orders by Wed. 18th Dec.

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD Tel. THO 1665
WEST CROYDON Catalogue 6d.

Buses 133 or 68 pass door. S.R.Stn. Selhurst. 48-hour Postal Service. P.& P. 1/–, over £2 post free. C.O.D. 1/6 (Export C.W.O. post extra no H.P.)

Shop closed 25th, 26th, 27th Dec.
OPEN ALL DAY (Wed. 1 p.m.)

The

Cooper-Smith High Fidelity Amplifier type BPI

Smith's of EDGWARE ROAD

COMPONENT PRICE LIST

for Main Amplifier as featured in this issue

Buy direct from the Designers to ensure 100% results
All enquiries promptly dealt with

		s.	d.
R1, R2	2.2kΩ ½W, 1% or matched, high stability ... pr.	3	0
R3, R4	2.2kΩ ½W, 1% or matched, high stability ... pr.	3	0
R5, R6	120kΩ ½W, 1% or matched, high stability ... pr.	3	0
R7	22kΩ ½W, 10% high stability		6
R8	18kΩ ¼W, 20% high stability		6
R9, R10	470kΩ ½W, 1% or matched, high stability ... pr.	3	0
R11, R12	4.7kΩ ¼W, 20% high stability ... ... pr.	1	0
R13, R14	220Ω 5W matched within 5%, wire wound pr.	4	0
R15	10kΩ 1W, 20%, high stability		9
R16, R17	39Ω ¼W, 20%, high stability ... ... pr.	1	0
R18	39kΩ ¼W, 20% high stability		6
VR1	2kΩ potentiometer, linear, slider earthed	3	6
C1	100pF mica		6
C2	1.5pF ceramic		9
C3	1.5pF ceramic		9
C4	0.25μF 350V working ...	1	1
C5	0.25μF 350V working ...	1	1
C6	16μF, 450V working, Daly...	3	9
C7	50μF, 25V working, Daly ...	1	9
C8	50μF, 25V working, Daly ...	1	9
C9	8μF, 500V working, Daly ...	3	3
C10	16μF, 450V working, Daly...	3	9

	s.	d.
C11 16μF, 450V working, Daly...	3	9
Mains transformer, 300-0-300V at 120mA, 6.3V at 3A ct, 5V at 3A. Electrovoice type A195 ...	47	3
Output Transformer 7,000Ω A-A, 3.5/15Ω sec. 12W, tapped at 20% of primary winding. Primary inductance 58H, leakage inductance 22.8H. Electrovoice type D73	41	0
Smoothing choke 10H, 110mA, 200Ω d.c. resistance, Electrovoice type 101M	21	3
V1 12AU7, Tungsram (inc. P.T.)	18	11
V2 12AX7, Tungsram (inc. P.T.)	18	11
V3, V4 6BQ5, Tungsram (inc. P.T.) pr.	31	2
V5 5Z4, Tungsram (inc. P.T.) ...	16	11
Chassis 12″ x 7″ x 2″, ready punched, bronze finish, with grommets	17	6
Group board, 30-way, 2¾″ wide, with fixing bushes and screws...	4	0
Fuseholder and fuse, 3A	4	0
Mains selector	1	6
2 Valveholders (int. octal) 9d. ea.	1	6
4 Valveholders (B9A) 9d. ea. ...	3	0
Mains plug and socket, Bulgin ...	3	9
Speaker plug and socket, 3-pin Cinch		7½
Coaxial plug and socket	2	6
S1 Switch, s.p.d.t., with knob ...	3	0
Nuts and screws, solder tags, t.c. wire and sleeving	3	0

Complete Kit, with full instructions £12.12.0
Built up and tested £14.17.0

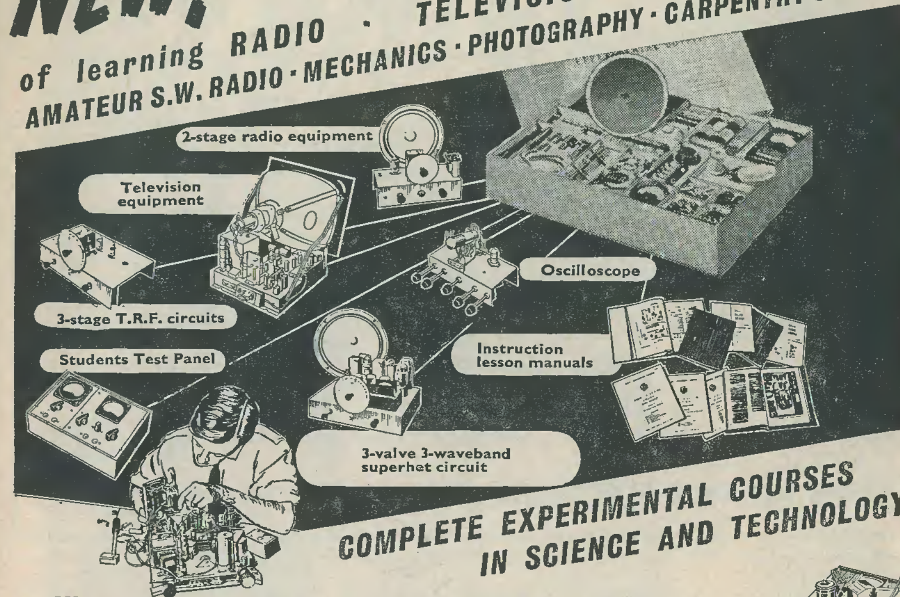
H. L. SMITH & CO LTD

287/9 EDGWARE ROAD · LONDON W2 · *Telephone* Paddington 5891

NEW! —THE PRACTICAL WAY

of learning RADIO · TELEVISION · ELECTRONICS

AMATEUR S.W. RADIO · MECHANICS · PHOTOGRAPHY · CARPENTRY etc. etc.



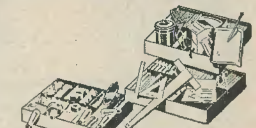
COMPLETE EXPERIMENTAL COURSES IN SCIENCE AND TECHNOLOGY

NEW—Completely up-to-date method of giving instruction in a wide range of technical subjects specially designed and arranged for self-study at home under the skilled guidance of our teaching staff.

NEW—Experimental outfits and lesson manuals are despatched on enrolment and remain the student's property. A tutor is allotted to each student for personal and individual tuition throughout the course.

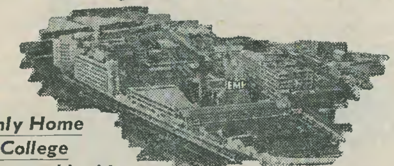
Radio and television courses, with which specially prepared components are supplied, teach the basic electronic circuits (amplifiers, oscillators, detectors, etc.) and lead, by easy stages, to the complete design and servicing of modern radio and television receivers.

If you are studying for an examination, wanting a new hobby or interest, commencing a career in industry or running your own full-time or part-time business, these practical courses are ideal and may be yours for moderate cost. Send off the coupon to-day for a free Brochure giving full details. There is no obligation whatsoever.



SUBJECTS INCLUDE:—

RADIO
SHORT WAVE RADIO
TELEVISION · MECHANICS
CHEMISTRY · PHOTOGRAPHY
ELECTRICITY · WOODWORK
ELECTRICAL WIRING · DRAUGHTSMANSHIP · ART, ETC.



The only Home Study College run by a world-wide Industrial organisation.

E.M.I. Factories at Hayes, England.

COURSES FROM 15/- PER MONTH

Send without obligation your FREE book.
E.M.I. INSTITUTES, Dept. 179X, London, W.4.

NAME............ Age............ (If under 21)
ADDRESS............
BLOCK CAPS PLEASE

I am interested in the following subject(s) with/without equipment.

(We shall not worry you with personal visits) (DEC) IC.85

EMI INSTITUTES

—*Part of "His Master's Voice," Marconiphone, etc. etc.*

REPANCO

HIGH GAIN COILS and QUALITY COMPONENTS
for the constructor

TRANSISTOR COMPONENTS

FERRITE SLAB AERIAL TYPE FS2. A new super-sensitive aerial, Long and Medium Wave, specially designed for transistor portable receivers. Complete with fixing brackets. Length $5\frac{1}{2}$"	13/6
COMBINED OSCILLATOR AND 1st I.F. TRANSFORMER TYPE OT1 (315 kc/s), fully screened, $\frac{13}{16}$" x $\frac{13}{16}$" x $1\frac{3}{4}$" ...	11/6
2nd I.F. TRANSFORMER TYPE TT2 (315 kc/s), 1" x $\frac{5}{8}$" dia....	5/-
3rd I.F. TRANSFORMER TYPE TT3 (315 kc/s), 1" x $\frac{5}{8}$" dia. ...	5/-
PUSH-PULL INTER-STAGE TRANSFORMER TYPE TT4. Ratio 1:1 ct. Stack $1\frac{3}{8}$" x $1\frac{1}{16}$" x $\frac{7}{16}$"	8/6
PUSH-PULL OUTPUT TRANSFORMER TYPE TT5. Ratio 15:1 ct. Stack $1\frac{3}{8}$" x $1\frac{1}{16}$" x $\frac{7}{16}$"	8/-

MINIATURE RANGE—For pocket receivers

FERRITE SLAB AERIAL TYPE FS3. Medium Wave only. With fixing grommets. Size 3" x $\frac{3}{4}$" x $\frac{5}{32}$"	7/6
OSCILLATOR COIL TYPE XO8. Medium Wave only. Overall size $\frac{1}{2}$" dia. x 1". Enclosed in Ferrite pots ...	5/-
I.F. TRANSFORMER TYPE XT6. Suitable for 1st and 2nd I.F. 455 kc/s. Size $\frac{1}{2}$" sq. x $\frac{11}{16}$" ...	10/-
I.F. TRANSFORMER TYPE XT7. Designed for 3rd I.F.T. or detector I.F.T. 455 kc/s. Size as XT6 ...	10/-
PUSH-PULL INTERSTAGE TRANSFORMER TYPE TT9. Ratio 1:1 C.T. Radiometal Core. Size $\frac{3}{4}$" x $\frac{5}{8}$" x $\frac{13}{32}$" ...	12/6
PUSH-PULL OUTPUT TRANSFORMER TYPE TT10. Ratio 8:1 C.T. Matched to 3 ohm speaker. Size as TT9 ...	12/6

Practical and Theoretical circuits enclosed with each Repanco Transistor Component

HIGH GAIN COILS

Dual-range Miniature Crystal Set Coil with circuit, type DRX1 ...	2/6
Dual-range Coil with Reaction. With 2 mains, 2 battery and Transistor Circuit type DRR2 ...	4/-
Ferrite Rod Aerial, Long and Medium Wave. With fixing brackets, type FR1	12/6
Matched pair TRF Dual-range Coils with Reaction. With mains, battery and feeder unit circuits, type DRM3 pr.	8/-
Pair Dual-range Superhet Coils. With mains and battery circuits, type SH4 pr.	8/-
Miniature I.F. Transformers, pre-aligned, 465 kc/s $\frac{13}{16}$" x $\frac{13}{16}$" x $1\frac{3}{4}$", type MSE ...	12/6

REPANCO EASY-TO-BUILD RECEIVERS

Constructors' Envelopes of easy wiring plans, instructions and detailed price lists of components

THE HIWAYMAN ... Four-valve superhet Dual-range Portable using Ferrite Rod Aerial	**Envelope 1/6** (post 3d.)
REPANCO ONE-VALVE ... Beginner's Dual-range Radio Set for use with headphones	**Envelope 9d.** (post 3d.)
REPANCO FM TUNER UNIT ... Using 4 EF91, 1 EB91, 1 EM80 Valves, Ratio Detector	**Envelope 1/6** (post 3d.)
REPANCO "THREE DEE" ... Dual-range Transistor Radio using 3 Transistors and Crystal Diode. Amazing loud-speaker reception from $7\frac{1}{2}$ volt battery supply	**Envelope 9d.** (post 3d.)
REPANCO "TRANSEVEN" ... A new 7 Transistor superhet Portable with preset station tuning using Repanco transistor components	**Envelope 1/6** (post 3d.)

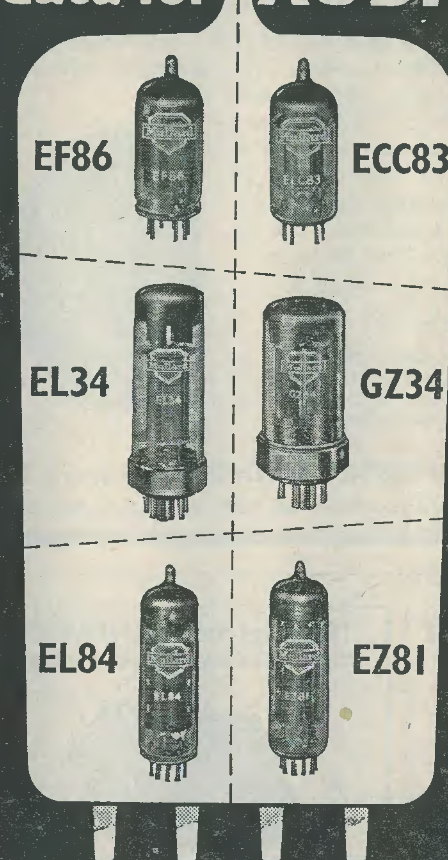
MAIL ORDER and TRADE—

RADIO EXPERIMENTAL PRODUCTS
LIMITED
33 MUCH PARK STREET COVENTRY
Telephone 62572

WHOLESALE and EXPORT—

REPANCO LTD
O'BRIENS BUILDINGS
203-269 FOLESHILL ROAD COVENTRY
Telephone 40594

data for AUDIOPHILES*



Audiophiles all over the world are demanding Mullard audio valves for their high quality sound equipment. And who can blame them when they know that the Mullard World Series of Audio Valves is the finest in the world.

Fill in the coupon below for free data on Mullard World Series Audio Valves.

** Audiophile—Enthusiast for high quality sound reproduction who is satisfied with nothing but the best.*

This popular book is available now from most dealers, price 3/6d. It contains designs and full constructional details of the new Mullard EL34 High Quality 20 Watt Amplifier, a Mullard Band II F.M. Tuner, pre-amplifiers for the Mullard EL34 Amplifier and for the popular Mullard 5 Valve 10 Watt Amplifier, together with other useful technical information.

COUPON

TO: MULLARD LTD., PUBLICITY DIVN.

Please send me, free of charge, leaflets on the Mullard World Series of Audio Valves, and details of "High Quality Sound Reproduction".

NAME...

ADDRESS...

....

Mullard

WORLD SERIES
AUDIO VALVES

Mullard

Mullard Ltd . Publicity Division
Mullard House Torrington Place
London WC1

MVM 349A

Christmas Greetings from the Editor and Staff of

The Radio Constructor

CONTENTS FOR DECEMBER

VOL. 11 NO. 5

DECEMBER 1957

ANNUAL SUBSCRIPTION 25/- including postage

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9

Telephone
CUNningham 6141 (2 lines)

Telegrams
DATABUX, LONDON

Editor
C. W. C. OVERLAND, G2ATV

Advertising Manager
F. A. BALDWIN, AMIPRE

NOTICES

THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should preferably be typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsmen will redraw in most cases, but all relevant information should be included.

All MSS must be accompanied by a stamped addressed envelope for reply or return. Each item must bear the sender's name and address.

TRADE NEWS. Manufacturers, publishers, etc., are invited to submit samples or information of new products for review in this section.

QUERIES. We regret that we are unable to answer queries, other than those arising from articles appearing in this magazine; nor can we advise on modifications to the equipment described in these articles.

ALL CORRESPONDENCE should be addressed to THE RADIO CONSTRUCTOR 57 Maida Vale London W9

REMITTANCES should be made payable to "DATA PUBLICATIONS LTD."

Suggested Circuits

The circuits presented in this series have been designed by G. A. FRENCH, *specially for the enthusiast who needs only the circuit and essential relevant data*

No. 85. A SENSITIVE PROXIMITY DETECTOR

WHENEVER A SUGGESTED CIRCUIT IS destined to appear in the December issue of *The Radio Constructor*, the writer usually attempts to present a device which has something of a "novelty" value about it. Frequently, however, devices which are initially intended to possess novelty value turn out to have basic applications which make them attractive for quite utilitarian functions, and it is very possible that the proximity detector which is the subject of this month's article enters such a category.

The circuit itself is that of a sensitive proximity detector which is capable of actuating an external electrical circuit whenever any person approaches a pick-up rod or plate. By employing circuitry which is a little more comprehensive than is usual for devices of this type, the unit is capable of being set up to give a high degree of sensitivity.

Basic Design

It is possible to employ several different techniques for proximity detection but, apart from photo-electric arrangements wherein a ray of light is interrupted, the simplest method is almost always provided by alteration in capacity between a pick-up rod or plate and earth caused by the proximity of the person approaching the device. An excellent means of taking advantage of this changing capacity in order that a switching circuit may be operated consists of coupling it to an oscillatory tuned circuit. Capacity variations will then cause oscillator frequency variations, which, with the subsequent use of tuned filters, may be very readily employed for operating a relay.

As originally conceived by the writer, it was proposed that the overall proximity detector circuit arrangement would comprise an oscillator whose tuned circuit was coupled to the pick-up rod or plate, a frequency changer stage employing a second oscillator, a tuned filter, and a detector coupled to a switching valve. The two oscillators were intended to work at a relatively high frequency, say around 15 to 20 Mc/s, whilst the tuned filter would be set to 400 to 500 kc/s. The two oscillators would be adjusted to give a frequency difference equal to that to which the tuned filter was set, whereupon small shifts in frequency in one oscillator would cause relatively large shifts in the frequency applied to the filter. Thus, assuming that the proximity of a person to the pick-up rod or plate caused the first oscillator to shift from, say, 20 to 19.8 Mc/s—a drop of 0.2 Mc/s, equivalent to a change in frequency of 1%—the resultant change in frequency applied to the tuned filter could be of the order of 500 to 700 kc/s—a shift of 40%. In other words, by employing a frequency changer stage and a relatively low frequency tuned filter in the device, small changes in pick-up capacity to earth would result in very large changes in the frequency applied to the tuned filter stage; and the device would be in consequence much more sensitive than if tuned filters adjusted to the oscillator frequency itself were employed. It will be appreciated, of course, that this is merely employing conventional superhet principles to provide a high degree of selectivity, but the point is worth some discussion in this particular context.

Having settled the basic arrangement, it next became necessary to translate this into a form which required no specialised components and which was suitable for amateur construction. At once two potential difficulties presented themselves. The first of these was that the two oscillators would have to be carefully isolated from each other in order to prevent pulling. The requirements of the design necessitated the oscillator circuit coupled to the pick-up rod or plate being housed in a separate unit from the main chassis, and so a partial solution to the problem of pulling would be given by employing a double triode here, the second triode acting as a cathode follower buffer amplifier. Even when such a buffer amplifier is employed some slight pulling might still be evident (due to the stray capacities in the simple circuit arrangement intended), but this should not be too excessive and could, in any event, be kept to a low value by keeping the coupling between the oscillator and the cathode follower at a low level. The second difficulty anticipated was that of obtaining acceptable performance from the tuned filter and subsequent detector. An obvious choice for the tuned circuits in the filter would be provided by conventional 465 kc/s i.f. transformers, and it would be desirable to employ at least two of these. At the same time the r.f. voltage applied to the detector circuit would have to be of the order of at least several volts if reliable switching action was to be given; and such a voltage would not be forthcoming from the frequency changer anode whilst maintaining a low value of coupling between the pick-up oscillator and cathode follower. It was finally decided that the best solution to these various requirements would be given by employing two i.f. transformers in the tuned filter section, together with an amplifying valve. The use of an amplifier would enable the requisite high voltage input to the detector to be obtained, and it would give considerably greater scope to the range of adjustments needed for coupling the pick-up oscillator to the cathode follower. A gain control on the amplifier would also enable a panel sensitivity control to be provided.

The remainder of the circuit difficulties anticipated were fairly easy to solve, and are covered in the circuit description which follows.

The Circuit

The finished circuit of the proximity detector accompanies this article, and it will be noted that, as was mentioned above, the pick-up oscillator is housed in a separate unit away from the main chassis.

This unit employs a double triode valve of which one half, $V_{1(a)}$, functions as an oscillator. The oscillator tuned circuit is provided by L_1 in parallel with C_2 and C_s, the latter being the stray capacity between the pick-up rod or plate and earth. A feedback winding, L_2, causes the stage to oscillate. If any earthed body approaches the pick-up rod or plate the value of C_s changes, as, in consequence, does the frequency of oscillation of $V_{1(a)}$. $V_{1(b)}$ is a cathode follower whose grid is connected to L_2, and which causes the oscillator voltage to be built up across R_8. A low value of resistor is chosen for the R_8 position and this, shunted by the output impedance of $V_{1(b)}$, presents an impedance to the coaxial cable coupling the pick-up unit to the main chassis of approximately 100 ohms. There may be some slight clipping of negative half-cycles in the cathode follower stage if it is necessary to give C_6 a high value during setting up, but this should not cause any difficulties in the device we are considering here.

The coaxial cable coupling the pick-up unit to the main chassis may be normal 75 ohm television feeder, and it is terminated in a resistor, R_{10}, of 100 ohms. The mismatch at either end of the cable should not cause any difficulties provided that it is not longer than some fifteen feet or so. The pick-up oscillator frequency is then applied to g_1 of the frequency changer $V_{2(a)}$.

The oscillator triode $V_{2(b)}$ works at a frequency which ensures that the difference frequency given at the anode of $V_{1(a)}$ is that to which the tuned filter coils are adjusted. It is essential, also, for $V_{2(b)}$ to oscillate at a frequency *higher* than that at which $V_{1(a)}$ functions because the latter will always drop when an earthed body approaches the pick-up rod or plate. If $V_{2(b)}$ oscillated at a lower frequency than $V_{1(a)}$ it would be possible for the latter to be detuned by proximity effects below $V_{2(b)}$ such that the tuned filter frequency appeared once more at the anode of $V_{2(a)}$. This state of affairs would result in unreliable operation.

The tuned filter consists of two conventional 465 kc/s i.f. transformers coupled by an amplifying valve V_3. The sensitivity control R_{18} enables the gain of V_3 to be adjusted.

The double triode V_4 is employed to provide a detector for the output of the tuned filter together with a relay-operating valve. This part of the circuit is intended to function such that, when the pick-up oscillator is running at normal frequency, the output from

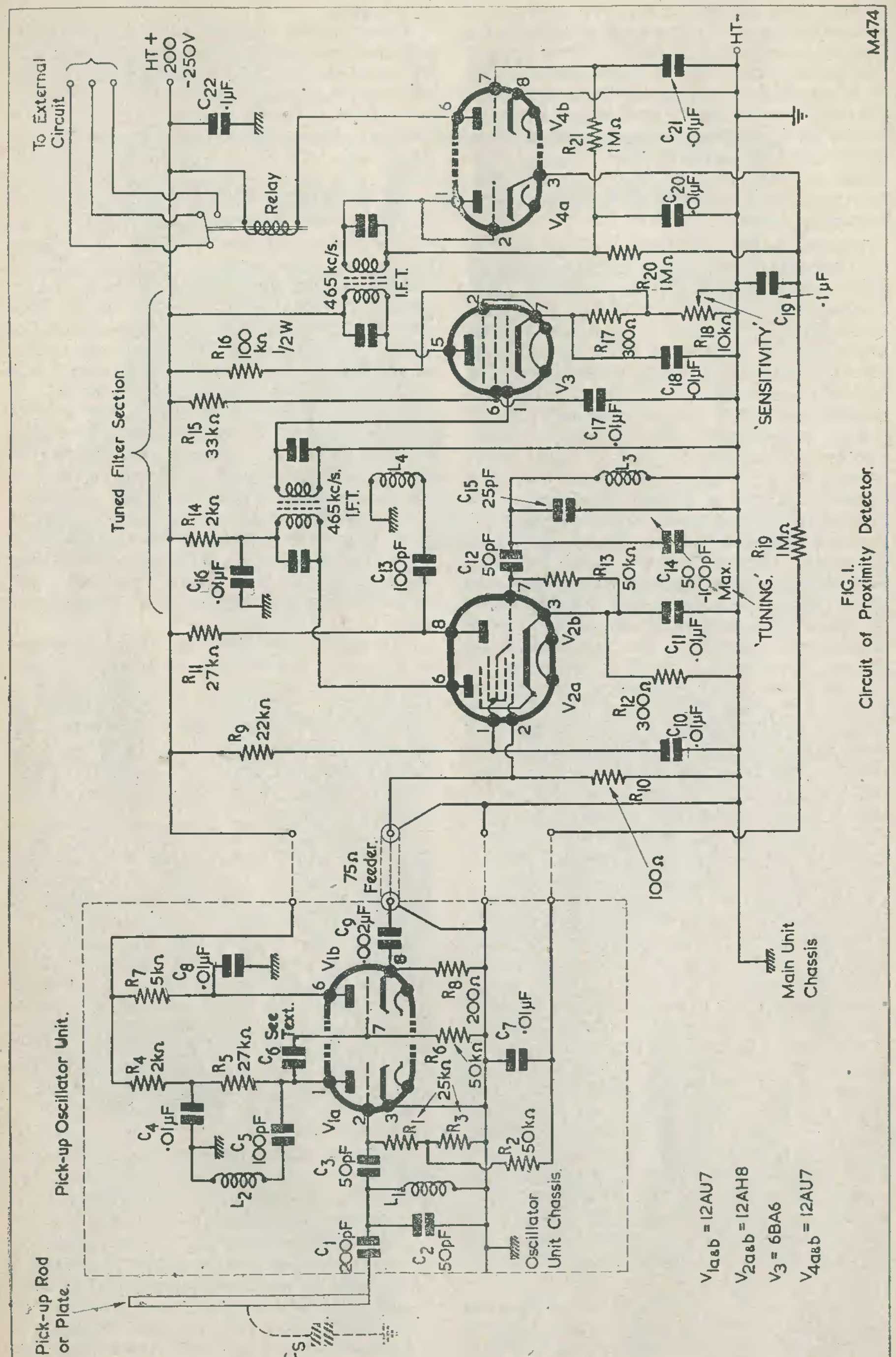


FIG. 1. Circuit of Proximity Detector.

the tuned filter section is detected and applied to the grid of the relay-operating valve as a negative d.c. voltage, thereby cutting it off. If the pick-up oscillator becomes detuned, the output from the tuned filter section drops or disappears altogether, whereupon the relay-operating valve conducts and energises the relay in its anode circuit.

In order to prevent too high an anode current in the relay-operating valve when the detected negative voltage from the tuned filter is zero, it is necessary to apply a fixed standing bias to this valve. In the circuit shown here a potential of approximately 5 volts negative is obtained by tapping into the grid leak, R_1, R_3, of the pick-up oscillator $V_{1(a)}$. This voltage, decoupled by R_2 C_7 and R_{19} C_{19}, is that to which the detector load R_{20} is returned, with the result that, in the absence of detected voltage, 5 volts negative to cathode is still applied to the relay-operating triode. In the diagram this triode is provided by $V_{4(b)}$; $V_{4(a)}$, with grid and anode strapped, being the detector.

Practical Points

Before carrying on to a description of setting up the device, it is necessary to discuss one or two practical points.

It was mentioned above that the tuned filter section may employ conventional 465 kc/s i.f. transformers, these being readily obtainable through normal channels. The coils L_1, L_2, and L_3, L_4, may also be similarly easily obtained, as they need consist only of conventional short-wave oscillator coils intended for covering a range of 5–18 Mc/s, or thereabouts.

The relay controlled by $V_{4(b)}$ should have a high resistance winding, and should be capable of being energised by a current of 10mA. Slightly less sensitive types, energising around 15mA, could also be employed, but these necessitate a relatively high current in $V_{4(b)}$ when this valve is "on." The process of adjusting the fixed bias to $V_{4(b)}$ to accommodate such relays (or to take up differing oscillator grid currents) is discussed later.

It may be noted that an earth connection to the main chassis is shown in the diagram. This is desirable but not essential. A fairly reasonable earth connection would be given by connecting a 0.01μF 750 w.v. condenser between one side of the mains input and chassis.

Setting Up

So long as the principle of operation is understood, it is a fairly easy task to set up the device once it has been completed. It is first of all necessary to temporarily connect a meter switched to read 10mA in series with the h.t. feed to $V_{4(b)}$. The i.f. transformers may then be aligned by injecting a signal generator set to 465 kc/s into g_1 of $V_{2(a)}$, attenuating output as alignment proceeds in order to prevent $V_{4(b)}$ being cut off. Alignment is for minimum reading in the meter.

With the pick-up oscillator connected to its rod or plate, $V_{2(b)}$ oscillator should next be set up for minimum reading in the meter. For this operation the slider of R_{18} should be positioned approximately one-third up from the earthy end of the track. It will also be necessary to adjust C_6 at this stage, the value of this condenser being such that just sufficient voltage appears at the tuned filter output to cut off $V_{4(b)}$ when $V_{2(b)}$ oscillator is at correct frequency. If it is found that it is difficult to obtain a sufficiently loose coupling by reduction of the value of C_6, an additional condenser (approximately 50pF) should be shunted across R_6 and the process of adjusting C_6 re-commenced.

The standing bias voltage for $V_{4(b)}$ should finally be checked by ensuring that the anode current of this valve reaches the value needed to operate the relay (see above) when the output of the tuned filter section drops to zero. If the standing bias voltage is too great it may be reduced by reducing the value of R_3, and vice versa. Incidentally, this bias voltage will not cease if the pick-up rod or plate happens to be touched, as the presence of C_1 ensures that the oscillator still keeps running under such conditions.

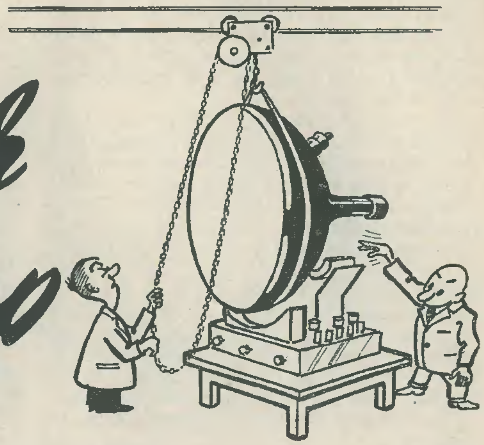
When it is desired to use the device, all that is necessary is to switch it on and allow it to warm up for some ten minutes or so. C_{14} should then be adjusted (ensuring that $V_{2(b)}$ oscillates *above* $V_{1(a)}$) so that the relay de-energises. Holding one's hand near the pick-up rod or plate should then cause the relay to be energised. Careful adjustment of R_{18} (with perhaps a slight re-setting of C_{14} as tuned filter gain is increased) can bring the detector to optimum sensitivity, should this be desired.

Drift

A final precautionary note has to be made by drawing attention to the possibility of frequency drift in the oscillators. Since both oscillators run from the same h.t. line, variations in mains voltage should have approximately the same effect on both. Long-term thermal drift may cause difficulties, and can best be alleviated by providing adequate ventilation to both oscillators. Good quality silver-mica condensers should be employed in both oscillator tuning circuits.

Finally, it should be pointed out that the sensitivity of the pick-up rod or plate will be roughly proportional to its size or area. It should be kept well clear of earthed objects. The overall sensitivity of the arrangement may be reduced, incidentally, by increasing the value of C_2, and adjusting that of C_{14} accordingly.

In your Workshop



This month Smithy, aided by his able assistant, Dick, examines Christmas from the point of view of the Serviceman. He also deals with one or two subjects suggested in readers' letters

SMITHY'S ENTRY INTO THE WORKSHOP ON most days was usually slightly in advance of Dick's. The Serviceman was mildly surprised one December morning, therefore, to find on his arrival that the Workshop was ablaze with light and, judging from the considerable amount of banging and hammering which emanated from within, that an extensive project of work appeared to be in progress. Somewhat suspiciously Smithy opened the door, to find his assistant balancing precariously on a chair and putting the final touches to a large paper bell suspended from the centre of the ceiling. Around the room there was evidence of Dick's enthusiastic application to his self-appointed early morning task. Amongst other things the signal generator was liberally festooned with tinsel; a paper chain stretched diagonally across the ceiling, drooping somewhat over the sink; a small Father Christmas beamed benignly at Smithy from the tool-rack on the wall; large blobs of cotton-wool were stuck over the surface of the window; and the motto "God Rest Ye Merry, Gentlemen" blazoned out above the rack on which intermittent receivers underwent their soak tests.

Dick paused in his labours and looked modestly at Smithy.

"Just thought I'd brighten the place up a bit," he remarked casually.

Smithy took the scene in slowly, his first reactions being not entirely unconnected with the thought that it was a good thing that Christmas only came round once a year. However, a glance at Dick's face made him suppress any comments of that type.

"Well, you've certainly made a good job of it, Dick," he remarked at length; "only, don't you think you're a little early? After all, there are nearly three more weeks to go before Christmas Day."

"Oh, I've only just *started*," replied Dick. "I shall be adding quite a lot more each day!"

Christmas Rush

Smithy had no answer to this, and he took off his overcoat and settled down to work. Dick put the final touches to the decorations he had put up, and busied himself also. There were plenty of receivers in for repair and the time passed by very quickly. So quickly, indeed, that Dick and Smithy were surprised when a glance at the clock showed that a break for tea was indicated.

"Phew," commented Dick, as he sat down and sipped at the cup he had prepared. "The time seems to have gone by like lightning this morning! Is it my imagination, Smithy, or does there seem to be more work just now than we usually have?"

"Well, it's certainly beginning to pile up," admitted Smithy. "I should say that we're just beginning to experience the trade phenomenon known as the 'Christmas Rush.' The rush of work which appears every Christmas affects almost everyone connected with domestic radio or t.v., from the big manufacturers right down past the smaller retailers to the servicing people such as ourselves. What happens, of course, is that the public order more radio and t.v. sets for Christmas than at any other time of the year, and manufacturers, wholesalers and retailers are kept right on their toes getting sets into the customer's homes before the all-important Christmas Day. Some of the bigger factories work extra overtime right up to the last minute before the Christmas break. From the servicing point of view, people suddenly seem to remember that they *must* have their sets, or their 'reserve' sets, fixed up before December 25th, and so our work mounts up as well. I can remember several years when I've been hard at it in the workshop until nine o'clock on Christmas Eve, in order not to disappoint somebody. After Christmas Day everything goes quiet again until around the end of January, whereupon trade returns more or less to normal. In some years the 'Rush' is not so marked as in others, but it's always easily detectable, especially if you're connected with the manufacturing or retail side."

"I suppose the quiet time after Christmas Day is due to the fact that much of the work has been cleared up beforehand," said Dick.

"Partly that," replied Smithy, "and also because everybody's broke! It's true that Christmas represents a good fillip to the trade these days, but the overall scene wasn't so funny before the war when the demand for radio sets was even more seasonal than it is now for radio and t.v. In fact, business was spread out over the year so badly that some factories used to give their entire labour force the sack on Christmas Eve, taking them on again three or four months later."

Dick was silent for a moment.

"Well, let's hope those days don't come back again," he remarked eventually.

"Let's hope so, indeed," agreed Smithy. "Perhaps we're fortunate in having television nowadays to even things out a little."

Morning Alarm

"To change the conversation to a more cheerful note," commented Dick, "I wonder if you could give me a little quick advice. I've promised one of my relatives as a sort of Christmas present that I would fix up a little time switch which would turn on his bedroom radio in the morning. I rather wish I hadn't now, because it looks as though it's going to cost me a little more money than I had originally intended. At least it will if I'm going to make a really pukka job of it."

"Not to worry," grinned Smithy, "there's a simple little device which I've been using myself for quite a long time and which only cost me a few shillings to knock up. All you need is a relay with two sets of 'make' contacts—that is to say, sets of contacts which close when the relay coil is energised—a toggle switch and a battery. You then connect these up into a circuit like this (Fig. 1). The two terminal points which I've marked 'To Remote Contacts' connect to a pair of contacts on a clock. To take advantage of the gadget all you have to do is to tune the receiver to the station you want before you get into bed and leave it switched on. You put the switch on the relay unit to the 'Alarm' position, whereupon its contacts open-circuit the mains supply, and the set becomes silent. At the appointed hour in the morning the contacts in the clock short-circuit, thereby energising the relay. This operates and its 'B' contacts complete the mains supply to the receiver, whilst its 'A' contacts short-circuit those in the clock. The relay in consequence becomes 'held on' by its own contacts and remains energised, regardless of whether the clock contacts remain closed or not. The receiver is now switched on and commences to play. At any later time which happens to be convenient, the toggle switch on the relay unit is returned to the 'Reset' position, with the result that the relay becomes de-energised. The mains supply to the receiver remains connected, however, it being completed this time through the toggle switch contacts."

"That sounds simple enough," remarked Dick, "and I presume that the only time the energising battery has to supply any current is during the time between the closing of the remote contact and the resetting of the switch."

"That's right," agreed Smithy. "Normally, you should get quite a long life from the energising battery as it is only required for short periods. However, what is to my mind the greatest advantage of the gadget is that you only require a momentary short-circuit across the remote contact terminals for the relay to switch on and stay on; so that there is no need to worry if the remote short-circuit is a little intermittent, as might occur if home-made clock contacts were used. Incidentally, the relay contacts employed for switching the mains circuit do not have to be very heavy as they only switch the radio *on*. They never have to switch the radio *off*, which is when sparking would be at its worst."

"What about the contacts at the clock?"

"Well, that's where your ingenuity comes in," remarked Smithy. "It shouldn't be beyond the limits of an amateur handyman to fix a couple of contacts to a clock which close at a certain time, even if these contacts consist of something as simple as a piece of wire which is touched by the hour hand as it travels round. With alarm clocks there is usually a movement in a pawl when the alarm goes off, and this pawl could possibly actuate a pair of contacts."

"Fair enough," commented Dick. "It seems to be a neat gadget, and I'll get started on one this very evening."

"Before concluding," added Smithy, "I should mention that there is one important point you should bear in mind. This is that one of the relay contact sets carries mains voltage, whereupon you want to make certain that its insulation to the relay yoke is reliable. You don't want mains voltages appearing at the remote contacts. If one side of the remote contact circuit is made up via the clock chassis itself, this should be connected to a reliable earth."

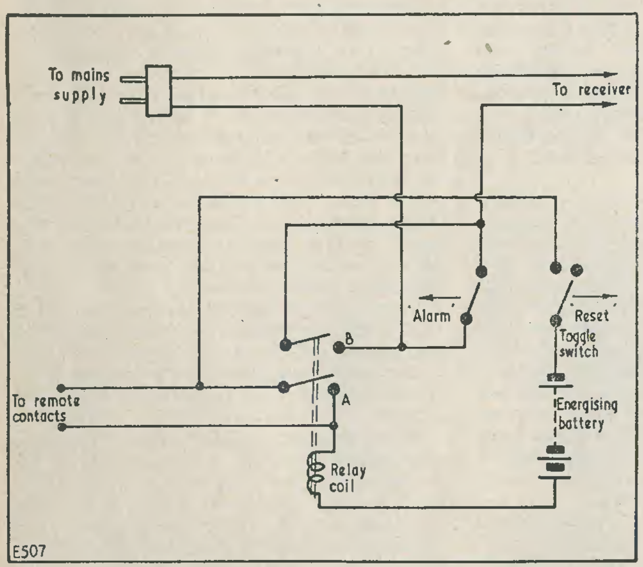


Fig. 1. The simple alarm circuit described by Smithy. The relay is shown in the de-energised position

Plastics

Smithy put his emptied tea-cup back on the bench and he and Dick returned to their work. After a while Dick walked over to the cupboard and extracted a sheet of polythene, from which he cut a small section. Smithy, who had been watching him out of the corner of his eye, cleared his throat preparatory to issuing a statement.

"By the way," he remarked, "I hope you're being a little careful as to how you use that polythene."

"Why's that?" said Dick, a little startled.

"I seem to remember some time ago that you said that polythene was ideal stuff for adding extra e.h.t. insulation."

"I did," admitted Smithy, "but I didn't infer that it should be used indiscriminately. Very often you have to use your judgment as to whether a component should be replaced or whether the judicious use of extra insulation can clear the fault it has developed. When I mentioned the subject last time I pointed out also that polythene was inflammable. As a matter of fact, polythene can actually be set on fire by a strong e.h.t. arc, so you should keep an eye open for risks of that sort."

"O.K.," remarked Dick. "All I wanted to use it for here was in the deflection yoke. There is an occasional spark between the line coils and the core, and it appears as though the original insulation has been damaged at some time in its life."

"Well, that should be all right," said Smithy. "Provided that they're fairly low impedance coils any pulse voltages appearing across them should be reasonably low."

"I don't know whether you've noticed it as much as I have, Smithy," commented Dick, turning round from his bench, "but we seem to be entering the Plastics Age with a real vengeance these days. I suppose I would be correct if I said that polythene and p.v.c. represent the main plastics which have affected domestic radio and television."

"Well, that's not entirely true, because polythene and p.v.c. are fairly recent entries into the plastic field," replied Smithy. "They were preceded by quite a few other types of plastic. What was probably the first important plastic to appear did so in the latter half of the nineteenth century, and this consisted of celluloid, or xylonite. This was followed, round about the First World War, by phenol formaldehyde, which you know under the very familiar name of Bakelite. Phenol formaldehyde plastics have been in constant use in the electrical and electronic world ever since their introduction. Another type of material very common in the radio trade, and which could not be made in its present form without plastics, is what is called synthetic resin bonded paper, or s.r.b.p. This followed shortly after the inception of phenol formaldehyde, and you are probably more familiar with it under the name Paxolin. S.r.b.p. consists of layers of paper bonded together into a homogeneous whole by means of a plastic material such as the phenol formaldehyde I have just mentioned, the result being a hard insulating sheet which can be cut to shape, stamped out, and drilled or pierced as desired. By the way, don't be put off by that word 'synthetic.' It merely means that the resin which bonds the paper together is made by a factory process instead of being found naturally, as is shellac.

"Phenol formaldehyde is a thermosetting plastic. That is to say, it is moulded into its final form by the application of heat, this causing a change—known as 'curing'—in the chemical make-up of the material, which then becomes set into the shape you want it to take up. A fully cured thermosetting plastic cannot be remoulded into a new shape by later application of heat. There are other important thermosetting plastics which are used in industry, but these don't come to the attention of the radio or television engineer very frequently. On the other hand there are quite a number of *thermoplastic* materials which enter our work these days. Thermoplastic materials can be moulded into new shapes by successive applications of heat instead of being fixed in shape after their initial curing, as are the thermosetting plastics. I would say that the major thermoplastic materials we meet in radio are polythene, p.v.c., polystyrene and nylon.

"We have just been discussing polythene and I don't think I need to add that it is readily distinguishable by its slight softness and slight waxy feeling. In its natural colour polythene has a 'milky' transparency, and this 'milkiness' is usually apparent even in the coloured versions you see these days. For electronic applications polythene has an exceptionally high dielectric strength, this being of the order of 1kV per thousandth of an inch."

"Isn't polythene sometimes given different names?" asked Dick.

"The most frequent alternatives you will meet are polyethylene and Alkathene," replied Smithy, "and it is becoming so plentiful now that it is being used more for non-radio than for radio purposes. Our old friend p.v.c.—or, for the record, polyvinyl chloride—is also very prolific outside of radio in such applications as plastic mackintoshes and so on. By adding suitable fillers or plasticisers to p.v.c. it can be made very hard, or very soft, as desired. Plasticisers, incidentally, are compounds which make the material more flexible and rubbery.

"Polystyrene is a hard, rather brittle, material which goes plastic at a fairly low temperature. It is very transparent and gives a characteristic 'ringing' noise if you tap it. It's an excellent material for coil formers due to its ease of moulding and low losses. The other plastic I mentioned, nylon, is becoming used more and more in radio gear. In the 'solid' form as opposed to the thread, nylon is a tough and hard plastic, and has a white appearance. You will probably be finding nylon coil formers in some of the more modern receivers."

"Well, that's quite an interesting bit of information," commented Dick. "I'm afraid I've rather fallen into the habit of looking upon these materials just as 'plastics' only. I suppose that, if I'm going in for electronics as a career, I should begin to take a keener interest in the various types."

"I would certainly recommend you to do so," agreed Smithy. "Plastic materials are being used so much these days in radio and t.v. that a little basic knowledge on their characteristics and make-up is invaluable. Incidentally, you don't need anything more than the chemistry they teach you at school to get a good insight into the *use* of plastics."

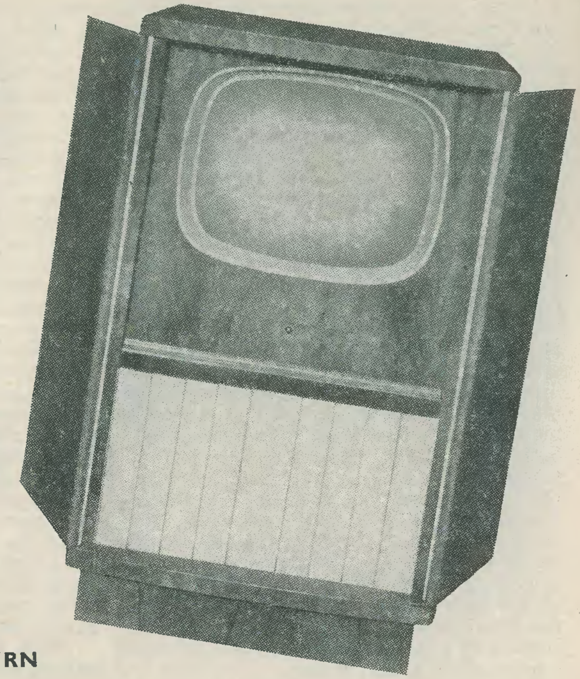
"That's all very well," protested Dick, "but whilst I'm prepared to gen up on plastics, I don't want to saddle myself with a lot of textbooks which go too deeply into the subject."

"I can sympathise with you there," admitted Smithy. "However, there is one book I would recommend to you that costs only a few shillings.* This is called 'Plastics in the Service of Man,' and it gives you an excellent insight into the manufacture and use of the plastics employed today. I'll give you a copy for Christmas!"

"Thanks very much, Smithy," said Dick. "Now I can begin to see why there is a Christmas rush in the publishing trade as well as in radio and t.v.!"

* *Plastics in the Service of Man* by V. E. Yarsley and E. G. Couzens, Pelican Books.

The MAYFAIR Turret Tuned Band 1-Band 3 Home Constructor TELEVISOR



PART 4

by **S. WELBURN**

In this, the last article in the series describing the construction of the Mayfair televisor, S. Welburn deals with the final steps in assembly, together with the procedure for setting up the complete receiver

In the first three contributions to this series we discussed the construction of the various sub-chassis which make up the "Mayfair" televisor. In this final article, the assembly of the sub-chassis to form the complete receiver is described.

General Assembly

The complete Mayfair chassis is provided by fixing together the various sub-assemblies in the manner illustrated in Fig. 13. This diagram shows the positions of the units when viewed from below. It will be found that holes in the sides of each sub-chassis correspond with holes in adjacent sub-chassis, whereupon assembly may be carried out by passing 4BA nuts and screws through these holes. Fig. 13 also shows the flat strap which joins the power unit and time-base sections. This strap should be secured with 4BA nuts and screws, and it serves to strengthen the composite assembly. Finally, the rear assembly bracket is fitted, also with 4BA nuts and screws, to the rear of the vision i.f. sub-chassis, the sound i.f. sub-chassis, and the power unit. The composite assembly now becomes rigid and capable of being handled without undesirable bowing.

It next becomes necessary to fit the inter-connecting wiring between the sub-chassis. First of all connect the free end of C_1 (Fig. 9) to tag 2 of tag-strip H (Fig. 6), the inter-connecting lead passing through grommet G1 of Fig. 9. Through this same grommet pass the lead which is connected to tag 1 of tag-strip D (Fig. 6), and connect this to tag 3 of the contrast control R_{34} (Fig. 9). Connect together tags 1 and 2 of the contrast control R_{34} and earth these to tag 3 of tag-strip A (Fig. 9). Connect tag 2 of strip F (Fig. 6) to tag 2 of strip B (Fig. 9), passing this lead also through grommet G1 (Fig. 9). Join tag 2 of strip B (Fig. 9) to tag 1 of condenser C_2 (Fig. 2), running the lead through the large hole between the timebase and power unit sections. Connect pin 7 of valveholder S (Fig. 6) to tag 2 of strip A (Fig. 12). Connect pin 1 of valveholder W (Fig. 6) to pin 7 of valveholder Z (Fig. 12) and continue this lead to pin 7 of valveholder X (Fig. 2), the lead passing through the large hole between the sound i.f. and power unit sub-chassis. Using the same hole, connect tag 2 of strip D (Fig. 12) to tag 1 of strip B (Fig. 2); also connect tag 4 of strip D (Fig. 12) to pin 4 of valveholder X (Fig. 2).

The leads fitted for the following four connections pass through the large hole between the timebase sub-chassis and the power unit sub-chassis. Connect pin 7 of valveholder Z (Fig. 9) to the thick yellow lead (Fig. 2) which is bent back over the mains transformer to form an anchoring point. Connect pin 5 of valveholder Y (Fig. 9) to tag 1 of strip A (Fig. 2). Connect tag 2 of strip H (Fig. 9) to tag 4 of strip H (Fig. 2). Connect pin 4 of valveholder W (Fig. 9) to tag 3 of strip H (Fig. 2).

The two leads from tag-strip F to the on/off switch run through the ventilation hole under the smoothing choke on the power-pack sub-chassis, and across the top surface of the composite chassis.

When the sound i.f. strip was assembled, two screened leads were passed through an 8-in length of 5mm. sleeving for later connection to the volume control R_{16}. Of these two leads, identify that connected to the grid of the 6Q7 (V_4 in Fig. 11) and, referring to Fig. 5, connect its inner conductor to tag 2 of the volume control. Connect the inner conductor of the other screened lead to tag 3 of the volume control. Connect the outer braiding of both screened leads to tag 1 of the volume control, and bond this tag to the metal case of the control.

Fig. 14 illustrates the scan coil assembly, to which the following connections are made. The resistors and condensers which will be referred to were shown in the timebase circuit,

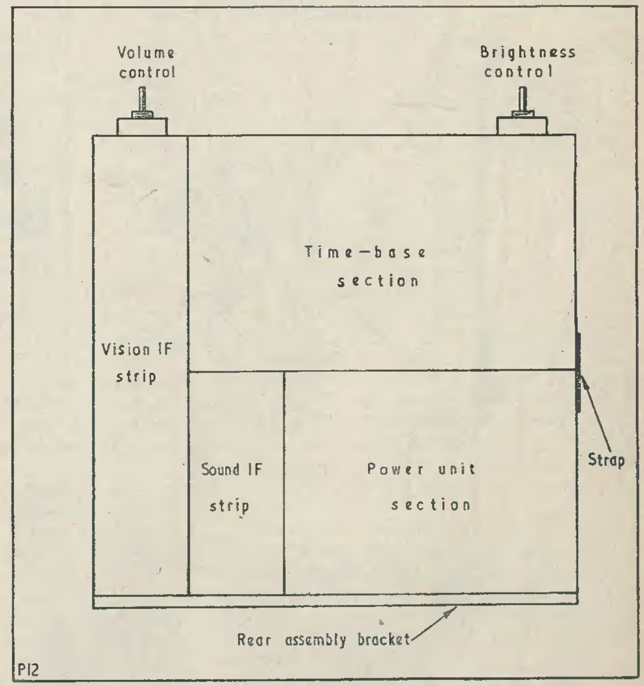


Fig. 13. How the various sub-chassis of the Mayfair *fit together*

Observing the layout shown in Fig. 2, connect one conductor of the mains lead to tag 1 of strip F, and the other conductor to tag 4 of the mains voltage panel. Connect tag 1 of strip F to one contact of the volume control on/off switch, and tag 2 of strip F to the remaining contact. The two

Fig. 7, and were specified in the timebase parts list. Connect the 2.2kΩ ½ watt resistor, R_{39}, between tags 5 and 6 of the scan coil assembly. Connect the second 2.2kΩ ½ watt resistor, R_{40}, between tags 4 and 5 of the scan coil assembly. Connect one end of the 10kΩ 1 watt resistor, R_{37}, to tag 2 of the scan coil assembly; and one end of the second 10kΩ 1 watt resistor, R_{38}, to tag 3 of the scan coil assembly. Connect the 100pF condenser C_{21} between the free ends of R_{37} and R_{38}, ensuring adequate clearance from the other tags and components on the tag-strip.

Next come the leads connecting the scan coil assembly to the main chassis. The length of these leads depends upon the type of tube and mounting used, but their installation is described at this stage in order to maintain continuity and because it should be possible to judge the length required with reasonable accuracy. It must be pointed out, however, that it is unwise to have excessive lengths of wire between the chassis and the scan coils, and this point must be borne in mind when the set and the tube are finally assembled together.

grommet G3 (Figs. 8 and 9). Refer to Fig. 8 and identify the frame output transformer TR_3. Connect tag 4 of the scan coil assembly to the white tag, and tag 6 of the scan coil assembly to the red tag of this transformer.

The 1in by 5in phosphor-bronze strip specified in the timebase chassis parts list is next fitted to the metalwork of the scan coil assembly, a 4BA solder tag being fitted under the fixing terminal which secures it. The position taken up by the phosphor-bronze earthing strip is shown in the tube assembly diagram, Fig. 15. The function of the strip is that of making contact to the outer conducting surface of the c.r.t.

The Cathode Ray Tube

Connections to the cathode ray tube will vary slightly for different types, and it is

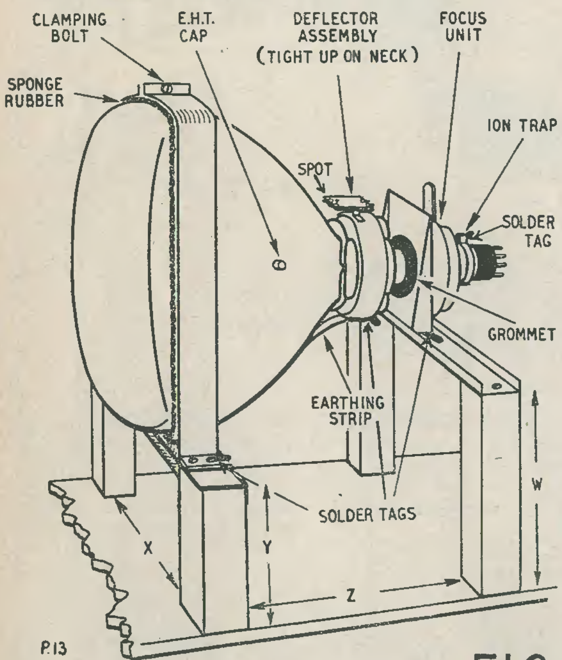
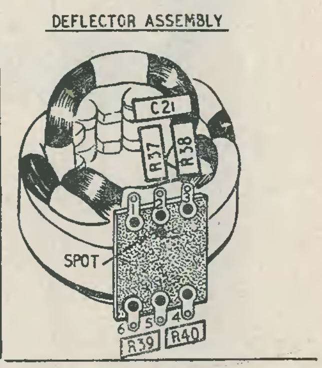


FIG.14



	17" TUBE	14" TUBE
W	9"	8"
X	15¼" MIN:	15¼" MIN:
Y	5½" MIN:	5½" MIN:
Z	9"	7½"

FIG.15

Fig. 14. Tag layout on the scan coil assembly, showing also the resistors and condenser which are connected to it. Fig. 15. The tube mounting assembly

Connect tag 3 of the scan coil assembly (Fig. 14) to pin 3 of valveholder Z (Fig. 9). Connect tag 1 of the scan coil assembly to tag 3 on the line linearity control (Fig. 9). The two leads just mentioned pass through

advisable for the constructor to check the appropriate literature before finally completing the wiring to the duodecal c.r.t. base. The instructions which follow apply to normally encountered tubes.

Pins 1 and 12 of the duodecal base should be the heater connections, and these are taken to the appropriate points in the power unit chassis. For 6.3-volt tubes connect pins 1 and 12 of the duodecal base to tags 2 and 4 of tag-strip A (Fig. 2). For 2-volt tubes connect pins 1 and 12 of the duodecal base to tags 3 and 4 of tag-strip A (Fig. 2). The heater leads should travel through grommet G3 of Fig. 8 and then through the large hole between the timebase and power unit sub-chassis. Pin 11 of the duodecal base should be cathode and is connected to the video output of the vision i.f. strip. The video output is supplied by the 24in lead previously connected to tag 3 of tag-strip L (Fig. 6), and it passes through the adjacent grommet G1. On Mullard MW.43 and similar tubes, pin 11 of the duodecal base should be joined to pin 7 (anode 2). Pin 7 should otherwise be left blank. Pin 2 of the duodecal base should be c.r.t. grid, whereupon this connects to tag 2 of tag-strip F (Fig. 9), the lead passing through grommet G3 (Fig. 8). Pin 10 of the c.r.t. base should be anode 1, whereupon this is connected to tag 2 of tag-strip J (Fig. 9), this lead also passing through grommet G3 (Fig. 8).

With the exception of the cathode lead, the wiring to the c.r.t. base may be grouped together, if desired. The cathode lead should be kept separate in order to maintain a low capacity to earth.

Mounting the Tube

Tube mounting details are given in Fig. 15. As different constructors may have varying ideas for housing the completed televisor, the dimensions given in this diagram are for minimum clearance. When the dimensions illustrated are employed, the complete chassis may be fitted on the shelf underneath the tube. The tube mounting assembly shown in Fig. 15 is that employed in the ready-made cabinets which are available for the *Mayfair* televisor.

The following important points should be observed with regard to the tube mounting. First of all, the focus unit should be spaced away from its mounting bracket by means of a single 2BA full-nut on each bolt. Solder tags should be fitted under assembly bolts on the front tube support, rear tube support and ion trap magnet (when the latter is required). These solder tags, and that connected to the metal work of the scan coil assembly, should then all be connected together by flexible P.V.C.-covered wire, a final chassis connection being made to tag 2 of tag-strip E of the power unit chassis (Fig. 3).

The Turret Tuner

The turret tuner is the final assembly to be wired in. This is not mounted mechanically to the chassis but is connected into circuit via fly-leads.

The turrent tuner receives its power supplies by connecting into the power unit sub-chassis. It is necessary, therefore, to refer to Figs. 2 and 3. First, connect a 5kΩ 5 watt resistor between tag 2 of condenser C_1 and pin 7 of valveholder Y on the power unit sub-chassis. This resistor is supplied with the turret tuner as part of the final assembly parts list. It is not shown in Fig. 2. The five flexible P.V.C.-covered leads from the tuner are next connected, these all passing through grommet G1 (Fig. 2). Connect the red lead from the tuner to pin 7 of valveholder Y (Fig. 2). Join the yellow and pink leads together and connect these to the thick yellow lead bent back over the mains transformer (Fig. 2). Connect the black lead to earthing tag T2 (Fig. 2). Connect the blue lead to tag 4 of tag-strip A on the *sound i.f.* sub-chassis (Fig. 12).

The two coaxial leads from the turret tuner are next connected. That protruding from the rear of the tuner is the output lead, and its inner conductor connects to tag 6 of the Input Coil (Fig. 6). The outer braiding of this lead connects to chassis via tag 3 of strip B (Fig. 6). The coaxial lead from the top of the turret tuner is the aerial input lead. Connect its inner conductor to the centre tag of the aerial input socket and its outer braiding to earthing tag T3 (Fig. 6).

A template is supplied with the turret tuner to enable it to be fitted to an undrilled cabinet. In order to mount the turret, the fixing and spindle holes should first of all be drilled, using the template to position hole centres accurately. The tuner is next fitted to the fixing holes with the aid of the self-tapping screws provided. Its valves should project vertically upwards. The indicating plate is next mounted by means of wood screws, care being taken to see that the correct channel indication appears at the top and to ensure that the wood screw centres correspond with the positions given on the template.

Although it is advisable to prepare the mounting holes for the turret tuner before finalising the televisor, it must be borne in mind that, should it become necessary to adjust the oscillator setting at any particular channel, this may only be done with the tuner unmounted.

Setting up the Televisor

After the televisor has been completed, it may be connected to the mains supply and switched on. It will prove helpful to connect an aerial to the receiver at this stage and to set the turret to a live channel. Allow one minute or more for the valves to warm up. The last valve to warm up will be the EY51 e.h.t. rectifier mounted on the line output transformer, and it should be possible to see a heater glow in this valve when the warming up period is complete. The brightness control should then be turned up until a raster is just visible. If the c.r.t. employed requires an ion trap magnet, this will have to be adjusted as specified in the tube manufacturer's literature before a raster will appear. Normally, the ion trap magnet is marked with an arrow, whereupon it should be positioned such that this points towards the screen and is directly above the line marked on the neck of the tube (usually in line, approximately, with pin No. 3). The ion trap magnet should be fitted on the glass of the tube neck, just slightly forward of the base. The setting of the ion trap magnet is fairly critical, and it is adjusted at this stage for maximum brilliance, reducing the brightness control as necessary.

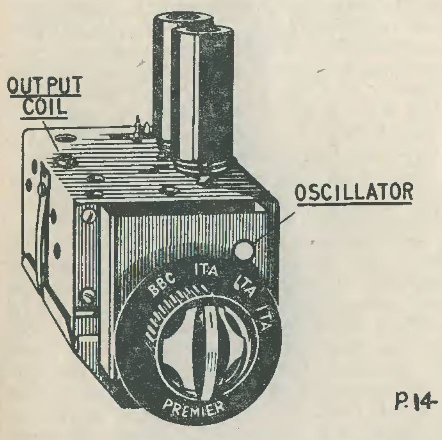


Fig. 16. The turret tuner, illustrating the positions of the output coil and the hole through which the oscillator core is adjusted

By adjustment of the contrast controls and the turret fine tuner, it should now be possible to obtain a signal, whereupon the line and frame hold controls may be adjusted to give a locked picture. The ion trap magnet is then finally set up in conjunction with the picture centring and focus controls (both on the focus assembly). A final slight resetting of the ion trap magnet might be necessary after these last two controls have been adjusted, as there may be a small amount of interdependence between them. It is permissible to use the ion trap magnet to assist in centring provided that this causes *no* decrease in brilliance. Similarly, the ion trap magnet should *not* be used to remove corner shadow if any decrease in brilliance is caused thereby. Any corner shadow which occurs may be cleared by altering the position of the scan coil assembly, which should be well up the neck of the tube.

As all the i.f. coils are pre-set, no adjustments should be necessary here. There will, of course, be slight variations from receiver to receiver due to differing wiring capacities, but these should cause negligible diminution in picture quality. If desired, a *small* adjustment to the sound i.f. coils may be made by primarily setting the fine tuner of the turret for optimum volume, and then adjusting the sound i.f. coils for maximum sound output. The above adjustment should be carried out on weak signal inputs only, in order to prevent the sound a.g.c. circuit from masking the results obtained during alignment. (The necessary weak signal may be obtained by adjustment of the vision contrast control with, if necessary, the temporary use of an inefficient aerial.) The correct fine tuning position of the turret is that which corresponds to maximum sound. If sound-on-vision occurs at this tuning point, the Sound Rejector Coil on the vision i.f. strip should be carefully adjusted to obviate this effect. Apart from the Input Coil on the vision i.f. strip, which is dealt with below, the vision i.f. coils are best left alone, any adjustments which are made being of the order of a half to a complete turn only on any single core.

If it is found that the channels required tend to lie outside the fine tuner range of the turret, the oscillator of the latter may be carefully adjusted with the aid of a trimming tool made of insulating material. (A plastic knitting needle with one end filed to the shape of a screwdriver blade can be used here.) The turret should be set to the channel which requires adjustment, the fine tuner set to the centre of its travel, and the oscillator adjusted for maximum volume through the hole depicted in Fig. 16. Adjustment of the turret oscillator should only be needed in occasional instances.

It may also prove helpful to adjust the output coil of the turret (see Fig. 16) in conjunction with the Input Coil of the vision i.f. strip when the receiver has been almost completely finalised. The adjustments should be made whilst receiving Test Card C, the requirement to aim for being a picture of good definition. This may not, incidentally, correspond to maximum picture brightness.

Instructions for alignment with a signal generator are given later in this article.

Insofar as the various panel controls are concerned, the functions of these are largely self-explanatory. It is worth noting, however, the effects given by the two linearity controls. The line linearity control adjusts, mainly, the left-hand side of the picture; and it enables this to match the right-hand side. Adjustments of line linearity may necessitate slight compensatory re-settings in line width. The frame linearity control provides a control over both the top and bottom of the picture, and may, in its turn, necessitate a slight re-setting of the height control.

TABLE I *Voltage and Current Readings*

Circuit	*Valve*	*Anode Volts*	*Anode Current*	*Screen Volts*	*Screen Current*	*Cathode Volts*	*Comments*
Sound i.f. Strip ..	V_1	180		180		1	
	V_2	190		190		2	
	V_4	150				1.75	
	V_1 (Fig. 1)	230	35mA	240	4mA	13	Power Unit
Vision i.f. Strip ..	V_3	200		200		1.75	Maximum Gain
	V_3	240		240		5	Minimum Gain
	V_4	240		240		2.2	
	V_6	80		240		9.5	Average Signal
	V_6	150		240		6.5	No Signal
Timebase Section	V_1	240		240			
	V_2	240		60		12	Pentode Section
	V_2	220		40 (Pin 2)			Triode Section
	V_3	250	22mA	270	3mA	25	
	V_4	100		200 (G_2/G_3) 30 (G_1)			
	V_5			120			Total Current 100/120mA
C.R.T. Final Anode: 12/14kV							
C.R.T. First Anode: 350/400 V							

Before concluding at this stage it should be pointed out that, if it becomes apparent that an increase in height is necessary, this may be accomplished by connecting an additional 0.1μF condenser across C_{20} (see Fig. 7) of the timebase chassis. Also, if it is found that a slight opening out occurs at the top of the picture, this may be cleared by connecting an additional 150kΩ resistor across R_{41} (Fig. 7) of the timebase section. Either of these modifications should be necessary only in isolated instances. A final point which requires emphasis is that, since the *Mayfair* televisor has a high degree of sensitivity, it may become overloaded in areas of strong signal strength. In such cases an attenuator should be inserted in the aerial lead.

Voltage and Current Readings

Voltage and current readings are given in the tables accompanying this article. It must be pointed out that these figures are for guidance only and that individual televisors may give readings varying by quite an appreciable amount from those quoted. Apart from e.h.t. voltages, the readings in the table were taken with an Avo Model 7. The e.h.t. readings were taken with an electrostatic voltmeter.

Signal Generator Alignment

Although, as was mentioned above, the vision and sound i.f. coils are supplied pre-aligned, it is possible that some constructors may wish to finally check the i.f. response with the aid of a signal generator. Alternatively, if the i.f. cores have been carelessly mis-adjusted, it may be necessary to bring these back into their correct positions. The details which follow give instructions for the alignment of the i.f. cores with the aid of a signal generator, and should only be required to cover the two instances just quoted. There should normally be no necessity at all for a signal generator during the setting-up of the *Mayfair*. It is important to note that the instrument employed must have accurate frequency calibration.

When the signal generator is used, the vision i.f. strip should be aligned first. An unmodulated output from the signal generator is required for this process, and the best method of reading the output given by the strip consists of connecting a voltmeter across

TABLE II
Power Unit Readings

Unsmoothed H.T.		340 volts
Smoothed H.T.		300 volts
HT+1	240V	70mA (average signal)
HT+2	240V	55mA
HT+3	180V	100/120mA
HT+4	270V	28mA

the diode load resistor R_{16}, or across the video anode load R_{18} (see Fig. 4). When the meter is connected across R_{16}, peak indications will be given by positive readings (chassis negative), and it is desirable, although not essential, to use a high resistance meter, such as an Avo model 8, or a valve voltmeter. Also, the positive lead of the meter should be decoupled by inserting in series a resistor of some 20kΩ or so, this resistor being positioned close to R_{16}. If the meter is connected across R_{18}, the voltage reading will increase as the output from the strip increases. Again a high resistance meter is desirable, although not essential; and it is advisable to decouple the meter lead connected to the junction of R_{18} and choke B with a resistor of approximately 20kΩ. In the absence of a meter it is possible to obtain a fairly approximate indication, during alignment, of the output amplitude from the vision strip by reason of the fact that a blank raster will brighten as output increases; but the results given here are not so positive as meter readings. The signal generator should always be attenuated such that an output indication which is just comfortably identifiable is given by the strip.

The vision strip is primarily prepared for alignment by disconnecting the junction of C_{13} and tag 1 of the Sound Rejector Coil. See Figs. 4 and 6. Connect the output of the signal generator between pin 7 (grid) of V_4 and chassis, and set it to give an unmodulated output at 17.5 Mc/s. Temporarily connect a 20pF condenser across the secondary of the Diode Coil, and align the primary (bottom core) for maximum output. Next, transfer the 20pF condenser to the primary of the Diode Coil and similarly trim the secondary (top core) for maximum output. Remove the 20pF condenser.

Re-connect the signal generator (still set to 17.5 Mc/s) to pin 7 (grid) of V_3 and chassis. Connect the 20pF condenser across the secondary of the 2nd I.F. Coil, and trim the primary (bottom core) for maximum output. Transfer the 20pF condenser to the primary and similarly align the secondary (top core)

TABLE III
Mains Transformer (voltage and current)

Primary input: 200–250 volts 50 c/s
H.T. Secondary: Voltage—300 (orange) 0 (black), 300 (orange)
Current: 300mA max.
L.T.1 Secondary: Yellow—6.3 volts 6.5 amps.
L.T.2 Secondary: Red/Yellow—21.5 volts, 0.3 amps.
L.T.3 Secondary: Green—5 volts 4 amps
L.T.4 Secondary (Black Common) Black/Yellow—2 volts 1 amp; Yellow —6.3 volts 0.3 amp.

FINAL ASSEMBLY Parts List

1 Turret tuner (*Mayfair* type) complete with valves, fixing bracket, and all leads. (A 5kΩ 5-watt resistor is also supplied with the turret tuner.) (Premier Radio)
1 Bracket, Control Mounting (for volume control) (Premier Radio).
2 Control knobs. (Width and Line Linearity.) (Premier Radio)
1 Strap (Timebase Chassis to Power Unit) (Premier Radio).
1 Rear Assembly Bracket (Premier Radio).
1 Giant Grommet (Premier Radio).
1 Insulated Anode Cap, for c.r.t.
1 Valveholder, duodecal.
1 Focus Unit. (State type of tube when ordering) (Premier Radio).
1 Focus Unit Bracket (Premier Radio)
1 Tube Support Bracket, Front (Premier Radio).
1 Tube Support Bracket, Rear (Premier Radio).
2 Tube Fixing Straps. (State type of tube when ordering.) (Premier Radio).
1 5in Rubber Strip (Premier Radio).
1 Loudspeaker.
Nuts, screws, washers, solder tags, etc.
Cabinets are available for the *Mayfair* televisor.

for maximum output. Remove the 20pF condenser.

The same procedure is followed with the 1st I.F. Coil. Re-connect the signal generator (at 17.5 Mc/s) to pin 2 (grid) of V_2 and chassis. Connect the 20pF condenser across the secondary of the 1st I.F. Coil and align the primary (bottom core); then transfer the 20pF condenser to the primary and align the secondary (top core) for maximum output. Remove the 20pF condenser.

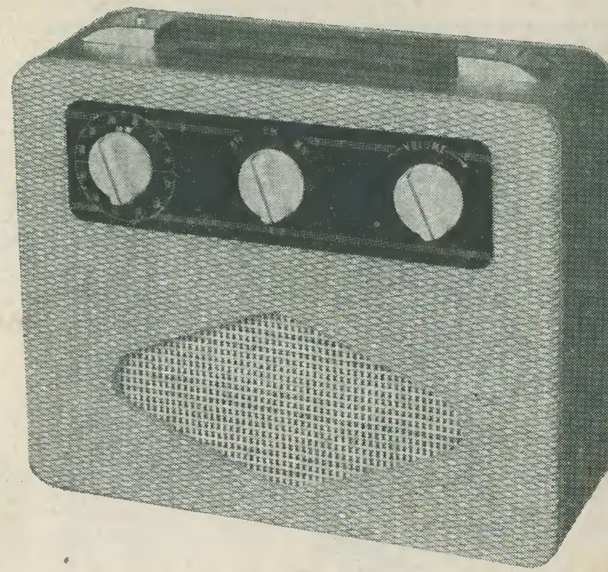
Finally, re-connect condenser C_{13} to tag 1 of the Sound Rejector Coil, and adjust the signal generator to 19.5 Mc/s. Align the Sound Rejector Coil carefully for *minimum* output from the vision i.f. strip, reducing signal generator attenuation as necessary to ensure that the rejection dip occurs accurately at sound i.f.

In the above procedure, the purpose of the temporary 20pF condenser is merely that of detuning one coil of a band-pass pair whilst the other is brought to resonance at the correct frequency.

With the signal generator still connected to pin 2 of V_2, and still set to 19.5 Mc/s, the sound i.f. strip may next be aligned. In this case the output of the signal generator should be modulated, whereupon the sound i.f. cores are adjusted for maximum volume from the speaker. The signal generator should be attenuated such that its modulation is just audible in order to prevent the a.g.c. line from masking the results obtained.

The Contessa

6-Transistor Portable Superhet



In this article, wiring details of the Contessa *transistor superhet are brought to a conclusion. Also given is full information on setting up and aligning the completed receiver.*

Part 2

by D. PETERS

IN LAST MONTH'S ISSUE, THE *Contessa* portable superhet was introduced to readers of this magazine. The circuit design was discussed in full, and step-by-step wiring instructions were given, these carrying the process of construction almost to completion. In commencing this month's article we carry on with the process of wiring.

Final Wiring Steps

Fig. 9 shows the next process which has to be carried out in the wiring of the *Contessa*, and it illustrates the manner in which the two trimmers TC_1 and TC_4 are fitted to the chassis. The moving vane terminals of these two trimmers (i.e. the central lead-outs) are soldered to a piece of short heavy-gauge wire, which then passes through the chassis, connecting to earth tag 7 (Fig. 2). The fixed vane tags of the trimmers are connected to the adjacent fixed vane tags on the two sections of the tuning condenser. The soldered connections between the trimmers and the tuning condenser tags are just visible, behind the trimmers, in Fig. 9. Also fitted at this stage is C_3, this condenser being located under the chassis and connecting between tag 1 of $L_{3(a)}$–$L_{3(b)}$ and the fixed vanes of $VC_{1(b)}$.

The next component to connect up is the volume control R_{12}, and the wiring required here is illustrated in Fig. 10. Reference should also be made to Fig. 8, wherein three chassis holes were designated with the letters "X," "Y" and "Z." These three holes allow the passage of leads employed in the volume control circuit, and they are referred to in Fig. 10. It will be noted that one of the wires soldered to the volume control connects to the resistor R_5. In the wiring stage illustrated in Fig. 7, one lead of R_5 was left unconnected. To complete the wiring now required, a length of tinned copper wire should be soldered to the free lead of R_5, this being passed through the chassis to the appropriate volume control tag. This lead, including the joint at R_5, should be covered with sleeving.

Fig. 11 illustrates the connections to the wave-change—on/off switch, and shows also the manner in which trimmers TC_2 and TC_3 are soldered to earth bus-bar "B." When making connections to TC_2 and TC_3 it is important to ensure that all the leaves which make up the tags are reliably soldered. Two leads pass through the chassis in Fig. 11, one being the positive (red) battery lead and the other the lead travelling to tag 1 of $L_{3(a)}$–$L_{3(b)}$. Both these leads pass through the large hole which is located at the front of the chassis between the wave-change switch and the tuning condenser. After passing through this hole the lead to tag 1 of $L_{3(a)}$–$L_{3(b)}$ should run parallel to the front edge of the chassis, turning at right angles close to tag 8 (Fig. 2) before travelling to the coil tag to which it connects. The red battery lead from the switch joins a black (or blue) lead soldered to the h.t. negative bus-bar to form a twisted pair terminating in the battery plug. Care should be taken to ensure that the red lead connects to the thick pin. The three tags designated "P," "Q" and "R" in Fig. 11 are connected up in the next stage in the wiring.

This next stage involves primarily the fitting of the long wave loading coil, L_2. The tags of this coil are soldered directly to the two switch tags marked "P" and "Q" in Fig. 11. The coil then becomes self-supporting and projects directly backwards from the switch, bearing slightly against the can of IFT_3. Its position is readily apparent in the photograph showing the top of the chassis.

The position of the final component to be mounted—the ferrite frame—is also shown clearly in the photograph of the top of the

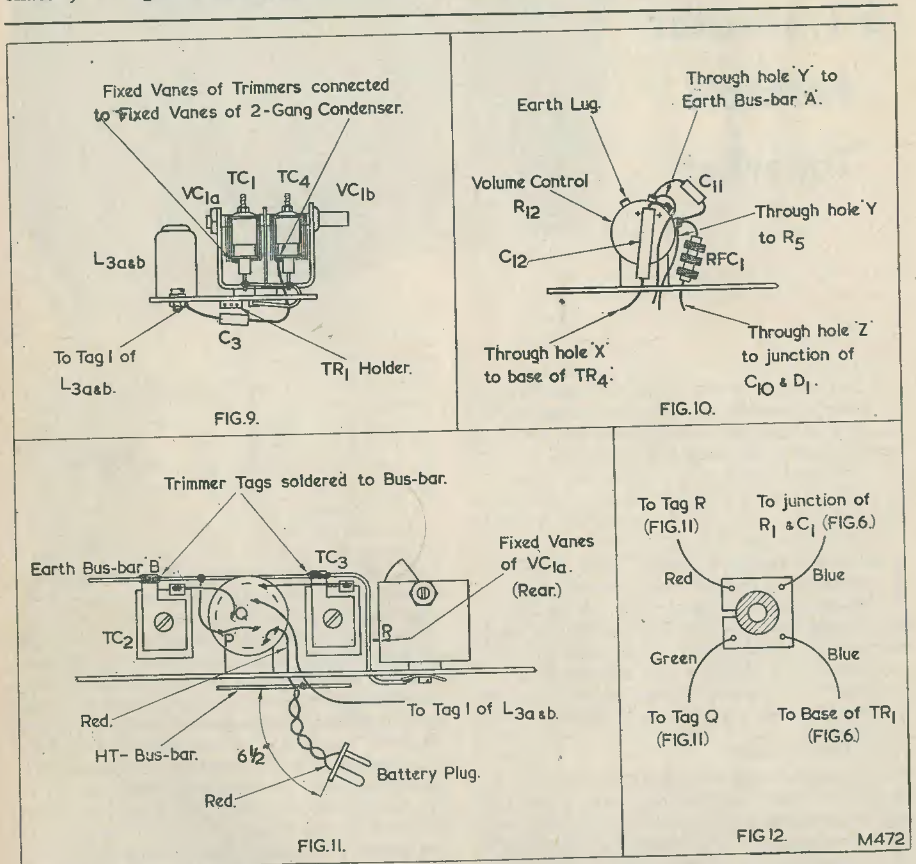


Fig. 9. Illustrating the method of mounting trimmers TC_1 and TC_4. Fig. 10. Wiring up the components in the volume control circuit. Fig. 11. Connecting up the wavechange—on/off switch. Fig. 12. The lead-out wires from the ferrite frame connect to the circuit points designated here. In this view the coil is behind the tag-ring

chassis. It should be fitted such that the slot in its tag-ring is towards the rear of the chassis. Fig. 12 gives a view of the ferrite frame tag-ring and indicates the circuit ponts to which the wires from its tags connect. The leads from the ferrite frame should, of course, be shortened as necessary before being finally connected. The two blue leads from the tag-ring pass through the small chassis hole adjacent to that through which earth bus-bar B passes, whereupon they then travel directly to the circuit points depicted in Fig. 12. It is advisable to ensure that the two blue leads are connected as shown in Fig. 12, since reversal may result in inferior performance. Care should be taken whilst handling the ferrite frame, as its core is brittle and may break if carelessly handled. It is for this reason that this component is the last to be fitted.

The chassis proper is now complete, all that is finally necessary being to connect the speaker leads (fitted in Fig. 8) to the speaker itself. It is worth while mounting the speaker in its cabinet before testing the receiver, whereupon it becomes possible to earth its frame at the same time as it is connected to the chassis. The earth connection to the speaker frame is provided by fitting a solder tag under one of the mounting woodscrews at the tag-panel end, and connecting this to the same speaker tag as is employed by the earthy output lead.

The *Contessa* receiver is now ready for testing.

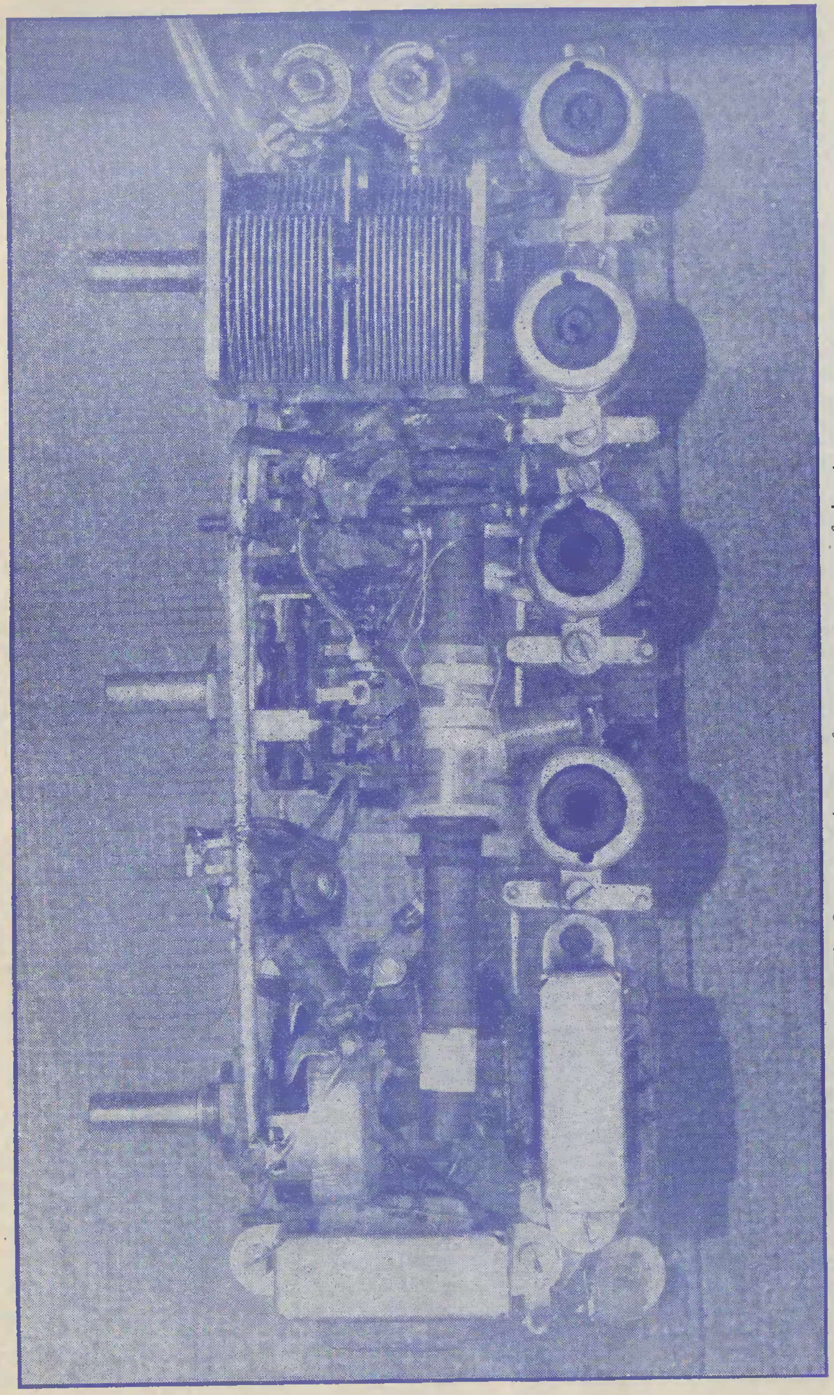
Testing the Receiver

If desired, a quick check for correctness of wiring may next be carried out, after which the transistors can be fitted to the appropriate sockets. Especial attention must be paid to ensure that the transistors are fitted correctly; i.e. emitter wire into emitter contact, base wire into base contact, and collector wire into collector contact. If inserted carefully the transistor lead-out wires will be firmly gripped by the contacts, with no risk of accidental disconnection later. After being fitted, the transistors should hang downwards from the underside of the chassis, adequate clearance being obtained from adjacent components. When the transistors have been inserted into their sockets the chassis needs to be handled carefully, and it is a good plan to provide props at either end whilst adjustments are being carried out. The battery plug may now be inserted into the 7.5-volt battery and the receiver switched on. If there is evidence of a.f. oscillation, resulting in the occurrence of a howl, the battery should be disconnected and the leads from the secondary of the output transformer reversed at the 2-way tag-strip. If there is no evidence of oscillation, a milliammeter should be inserted between the black lead from output transformer T_2 and the h.t. negative line, and the receiver switched on again. The combined collector current of TR_5 and TR_6 will now be indicated by the meter, and a reading of 4mA under no-signal conditions should be obtained. If the combined collector current is low, it is necessary to reduce the value of R_{16} until the required current is indicated, a simple method of doing this consisting of temporarily paralleling high value resistors (say 100kΩ to commence with) across R_{16}. The value of R_{16} must be decreased in *small* steps only. In most instances, however, it is probable that the required collector current will be obtained immediately after the receiver has been completed. With the circuit constants chosen it is doubtful if the collector current indicated will exceed 4mA but, should this occur, the value of R_{16} must be increased accordingly.

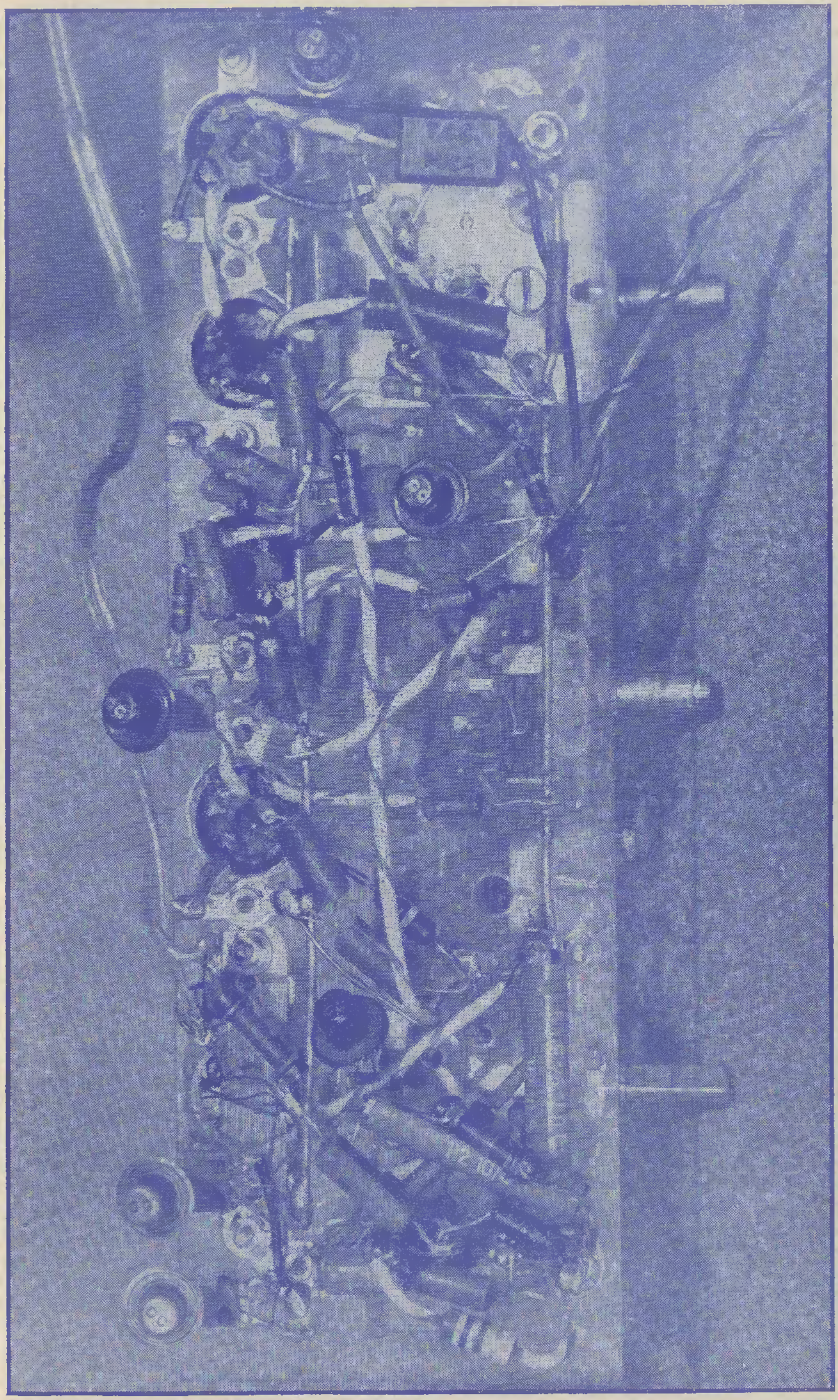
After R_{16} has been satisfactorily adjusted, the receiver can be checked and aligned. In the absence of a signal generator it is possible to carry out this process on received signals without any great difficulty.

The receiver should be switched to the medium waveband, the volume control set to the maximum position, and the tuning condenser carefully swung to see if any stations may be received. If, as is possible at this stage of alignment, no station is heard, stronger signals may be obtained by temporarily connecting a reasonably efficient aerial to the fixed vanes of $VC_{1(a)}$ via a condenser of 50 to 200pF. When a signal is picked up the tuning condenser should be adjusted for maximum volume, after which the i.f. coils should be carefully aligned. As alignment proceeds signal strength must be reduced as necessary, either by rotating the receiver when pick-up is made directly via the ferrite frame, or by disconnecting or loosening the coupling from the temporary aerial if the latter is used. When the i.f. transformers are finally aligned, tuning should be sharp, exhibiting good selectivity.

It next becomes necessary to set up the core of the oscillator coil, $L_{3(a)}$–$L_{3(b)}$, and the trimmer TC_4. The oscillator circuit is set up by tuning in a known station at the high frequency end of the medium waveband (tuning condenser vanes unmeshed) and adjusting TC_4 until the tuning condenser takes up what is judged to be its correct setting for this wavelength. A known station at the low frequency end of the band (tuning condenser vanes meshed) should then be selected and the core of $L_{3(a)}$–$L_{3(b)}$ adjusted to give a similarly correct tuning condenser setting. The process should be repeated once more at the high and low frequency ends of the band with the same two stations (the settings of TC_4 and the oscillator coil core are slightly interdependent), after which the medium-

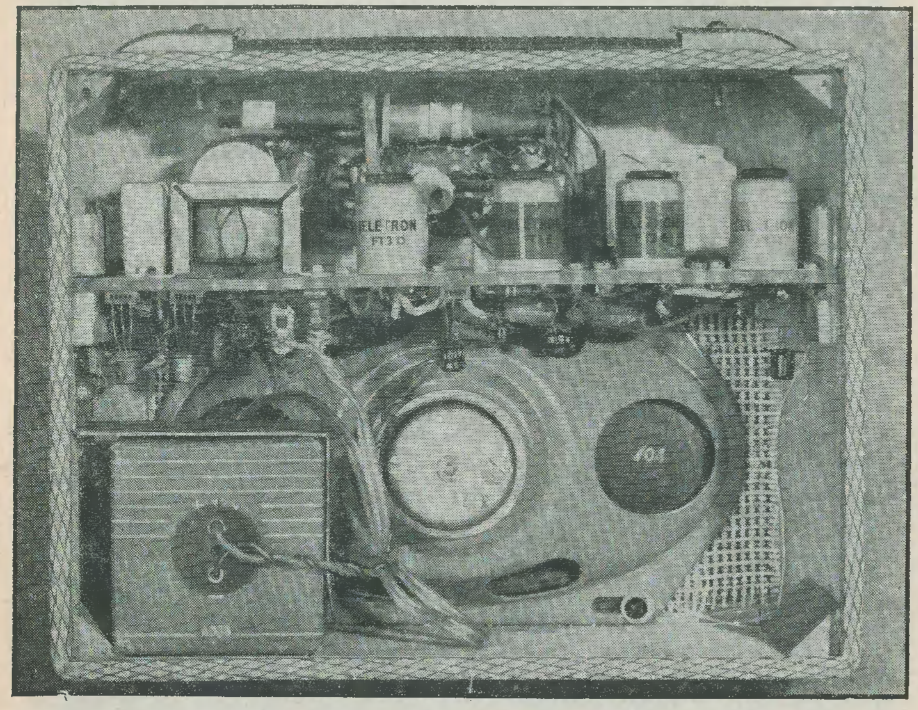


The Contessa—layout of components on top of chassis



The Contessa *chassis seen from below* wave oscillator circuit may be left alone. It is permissible, incidentally, to connect a temporary aerial to the receiver and work with strong signals whilst setting up the oscillator circuit, as the process is one of ensuring correct *frequency* coverage.

frequency can be carried out by means of experimental adjustments to TC_1. For instance, if after picking up the station at the low frequency end of the band, TC_1 is adjusted experimentally and it is found that signal strength increases for an increase of



The Contessa*—showing arrangement of units in cabinet*

Any temporary aerial which may have been employed should be removed altogether when the ferrite frame circuit is adjusted, although it may help, *primarily* only, to hold an aerial lead close to the ferrite frame coil in order to give a very small degree of capacitive coupling. Adjustments to the ferrite frame circuit should always be carried out with as small a signal input as is possible, rotating the receiver if necessary to reduce sensitivity. The tuning condenser is first of all adjusted to pick up a station at the high frequency end of the band, whereupon trimmer TC_1 is adjusted for maximum volume. A station at the low frequency end should then be selected, this being brought up to maximum volume by adjusting the position of the coil on the ferrite frame. As, due to hand-capacity effects, it may be a little difficult to judge the optimum position of the coil on the core, a good method of checking its resonant capacity in this trimmer, then the ferrite frame coil needs to be set nearer the centre of the ferrite rod in order to increase its inductance. TC_1, returned to its original position, may then once more be used to check whether this is the optimum position. (When less capacity is needed in TC_1, then the inductance of the ferrite frame coil has to be reduced, this being done by moving it away from the centre of the core.) The ferrite frame coil should be adjusted very carefully to avoid damage to the litz wire lead-outs from the coil to the tag-ring. Final checking of ferrite frame tracking can be made by setting up TC_1 for optimum volume at the high frequency end of the medium waveband, and ensuring that this condition is maintained at the low frequency end. TC_1 should always be finally adjusted at the high frequency end, where it has greatest effect.

When medium wave alignment is complete, the receiver should be switched to the long waveband. Using, if necessary, a temporary aerial coupled very loosely to the ferrite frame coil, trimmer TC_3 should be adjusted until a known station (preferably the B.B.C. Light programme on 1,500 metres) is received for a correct setting of the tuning condenser. The core of L_2 and trimmer TC_2 should then be adjusted for optimum volume. The best combination of the settings of L_2 and trimmer TC_2 is normally that which results in a relatively low capacity in TC_2.

Alignment with a signal generator follows much the same procedure as that just detailed. The signal generator output may be initially injected into the circuit via a condenser of 50 to 200pF connected to the base of TR_1. The signal generator should be set to give a modulated output at 315 kc/s. The i.f. transformers are then adjusted for maximum volume, reducing signal generator output as alignment proceeds.

To adjust the oscillator circuits, the signal generator should be applied, via a 50 to 200pF series condenser, to the fixed vanes of $VC_{1(a)}$. The oscillator circuits are then adjusted in the same manner as was described above, the signal generator providing the requisite signals at the high and low frequency ends of the band. Due to undesirable loading effects the signal generator should not be used for aligning the ferrite frame circuit, adjustment here being carried out on received signals as described previously.

Long wave alignment is also carried out in the manner previously described, although it may prove helpful to employ the signal generator for initially adjusting TC_3.

Final Adjustments

It may be remembered that, in the first article, it was stated that R_3 may have to be adjusted to suit particular transistors fitted in the TR_1 position. Normally no adjustment will be needed here at all, but if there is any tendency to squeg the value of R_3 should be increased until the effect clears. Squegging will make itself evident as a loud hiss, usually at the high frequency end of the medium waveband. Assuming that the set is initially very badly out of alignment after construction has been completed, it is just possible that slight squegging may be evident at one or two settings of the tuning condenser. If this occurs it may be necessary to temporarily increase R_3 during alignment, reverting to its nominal value afterwards.

It was stated earlier that, if a howl or other form of a.f. oscillation becomes evident when the receiver is first switched on, the connections from the output transformer secondary at the 2-way tag-strip should be reversed. However, incorrect phasing of the negative feedback loop may not always result in an audible oscillation, and it is desirable, after alignment has been completed, to check for correct phasing whilst a station is being received. This check may be carried out by primarily disconnecting R_{19} from the 2-way tag-strip (Fig. 8). Temporarily reconnecting R_{19} to the tag-strip whilst receiving a signal should cause a decrease in volume, and particularly in background hiss, when phasing is correct.

In order to assist in any further checks which may be required, prototype voltage readings were given at the appropriate points of the circuit illustrated in Fig. 1. These readings are relative to chassis, and were taken with an Avo Model 8 switched to the 10-volt range. The receiver was tuned to approximately the middle of the medium waveband, with no signal input, and the volume control set to minimum. It must be pointed out that readings taken on receivers built to the *Contessa* design may not *exactly* agree with those given in Fig. 1, this being due to component tolerances and slight discrepancies between transistors.

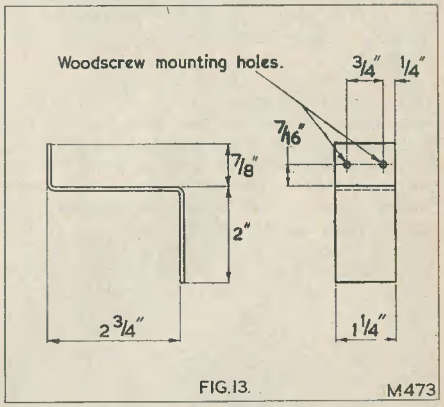


Fig. 13. The battery bracket. This is fitted to the inside of the cabinet with woodscrews

The Cabinet

If the cabinet specified in the parts list is obtained, housing the receiver is quite a simple operation. All that is then required is to fit the chassis to the side supports already provided. A minor point which requires attention is to ensure that transistor TR_4 is well clear of the speaker after the chassis has been installed. The front escutcheon may be glued to the cabinet or merely held behind the knobs. The latter method of fixing is quite satisfactory, especially if felt spacing washers are fitted under the knobs.

radio miscellany

LIMITATIONS OF SPACE LAST MONTH prevented me from mentioning some of the interesting points from an "Old Stager" letter received from Mr. B. G. Ashman of Stevenage. He truly qualifies for the Old Stager title on the grounds of remembering buying No. 1 of *Wireless World*, now in its 47th year of publication! He recalls the Omnigraph (which I briefly described in our September issue) being used for Morse training with the London "Terriers" in 1914. This model used well-cut discs driven by clockwork. With its aid, figure and letter groups could be practised single-handed, and it proved of considerable value for teaching correct spacing, but it was inclined to "splash" when used above 8 words per minute.

Like many old timers he still has some of the treasures of bygone days, included among them being the former and pins for making wavewound coils in the manner I described. This was marketed by Igranic (a name to conjure with in the early days of broadcasting), and as far as he can recollect the name Oojah was for a proprietary coil of this pattern marketed by (?) Burne Jones & Co. Also preserved are a couple of early Polar condensers built in heavily constructed brass boxes 3in × 3in × 1½in, in which springy metal plates are compressed to increase capacitance. This idea remains with us today in our trimming and padding capacitors, and has in its time been used to make variable grid leaks. In the latter carbon granules were used, the resistance decreasing under compression. Unfortunately they didn't spring back on their own, so to get a critical setting in an unstable circuit with a highly cherished "soft" valve, keen types, anxious to wring the utmost performance, detached their variable grid leaks and gently tapped the granules loose. This was a ritual when replacing soft valves—a frequent occurrence as they had very brief lives. As they were all "foreigners," one simply had to grin and bear it. I cannot recall the British manufacturers marketing soft valves, although they gave remarkable results as detectors. Another early device, tuning by the use of metal plates in the field of inductances, still survives in the modern slug-tuned coil and transformer. Sometimes it seems there is nothing new in radio. Electrolytics were used in the early part of the century, to disappear and re-emerge triumphantly years later. F.M., too, was used in the early days, only to be dropped in favour of a.m., and scanning systems were devised long before sound radio started, let alone before t.v. was thought practicable.

B.G.A. was lucky enough to be chosen for one of the first radio courses given to cadets at Marconi House, which jumped his knowledge forward from perikon crystals to the "real thing"—magnetic detection and two-electrode valves. He mentions that carborundum detectors were at that time doing regular service, and his introduction to the three-electrode valve was by way of an advertisement announcing the De Forest Ultra Audion valve.

Both these latter points bring back memories for me. In 1920 as a small lad I built my first receiver, which kept me weeks before rewarding me with a signal—this was "powered" by carborundum. My first valve set, built a few months later, used a triode, and it wasn't for two or three weeks much more rewarding. In the period when I was getting "no joy" I consulted a local "expert," an ex-First World War R.A.F. type (then the Flying Corps). To my horror he held a lighted match against my precious valve. As this treasured possession had cost me many weeks hard-saved pocket money I protested vehemently. He said: "You'll never get a signal out of these things unless you warm 'em up thoroughly. We always did it at Farnborough." I writhed in agony, feeling experiments with a box of matches on somebody else's valves may be all right, but it's not so clever watching other people do it with your property. Maybe he was confusing it with the engines. Any clot knew they had to be warmed up first. Funnily enough, years later mains valves came along and you really have to wait for them to warm up, but I have yet to hear of anybody trying to shorten the warming-up period with the aid of a box of matches!

Still Further Back

Another reader whose store of souvenirs dates from the really early days is Mr. J. W. Tilley of Redditch. He is only a little over half the age of some of our old time correspondents, so his detailed knowledge of the history of our hobby has been acquired by reading and collection. In quoting from a full-page advertisement in a copy of the *Meccano Magazine* for December 1923, he gives details of the Polar Bloc system and also mentions the Blackadda system of unit construction introduced in 1926. For the enquirers into this fascinating subject he gives the following references.

1913. A series of articles in *Work* (a weekly periodical published by Cassells) from October onwards describing the construction of a crystal receiver. This was re-printed in Part 22 of the *Amateur Mechanic* in August 1914. He also lists a number of subsequent articles, including the sets of cigarette cards which we discussed in this column some three or four years ago. He dates *How to make your own Wireless (Crystal) Set* and *How to make a Valve Amplifier for the BDV Crystal Set* as 1923. Twenty-five cards in each set.

He commends those interested to that excellent publication *Radio Communication, History and Development* (Science Museum Handbook). This is a H.M. Stationery Office book containing 58 fine plates, and costs 3/6.

centre tap ... *talks about items of general interest*

Finally, as there has been such a lively interest among "Vintagers" and the possibility of a nation-wide club opening up, he suggests that the little metal plates the manufacturers used to put on the back of the early sets might well be pressed into service as lapel badges. J.W.T. sends along his specimen. Set No. 805 made by B.S.A. Radio Ltd., Birmingham. Anybody got a lower number in that series?

Value for Saxpences

In view of the large amount of lively correspondence from readers on topics recently raised in this column, I am rather disappointed that the Aberdonian request for an ideal combined good-listening-extended-play-test-record brought in only three responses. Is it impossible to find so many virtues contained in a single record? Incidentally, none of the three claimed that their recommendation met up with the exacting requirements of our thrifty friend. They feel, however, that their choices can be depended upon to show up many common defects in reproduction systems and, when the amplifier is perfected, play an important role in a worth-while music record programme.

Firstly, W.H.J. of Enfield Road, Derby, chooses the Royal Philharmonic playing Elgar's "Pomp and Circumstance" Marches 1, 2, 4 and 5 (Philips NBE11002). It has strings, wind and percussion in quantity, and low notes as clean as any he has yet heard on a record. The end passage of No. 1 provides a severe test when the full orchestra plays fortissimo and is joined by a Grand Organ. (OPINION. A very good choice, which goes a long way towards meeting requirements.)

The second is from J.V., Salisbury Street, Bedford, who recommends Chabrier's "Espana." He writes: "This should sound clear and crisp—not like a roughly handled dustbin. It meets most of the qualities required and in addition is backed by a pleasing recording of Waldteufel's 'Skaters Waltz' " (Columbia SEL1528). (OPINION: A good choice. Perhaps not so exacting as No. 1 in some respects, but together they could provide a useful combination.)

Finally, E.D. of Earlsfield Road, S.W.18, writes: "I can hardly imagine any 7in record possessing all the points our Aberdonian friend demands, but for sheer tonal beauty with passages taken up by separate sections of the orchestra, sometimes simultaneously, and for rugged grandeur of swelling volumes Mendelssohn's 'Hebrides' Overture (Philips ABE10006) is hard to beat. For 'listening's sake' it should be played in a darkened room or with the lighting turned dim." (OPINION: An impressive record, especially when heard in the right mood. Backed by "Ruy Blas" Overture. Test qualities perhaps a little more limited, but would quickly reveal reproduction shortcomings to a critical ear.)

No doubt many amplifier enthusiasts refrained from expressing opinions because they thought too much was asked from a single record. Is anyone familiar with an E.P. recording they consider a still better test record than those mentioned?

The Show's the Thing

Those who, in view of the complication of the modern t.v. and f.m. receivers, have doubted the continuing popular appeal of the constructional side of our hobby, might well have been surprised at the big and enthusiastic attendance at the Radio Hobbies Exhibition. The exhibitors were greatly impressed at its success, and several of those not represented this year have expressed their intention of being there next time. At the moment it is not certain whether Phil Thorogood, G4KD,

continued on page 356

The PETITE Battery Portable Superhet

Described by

JAMES S. KENT

A NEW RECEIVER DESIGN HAS ALWAYS proved of interest to the home-constructor, whether it be t.r.f. or superhet, portable or "static," battery or mains operated, valve or transistor fitted. The design about to be described is of the valve portable type and has been expressly designed for ease of construction by the hobbyist fraternity.

A portable receiver is an admirable acquisition to the home radio equipment and, at this time of the year, when one is pre-occupied with the selection and purchase of Christmas presents, such a receiver may possibly fit the bill with respect to solving one such gift problem. For those requiring a portable design for outdoor use in the coming summer season, now would be the time to commence construction—so that it is completed well in time for the fine weather outings and forays.

From the front cover photograph it will be noted that the whole assembly is housed in an extremely attractive and professional-looking carrying-case. The front panel is of hammered bronze finish metal complete with a gold mesh speaker grille, the black knob and dials being well matched against such a background. The completed receiver weighs only some 5lb, and the two-tone case colours of red and grey, or fawn and red, make this portable both pleasing to the eye and easy to carry.

Circuit

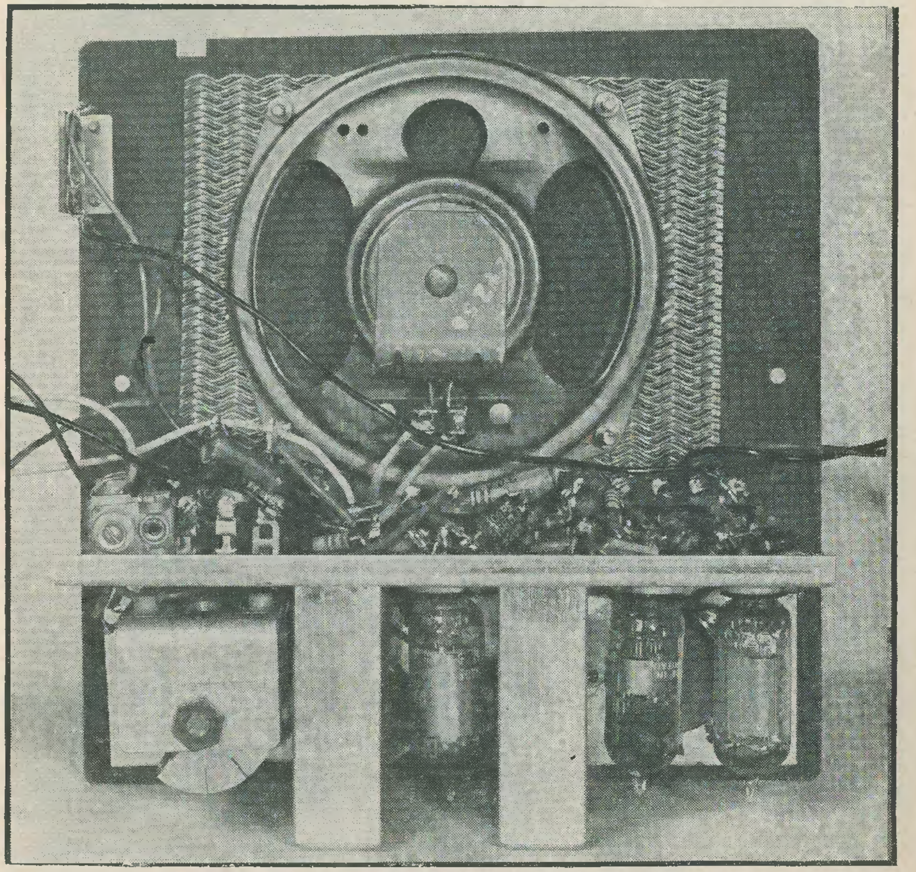
The frame aerial assembly, fitted inside the cabinet lid, is tuned by C_{3A} on the Medium wave position and by the combination C_{3A}, C_1 and C_2 on the Long wave position of the wavechange switch. The frequency changer is the Mullard DK96, a heptode type that performs extremely well in such an application. The numbers around the valve refer, of course, to the actual base connections. R_1, R_5 decoupled by C_{11} apply the a.v.c. voltage to both the frequency changer and the first i.f. stage. This effectively prevents overloading when tuned to the local transmitter. The oscillator section is tuned by C_{3B} with C_5 in parallel on the Medium wave and the additional C_8 on the Long wave position. C_7 is the oscillator padding condenser, and is in series with C_6; the latter, together with R_2, forms the oscillator grid components; the oscillator "anode," grid 3, is fed directly from the oscillator coil winding.

The output from this stage is applied across the first i.f. transformer, type 965P (465 kc/s) and from thence into the i.f. stage. This is a perfectly standard circuit designed around the Mullard DF96 r.f./i.f. pentode. The resultant output from this stage is rectified by the diode section of V_3, and the audio is fed via the slider of R_7, and C_{13}, into the pentode section of the DAF96. The potentiometer R_7 acts as the volume control. R_{10} is the V_3 anode load component, while R_9 is the screen series resistor decoupled by C_{14}.

The amplified a.f. is fed into the output stage via C_{16}, the condenser C_{15} filtering any residual r.f. to chassis. The grid leak and bias components respectively are R_{12} and R_{11}. The on/off switch is incorporated in the h.t.– and l.t.– lines, the switch itself being lid operated. The output from the DL96 a.f. pentode is fed into the speaker via the output transformer, C_{17} applying a measure of tone correction. The speaker is a 5in 3Ω type.

Place into position the grommets G_1, G_5 (small) and G_6 (large). Mount the valveholders W and X, Y with solder tag S_2 and Z with solder tag S_1 under one of the fixing screws. Note particularly from the diagrams the exact location of the valveholders. Fit the tag strips T_1 and T_4, following this by securing the trimmer condenser C_5 with a 4BA nut and screw through one tag direct to the chassis.

Secure into position the first i.f. transformer M (type 965P) and 2nd i.f.t. N (type 966P)—for correct location of these see Fig. 3. Fix into position the output transformer so that the lead-out wires are away from the chassis. The solder tags S_3 and S_4 are fitted one under each fixing screw. Next place and secure



Reverse of Petite *panel, showing arrangement of chassis, speaker and on-off switch*

Assembly

Figs. 2 and 3 show the above- and below-chassis assembly with respect to the main components. To commence the assembly, mount the components in the following order.

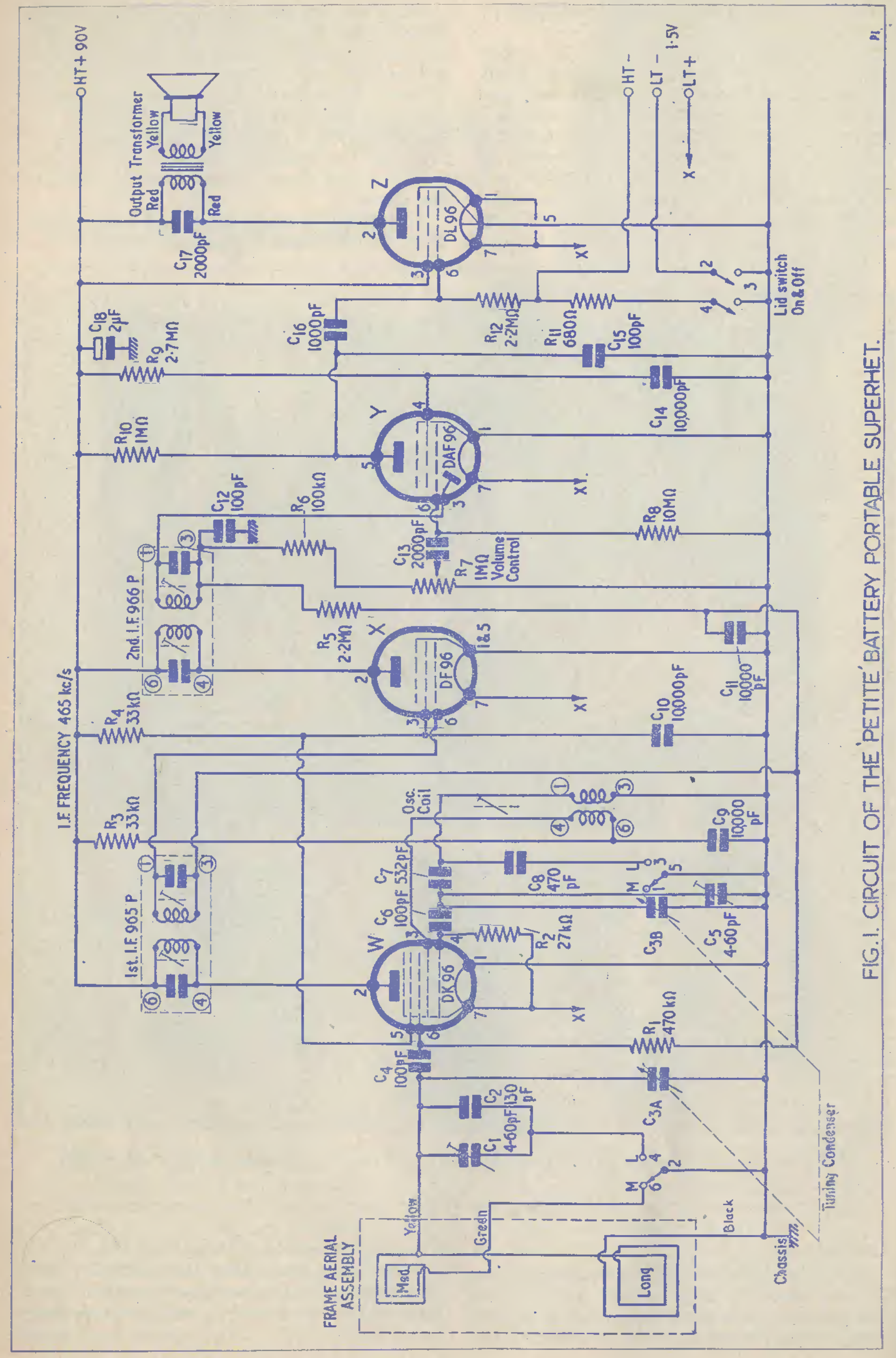


FIG. 1. CIRCUIT OF THE 'PETITE' BATTERY PORTABLE SUPERHET.

into position the wavechange switch and the volume control R_7. Mount the ganged condenser C_{3A}, C_{3B} using three fixing screws, and bend one tag clear of the first i.f. can.

Place into position the oscillator coil L by pressing it into the grommet G_6, the coil entering the grommet to a depth of approximately ½in.

This completes the assembly instructions. Note that the following wiring instructions may be carried out before fitting the front panel.

Wiring

Reference to Fig. 3 will show that all of the small components are depicted in their respective positions, and these should be placed as near as possible to the location indicated. It is very important to keep all the condensers and resistors with their leads as short as possible and as close as permissible to the chassis. With regard to the actual soldering, it is advisable to use a good quality flux-cored solder and an iron of the instrument type. Liquid fluxes should not be used as these cause corrosion at a later date and may result in the breakdown of components.

The tags shown in black (Fig. 3) are the fixing tags and will, therefore, be connected to the chassis as earth connections.

Connect together Z_7, Z_1, Y_7, X_7 and W_7 (these, of course, refer to the valveholder and individual tags of the respective valveholder). Wire and solder together Z_3, N_6, T_4, T_2 and M_6, following this by connecting together Z_5 to the centre contact of Z and S_1.

Having completed the above, solder and wire together the centre contact of Y to Y_1 and the solder tag S_2. Connect together the centre contact of X, X_1, X_5 and $T_3/_1$ (earthed tag of the T_3 tag-strip). Join together the centre contact of W, W_1 and $T_3/_1$.

Next, connect X_3 to W_5; W_4 to $T_1/_4$; L_1 to $T_1/_2$; M_1 to X_6; M_4 to W_2; N_3 to $T_3/_4$ and follow this by connecting W_6 to $T_2/_4$; L_4 to W_3; L_3 to $T_1/_3$; M_3 to $T_3/_2$; N_1 to Y_3; and lastly N_4 to X_2.

This completes the wiring with respect to the connection together of various points in the circuit. We now continue by including into the receiver all the resistors contained within the design.

Wiring the Resistors

The following enumerated resistors should be soldered, *at each end*, to the circuit points listed. Connect one end of R_1 to W_6, the other to $T_3/_2$; R_2–W_7 and $T_1/_4$; R_3–M_6 and L_6; R_4–M_6 and W_5; R_5–$T_3/_2$ and $T_3/_4$; R_6–$T_3/_4$ and $T_3/_5$; R_8–Y_1 and Y_6; R_9–Y_4 and $T_4/_2$; R_{10}–Y_5 and $T_4/_2$; R_{11}–$T_4/_4$ and $T_4/_5$ and R_{12}–Z_6 and $T_4/_4$.

Dealing next with R_7—the volume control potentiometer (see Fig. 2), connect tag 1 to the adjacent S_3, tag 2 through the grommet G_4 to $T_4/_3$ (see Fig. 3) and tag 3 of R_7 again through G_4 to $T_3/_5$.

This completes the resistor wiring instructions.

Wiring the Condensers

In the same manner as above, the condensers should be soldered into the circuit, *at each end*, to the following points.

Connect one end of C_1 to $T_2/_1$, the other end to $T_2/_3$; C_2–$T_2/_1$ and $T_2/_3$; C_4–$T_2/_1$ and $T_2/_4$; C_6–$T_1/_1$ and $T_1/_4$; C_7–$T_1/_1$ and $T_1/_2$; C_8–$T_1/_2$ and $T_1/_5$; C_9–L_6 and $T_2/_5$; C_{10}–W_5 and $T_2/_5$; C_{11}–$T_3/_2$ and $T_4/_1$; C_{12}–X_1 and $T_3/_4$; C_{13}–Y_6 and $T_4/_3$; C_{14}–Y_4 and $T_4/_1$; C_{15}–Y_5 and Z_5; C_{16}–Y_5 and Z_6 and C_{17}–Z_3 and Z_2.

Connect the free end of C_5 to $T_1/_1$. Follow this by soldering the positive end (+) of C_{18} to $T_4/_2$ and the negative end (−) to $T_3/_1$. Connect the variable condenser C_{3A} through the grommet G_3 to $T_2/_1$ and C_{3B} through the grommet G_1 to $T_1/_1$.

Continuing with the wavechange switch, connect together tag 2, tag 5 and the earthing tag S_4 (see Fig. 2); follow this by connecting tag 4 of the switch through the grommet G_3 to $T_2/_3$. Join tag 3 to $T_1/_5$ via G_2. Tag 6 is connected at a later stage and tag 1 is left blank.

The next component to wire into circuit is the output transformer. This is done by taking both the red leads through the grommet G_5, soldering one to Z_2 and the other to Z_3. These leads are interchangeable and, therefore, it does not matter which way round they are connected into the circuit. Feed the yellow leads through the grommet G_7, these two connections being soldered to the loudspeaker at a later stage.

Having proceeded this far it would be as well for the constructor to check over the partially completed receiver against the foregoing instructions, in order to ensure that no errors have been made with respect to the inclusion of components and the wiring.

Assembly of Front Panel to Chassis

This is the next step in the construction of the "Petite" receiver, and the first item to be dealt with is the lid operated on/off switch. Fit this switch using the small self-tapping screws supplied; the contacts should be facing inwards from the edge of the panel (see illustrations).

Secure the front panel to the chassis using 4BA screws, the nuts being fitted on the inside of the chassis.

Secure the speaker to the front panel, using four screws, the speaker mesh being inserted between the speaker itself and the panel. This mesh will be held rigidly in position when the speaker screws are securely tightened into place. The speaker should be so positioned that the connecting tags are towards the chassis. Next, solder to these two speaker tags the two yellow wires from the output transformer that were previously fed through the grommet G_7. These wires are interchangeable and may be connected either way round.

Take the calibrated scale and fit this to the tuning condenser (C_{3A} and C_{3B}) spindle. The condenser should be at maximum capacity, i.e. all the plates in mesh, and the scale adjusted until the line between 550 and 1,200 locates on the M.W. index line on the panel. The grub screw in the knob is then tightened.

The volume knob is next fitted to the spindle of R_7 (volume control) and secured by means of the grub screw, the position of the knob not being important. Next, fit and secure the knob to the wavechange switch.

We must next wire into circuit the lid operated on/off switch. Connect switch tag 4 to $T_4/_5$, taking this lead along the chassis below the speaker. Join tag 3 of the switch to $T_1/_3$.

Dealing with the battery connections next, we require for this four lengths of wire, each 8in in length, both ends being bared in preparation for the soldering process. Taking the l.t. connections first, solder the end of one wire to tag 2 of the lid operated switch and the other end to the thin pin on the two-pin plug (l.t. negative). Solder to the thick pin of the two-pin plug one end of a further length of wire and twist this around the length of wire soldered to the thin pin, and follow this by soldering the remaining free end of this wire to W_7 (l.t. positive). For the h.t. connections connect the end of one wire to $T_4/_4$ (h.t. negative). Taking the last remaining length of wire, solder one end to $T_4/_2$ (h.t. positive). Next, take the three-pin plug and, with the pins held away from you, the left-hand pin is connected to that wire coming from $T_4/_4$. Twist the remaining free-ended lead around this former wire and solder the free end to the right-hand pin of the battery plug. The top centre pin of this plug is left blank.

Frame Aerial

This is the next item to be included in the circuit, and wiring should be carried out as follows: to the yellow tag of the aerial solder one end of a 6in length of wire, the other end being connected to $T_2/_1$. Join the black tag of the aerial and $T_2/_5$ together by means of an 8½in length of wire. From the green tag of the aerial solder a 9½in lead through G_1, between C_{3B} and the chassis, to tag 6 of the wavechange switch.

Having completed the above, fit the frame aerial into the cabinet lid and under the detachable panel, with the frame windings towards the outside of the lid. The connecting leads should be taken under the edge of the frame back plate and thence through the slot provided in the lid and the panel.

The whole wiring and assembly processes are now complete, with the receiver ready for the calibration and lining-up of the various tuned circuits.

Calibration Using a Signal Generator

The receiver should be lined-up completely before fitting the whole assembly into the cabinet.

To commence, inject a 465 kc/s signal into the grid of W (pin 6) by connecting the generator lead to $T_2/_1$, having first removed the yellow frame aerial lead from this latter point. Adjust the i.f. cores for maximum output. Having achieved this, replace the lead on point $T_2/_1$. Next, switch to the Medium waveband and inject a 200-metre signal into the frame aerial by placing the output lead from the generator close to the frame. Turn the pointer knob to 220 metres and adjust the trimmer C_5 for maximum output. Following this, tune the generator to 500 metres and set the pointer knob to the same wavelength. Adjust the iron core of L for maximum output. Return to 220 metres and re-tune, checking again at 500 metres. Switch to the Long waveband and tune the generator to 1,200 metres, setting the receiver pointer to correspond. Adjust the trimmer C_1 for maximum output.

Calibration using Stations

It should be remembered here that the i.f. transformers are pre-aligned before despatch and, therefore, the cores should not be touched until a signal is received—when they may be carefully adjusted for the maximum output.

Turn the wavechange switch to the Medium waveband position and tune in a station towards the low end of the pointer scale, say, between 200 and 260 metres. Set the pointer to the station wavelength and adjust the trimmer C_5 until the transmission is heard at the maximum strength.

Having done this, turn the pointer to the wavelength of a station received locally at good strength between 450 and 550 metres, adjusting the iron core of L until maximum strength is obtained. Next, return to the first station and adjust the trimmer C_5, checking again at the higher wavelength station and readjusting the iron core of L if necessary. Repeat this procedure several times until no further signal strength improvement is possible. Turn the wavechange switch to the Long waveband position and tune in the B.B.C. transmission on 1,500 metres. Adjust the trimmer C_1 until the maximum audio output is achieved.

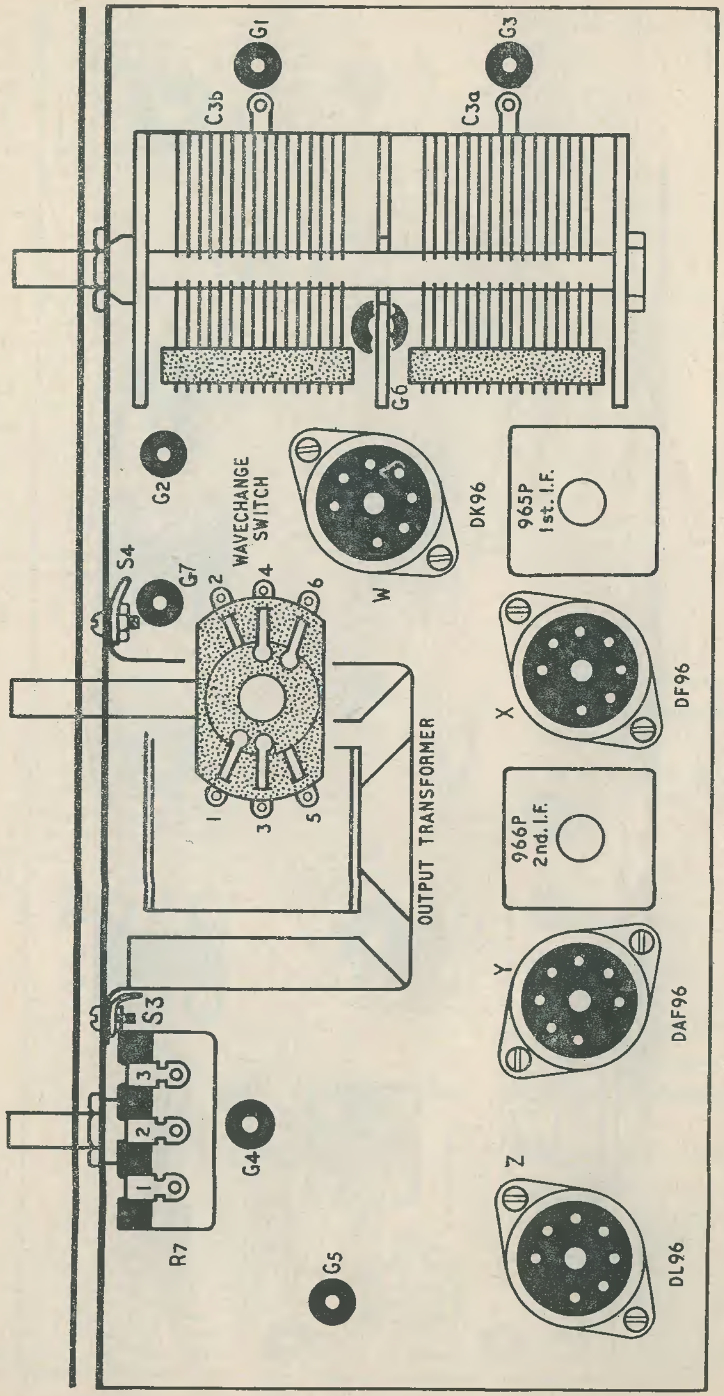
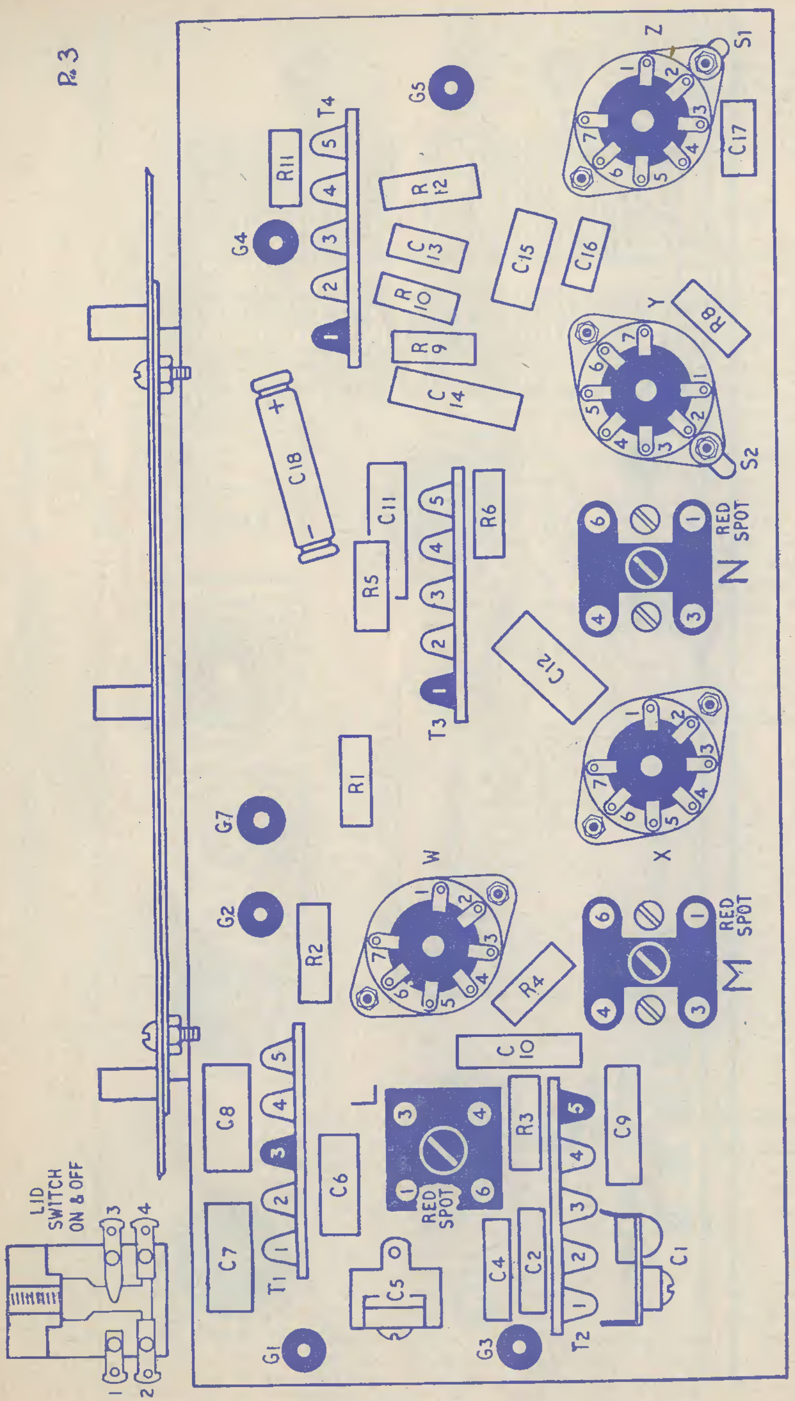


Fig. 2. "Top" of Petite chassis showing layout of components



Component layout "beneath" chassis and details of on-off switch

It should be remembered that the "Petite" is fitted with a frame aerial and, this being so, the maximum signal strength receivable from any station will only be achieved when the edge of the cabinet lid points directly at the locality of the transmitter. It follows, therefore, that the receiver should be rotated in order to obtain the maximum output from any given station.

Having completed the lining-up process, the receiver assembly may be enclosed within the cabinet, but first the batteries must be securely contained before finally placing into position the whole assembly.

Inclusion of Batteries

The correct positions of the batteries, looking into the base of the cabinet, is that the l.t. battery should be on the right with the h.t. battery on the left, the plug of the latter being placed towards the back of the cabinet.

The batteries are now secured into the cabinet with the metal clamp provided, this being fitted over the bolt in the base of the cabinet and held into position by the special nut provided for this purpose.

The receiver itself is firmly secured into the cabinet by inserting the two screws provided into the brackets fitted within the cabinet.

Conclusion

The "Petite" portable receiver is not only comparatively easy to construct, as may be gathered from the foregoing, but is also an ideal workshop project for the few remaining months of winter. Those commencing construction now will have on hand, at the ideal time, a portable receiver for the summer occasions when such a receiver will make all the difference to those family outings to the coast or countryside. To those thinking of the proverbial seasonal stocking—what better "filler" than this!

Component List

Resistors

R_1	470kΩ $\frac{1}{2}$ watt
R_2	27kΩ $\frac{1}{2}$ watt
R_3	33kΩ $\frac{1}{2}$ watt
R_4	33kΩ $\frac{1}{2}$ watt
R_5	2.2MΩ $\frac{1}{2}$ watt
R_6	100kΩ $\frac{1}{2}$ watt

Component List—*continued*

R_7	1MΩ pot.
R_8	10MΩ $\frac{1}{2}$ watt
R_9	2.7MΩ $\frac{1}{2}$ watt
R_{10}	1MΩ $\frac{1}{2}$ watt
R_{11}	680Ω $\frac{1}{2}$ watt
R_{12}	2.2MΩ $\frac{1}{2}$ watt

Condensers

C_1	4–60pF Trimmers
C_2	130pF, 2% mica
C_{3A}, C_{3B}	Ganged variable
C_4	100pF
C_5	4–60pF Trimmers
C_6	100pF
C_7	532pF, 2% mica
C_8	470pF, 2% mica
C_9	0.01μF, ceramic
C_{10}	0.01μF, ceramic
C_{11}	0.01μF, ceramic
C_{12}	100pF
C_{13}	0.002μF, ceramic
C_{14}	0.01μF, ceramic
C_{15}	100pF
C_{16}	0.001μF, ceramic
C_{17}	0.002μF, ceramic
C_{18}	2μF, 150V wkg., Electrolytic

Valves

V_1	DK96 (W)
V_2	DF96 (X)
V_3	DAF96 (Y)
V_4	DL96 (Z)

Batteries

H.T.—Ever-Ready type B126 or equivalent
L.T.—Ever-Ready type AD35 or equivalent

O/P Transformer (Premier Radio Co.)
Knobs, Dials and Wavechange Switch (Premier Radio Co.)
Lid Switch (Premier Radio Co.)
Valveholders
Tag-strips and Battery Clamp (Premier Radio Co.)
1 IF Transformer, type 965P (M) (Premier Radio Co.)
1 IF Transformer, type 966P (N) (Premier Radio Co.)
Oscillator Coil (L) (Premier Radio Co.)
Frame Aerial Assembly (Premier Radio Co.)
Grommets, screws, etc.
Speaker, 5in, 3Ω
Cabinet, Chassis and Panel (Premier Radio Co.).

ERRATA

THE "MAYFAIR" TELEVISOR

In part two of the October issue, two errors occurred, and should be noted.

R_5 was given as 2.2kΩ in the circuit diagram and 10kΩ in the Components List. 2.2kΩ is correct.

C_{22} (across R_5) was not included in the Components List. The value is 10pF, as given in the circuit diagram.

NEW RADIO CLUB

A new club, to be known as the "Roch Valley Radio Club," has been formed in Rochdale. Meetings will take place each Tuesday at 8 p.m. in the Windmill Hotel, Sudden, Rochdale. All people interested will be made welcome. For the present all enquiries to be made to D. J. Power, Esq., 2 Clement Street, Rochdale.

A CONSTRUCTOR VISITS THE . .

1957 RADIO HOBBIES EXHIBITION

UNLIKE previous such exhibitions where the accent had been on the purely amateur radio communication aspect of the hobby, this one presented a much wider scope, which was reflected in the number of exhibitors. The ultimate success of the venture is shown by the fact that the total attendance was nearly three times that of the previous Amateur Radio Exhibition.

From the outset it was apparent that the whole venture would not only strike a new note, but also bring in the current popular trend of "Do It Yourself." This was very evident from the number of stands that featured items of radio equipment in kit form; these included receivers, test gear of all kinds, transmitters and even aerials.

Two stations were "on the air" directly from the hall, one operating on the 2-metre band and the other on various frequencies on the lower communication bands. Many contacts were made despite the fierce competition for QSO's by outside stations, all contacts being rewarded by a special QSL card.

For a review of the various stands we call first at:

London UHF Group

Many items of equipment, specifically designed for the high frequencies involved, were on show—all being built and lent by members of the group. Noted at random were a 2,300 Mc/s transreceiver by N. Caws, G3BVG, a 1,300 Mc/s transmitter and a 70 cms exciter, both by A. L. Mynett, G3BHW. This stand housed the 2-metre station previously referred to, the equipment for this being supplied by H. F. Smith, G2DD, G. M. Stone, G3FZL, and A. J. Worrall, G3IWA respectively. Staffed entirely by members of the group, the station call-sign varied according to the operator concerned, each using his own call-sign suffixed by the necessary /A.

Royal Navy

While the exhibition colour scheme generally was yellow and black, this stand was attractively styled in blue—a most appropriate colour. The first thing to catch one's eye here was the magnificent large-scale model of an aircraft carrier at speed, complete with a flight deck of planes and a full regalia of radar and other antennas. A relief map of the world, complete with a system of lights showing the communication networks and the method by which any ship in any part of the globe could contact base, was also a feature of some interest. Of interest to the radio fraternity was the CHC receiver. Entirely new in conception, its principle of operation permits the frequency range of 500 kc/s to 30 Mc/s to be covered in thirty 1 Mc/s bands without switching. Other features of this receiver, around which a crowd of enthusiasts was constantly gathered, is the automatic cancellation of local oscillator drift, built in facilities for timing scale calibration every 100 kc/s, i.f. and a.v.c. outlets for diversity reception techniques, and a plug-in adaptor to cover the range 12.5 kc/s to 1 Mc/s. Another receiver of interest was the B40D, this one covering from 650 kc/s to 30 Mc/s, and having circuitry making it suitable for the reception of FSK signals on a teleprinter. This receiver is of a general service type extensively fitted for service both ashore and afloat.

Enthoven Solders Ltd.

Soldering demonstrations, particularly of aluminium, were a feature of this stand. Of great interest to many was the Vibroscope, an electric tool for the etching of all metals. Operating from the mains via a transformer, it effectively etches nameplates, panels, cutlery, tools and dies, etc. Alternatively, the Vibroscope may be operated from a 4 or 6-volt car battery. The Superspeed soldering iron featured will generate at will any desired amount of heat, the hand switch giving complete temperature control. Automatically switching off whilst not actually soldering, maximum temperature is achieved in six seconds from the switching-on time.

Royal Air Force

Of interest here, apart from the apprentices actually constructing a bandswitched amateur transmitter on the stand front, was the 2-metre station complete inside a tent—the whole presentation being G8FC/A as operated during the R.S.G.B. 2-metre Field Day on 18th August this year by Mr. Seymour, G3GNS/P.

Short Wave Magazine Ltd.

On show and sale here were the latest American radio books and manuals. The *Short Wave Magazine* is of special interest to the S.W. enthusiast, covering as it does all the activities of the transmitting enthusiast, including constructional and operating articles, Dx Commentaries, v.h.f. news, and other items of interest.

The Minimitter Company Ltd.

This stand proved of great interest to the amateur transmitter and listener by virtue of the fact that specialised equipment most suited to their needs was on display. Of these the Minimitter Amateur Band Converter was specially noted. This converter allows any receiver, capable of reception on either 1.5 or 6 Mc/s, to operate on any of the five main amateur communication bands without alteration. A large full vision slide-rule type dial, accurately calibrated in kc/s, is fitted. The frequency ranges are: 3.5 to 3.8

Mc/s; 7.0 to 7.3 Mc/s; 14.0 to 14.4 Mc/s; 21.0 to 21.45 Mc/s and 28.0 to 30.0 Mc/s. Valve types are a 6BX6 and a 6AJ8, with a contact-cooled metal rectifier supplying the required power. The "Mercury" transmitter also attracted considerable attention with its obvious eye appeal of two-tone silver/grey hammer finish, chrome handles and black panel fittings. The transmitter itself is assembled in four individual units —each being easily removable for any necessary maintenance—the method of assembly ensuring complete screening of the separate sections. The "Mercury" operates on five amateur bands, namely 3.5, 7, 14, 21 and 28 Mc/s, and it is capable of d.c. inputs of up to 150 watts which can either be 100% amplitude or narrow band f.m. modulated, for telephony working.

E. J. Philpott's (Metalworks)

L. Philpott, G4BI, has for many years specialised in making cabinets, chassis, racks and panel assemblies, and sheet metalwork of all types and descriptions, both to individual requirements, and as standard stock lines. The company will, as a service to constructors, drill all metalwork to specification and return complete with hammered finish in the required colour. Alternatively, a chassis drilled by the constructor himself may be forwarded for treatment in the desired finish. Those requiring further details and the illustrated brochure should write to Chapman Street, Loughborough.

Standard Telephones & Cables Ltd. (Brimar)

Several items of interest here caught the writer's eye. Among these was the new Brimar 25P1 High Quality Amplifier having 25 watts maximum output at 0.1% distortion using an ultra-linear push-pull output stage. Another item of great interest to the hi-fi fan was the "Virtuoso" quality amplifier designed and constructed by W. E. Thompson, A.M.I.P.R.E., full details of which will be commenced in *The Radio Constructor* for February. Also on show were the new 90° t.v. tubes C17SM and C21SM, together with a range of 70° types, all with electrostatic focus. A range of car radio valves, operating from a 12-volt h.t. line directly from the car battery, were also displayed, these being the types 12AC6, 12AD6, 12AE6 and the 12K5. The well-known Brimar semi-conductor devices such as transistors, Brimistors and germanium diodes were also to be seen.

E.M.I. Institutes Ltd.

This Institute, famous for its popular complete practical home training courses in radio, television and electronics, provided an interesting display of equipment, which the student builds and studies at home. Of special interest was the tape recorder type CPR/1 which incorporates a hi-fi amplifier, and a 24in t.v. receiver. A signal and pattern generator, a miniature oscilloscope and a four-valve t.r.f. receiver were also to be seen. All these items of equipment are retained by the student as his own property once these have been constructed side by side with the theoretical instruction.

Amateur T.V.

This provided much general interest—particularly as live interviews, etc., were going on almost the whole of the time. A mass of t.v. transmitting equipment was on display, including an image orthicon camera control unit by G3KOK/T, and a photicon camera control unit by G2WJ/T, both of the cameras also being constructed by the same amateurs respectively. Other items of equipment to be seen were two caption scanners, a test card "C" monoscope camera and test pattern generators.

K.W. Electronics Ltd.

This firm, now famous for its G8KW Multiband Trap Aerial, had a varied selection of equipment both for the amateur radio enthusiast and for the home constructor generally. Of note here was the portable record player kit, this being battery operated and complete with a 45r.p.m. turntable, pick-up and all parts for constructing the amplifier. The price, com-

continued on page 347

The Cooper-Smith TYPE BPI HIGH FIDELITY AMPLIFIER

Part 1

by J. COOPER

TECHNICAL DETAILS

Main Amplifier

Output 10 watts rated, 12 watts peak.
Total Distortion better than 0.15% at 10 watts.
Frequency Response within 1 db 20–25,000 c/s.
Noise and Hum 80 db below rated output.
Output Stage "Class A" ultra-linear.
Negative Feedback 18 db.
Output Impedances 2–3 and 12–15 ohms.
Circuitry: new all push-pull circuit ensuring perfect balance over audible frequency range and beyond.

The object of an amplifier is to magnify certain electrical impulses. Any alteration to the form of the impulses during this process is known as distortion, and a "high fidelity" amplifier can only be so described when the output is the same "shape" as the input, but much greater.

This is achieved in "hi-fi" amplifiers in various ways and with varying success. In the Cooper-Smith it is achieved with the greatest success by a process known as "balanced phase inversion," and by the employment of the special components that this involves. It may fairly be described, in fact, as a precision instrument. This is how it works.

The impulses are fed via a pre-amplifier (to be described later) into V_1 (see Fig. 1). This valve, a 12AU7 triode, is actually *two* valves and is shown thus in the diagram. Now for push-pull operation it is necessary that the signal applied to each half of the output stage (V_3 and V_4) be equal but opposite, i.e. 180 degrees out of phase, so that when one grid is driven positive the other is "going negative." In this way the work is shared, resulting in approximately double the amount of power output and less distortion. To do this some means must be found of converting the incoming signal to two "out-of-phase" impulses. This function is known as "phase inversion" and is performed by V_1 in conjunction with V_2, which is also two valves in one (12AX7, high impedance twin triode). It will be obvious that the impulses must be perfectly balanced, and this condition has never been achieved hitherto except by the use of a very costly transformer, although many circuits using valves have been tried which resulted in unbalance at some point in the audio spectrum, usually in the higher frequencies.

The phase inversion circuit used in this amplifier, which is much too complicated to explain here, was developed in the U.S.A. for use in medical apparatus where perfect balance was essential at all frequencies from the extremely low up to around 1 Mc/s. This accounts for the low percentage of distortion (0.15% at 10 watts) of this amplifier.

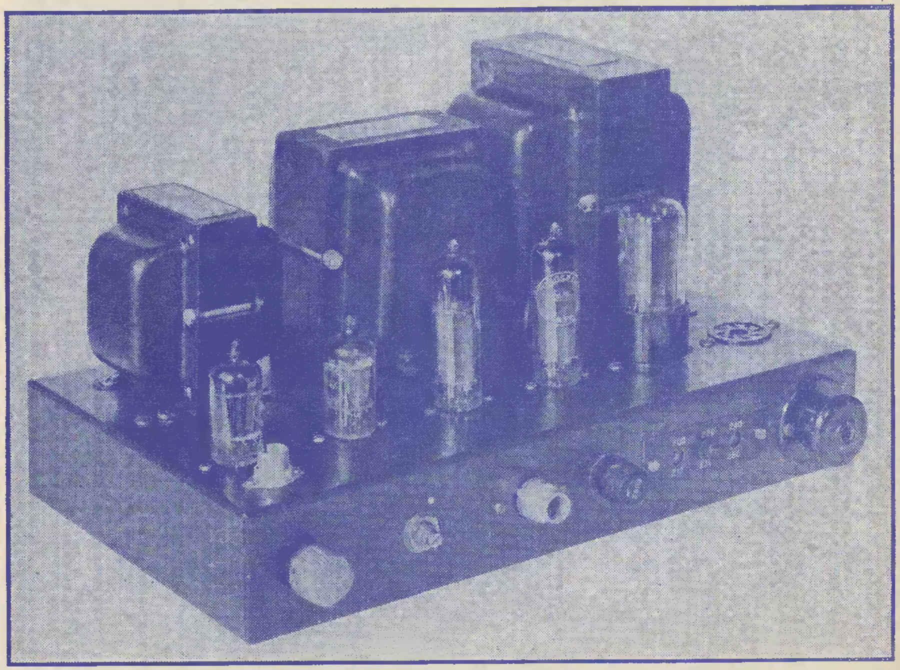
To ensure perfect balance, VR_1 is incorporated. When the two grids of V_1 are connected together by S_1 the valves are in phase and should cancel out, and adjustment of VR_1 to lowest volume achieves this condition. When S_1 is returned to normal position the valves are balanced and functioning correctly.

High stability resistors are used throughout to prevent drift off balance (though much more expensive than ordinary ones), and the reason for the use of matched pairs will be obvious. Another factor in eliminating distortion is the use of direct coupling between V_1 and V_2, which reduces phase drift to a minimum. The stage gain here is approximately 25.

The amplified signal, which is adequate to provide the necessary 10 volts grid swing, is now fed by resistance-capacity coupling to the output valves V_3 and V_4 (EL84 pentodes) which are, of course, also in push-pull. The feature of this stage is that it is "ultra-linear." Pentode valves have a very high efficiency but are liable to "peaking," an annoying form of distortion which is eliminated in this circuit by feeding the screen grids from taps in the primary of the output transformer instead of directly from the h.t. line. This gives the valves the low distortion qualities of triodes, while retaining the efficiency of pentodes.

The output transformer, which is the most important single component in the amplifier, is specially made, as are the power transformer and choke, by Electro-Voice Ltd., a firm well known in the scientific world, and is of the highest standard. It has a high primary inductance, giving full bass response, and the low leakage inductance necessary to prevent the loss of high frequency signals and to ensure that the large amount of feedback used in this amplifier does not cause instability.

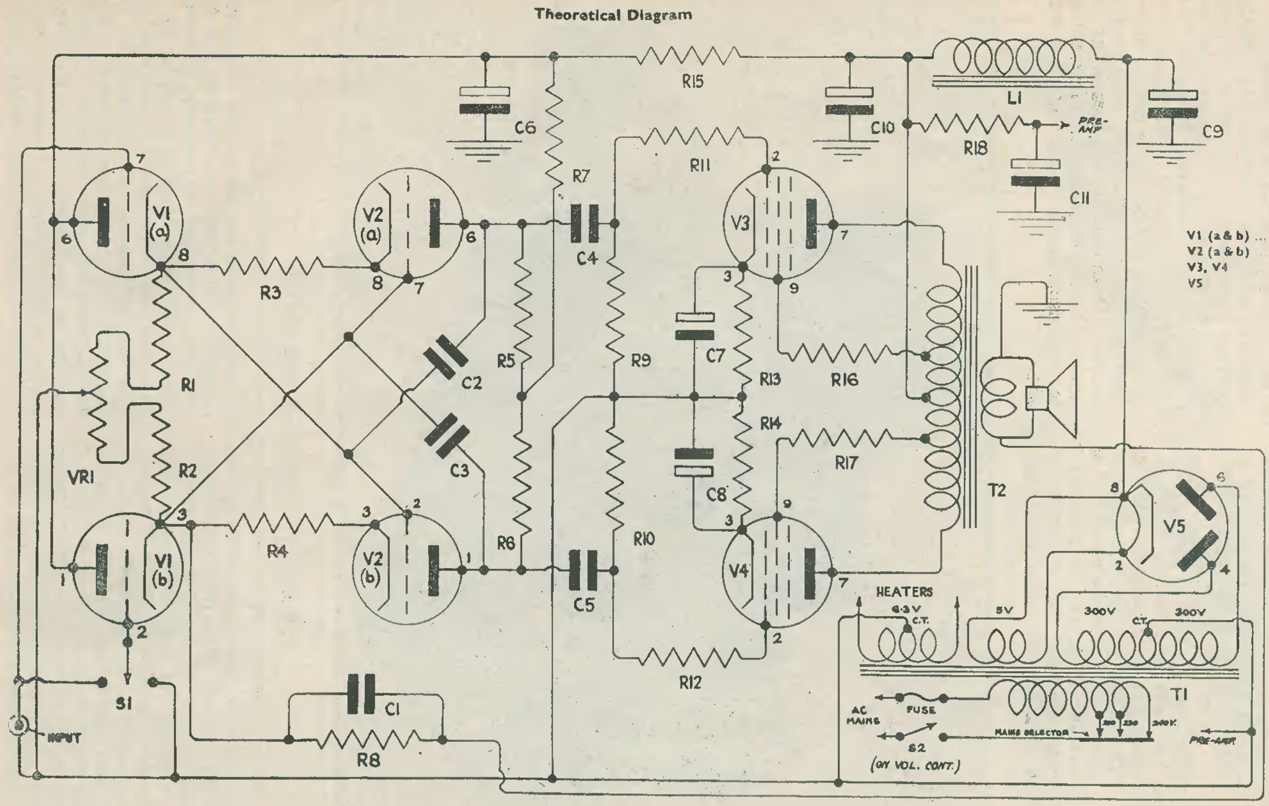
Negative feedback is obtained by feeding the signal back from the secondary through R_8 to the cathode of V_1. This has the effect of levelling the frequency response and reducing hum and noise. Introduction of negative feedback into an amplifier necessitates a higher overall gain than would otherwise be the case, to compensate for the reduction in gain that it entails. The resulting flat response, however, makes this well worth while.



Three-quarter front view of main amplifier unit

This completes our description of the main amplifier, which, although complete in itself, still needs some form of control; this is provided by the pre-amplifier, which is to be described later. The pre-amplifier could have been incorporated in the main amplifier, but is housed in a separate screened unit to enable it to be placed in the most convenient position in the cabinet, only two plug-in cables being required to connect the two units. (The main amplifier is designed to give

Theoretical Diagram



The "Cooper-Smith" High Fidelity Amplifier. For the sake of clarity, the valve heaters have been omitted. The connections to these are given in the wiring instructions

easy access to all connections, controls, etc., from one side only.)

Now a few words of warning. Don't expect 100% "exactness." An amplifier, no matter how good it is, is only a link in a chain:

Performer — Studio — Microphone — Transmitter — Atmospheric conditions—Receiver—AMPLIFIER — Loudspeaker — Listening room—Your ear.

or

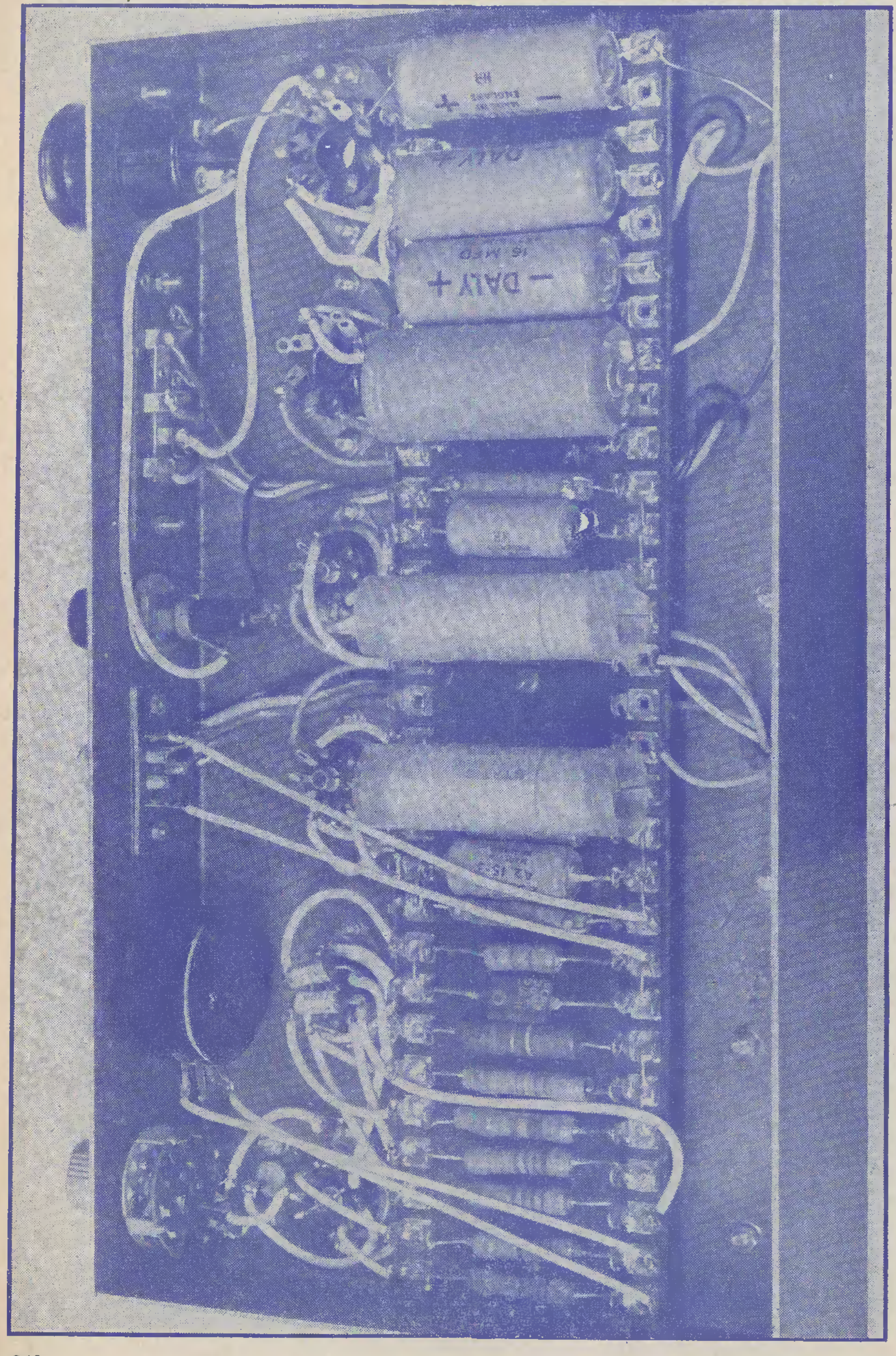
Performer — Studio — Recording Apparatus —Original Recording—Record Factory—AMPLIFIER — Loudspeaker — Listening Room—Your ear.

And in the same way as the strength of a chain is that of its weakest link, so the exactness of the reproduction is only as good as that of the worst factor above—and none of these is perfect. For example, although f.m. can provide distortionless and interference-free reception with a wide frequency range, if the broadcast consists (and it very often does) of a poor recording of a good performance the results you hear won't be any better than if you had a poor amplifier (it will probably sound worse, as you may be able to hear the faults better!). Similarly, it's no use feeding this amplifier from a poor pickup or into a poor loudspeaker. However, your amplifier will be above reproach . . . other things can be improved later—at least, those you are able to control.

MAIN AMPLIFIER PARTS LIST

Set out for easy reference to Circuit Diagram

R_1, R_2 — 2.2kΩ ½W 1% or matched, high stability
R_3, R_4 — 2.2kΩ ½W 1% or matched, high stability
R_5, R_6 — 120kΩ ½W 1% or matched, high stability
R_7 — 22kΩ ½W 10%, high stability
R_8 — 18kΩ ¼W 20%, high stability
R_9, R_{10} — 470kΩ ¼W 1% or matched, high stability
R_{11}, R_{12} — 4.7kΩ ¼W 20%, high stability
R_{13}, R_{14} — 220Ω 5W matched within 5%, wire wound
R_{15} — 10kΩ 1W 20%, high stability
R_{16}, R_{17} — 39Ω ¼W 20%, high stability
R_{18} — 39kΩ ¼W 20%, high stability
VR_1 — 2kΩ Potentiometer, linear, slider earthed
C_1 — 100pF mica
C_2 — 1.5pF ceramic
C_3 — 1.5pF ceramic
C_4 — 0.25μF 350V wkg.
C_5 — 0.25μF 350V wkg.
C_6 — 16μF 450V wkg. (Daly)
C_7 — 50μF 25V wkg. (Daly)
C_8 — 50μF 25V wkg. (Daly)
C_9 — 8μF 500V wkg. (Daly)
C_{10} — 16μF 450V wkg. (Daly)
C_{11} — 16μF 450V wkg. (Daly)
Mains Transformer 300–0–300V, 120mA; 6.3V, 3A CT; 5V, 3A (ElectroVoice A195)
Output Transformer 7,000Ω A-A, 3.5/15Ω sec 12W tapped at 20% of Pri. winding, Pri. ind. 58H, leakage ind. 22.8H (ElectroVoice D73)
Smoothing Choke 10H, 110mA, 200Ω DC res (ElectroVoice 101M)
V_1 — 12AU7
V_2 — 12AX7
V_3, V_4 — 6BQ5 ≡ EL84
V_5 — 5Z4
Chassis 12×7×2in ready punched, bronze finish, with grommets (H. L. Smith & Co. Ltd.)
Group Board 30-way 2¾in wide with fixing bushes and screws (H. L. Smith & Co. Ltd.)
Fuseholder and fuse, 3A
Mains Selector
Valveholders Int. Oct. (2)
Valveholders B9A (4)
Mains Plug and Socket (Bulgin)
Speaker Plug and Socket, 3-pin (Cinch)
Coaxial Plug and Socket
S_1 Switch, S.P.D.T. with knob
Nuts and screws, solder tags, T.C. wire, sleeving



Underneath of Cooper-Smith Amplifier *chassis—compare with point-to-point wiring diagrams in next issue*

Whilst on the subject of records, we'd better mention "surface noises." When you hear your favourite records on hi-fi apparatus for the first time you will probably hear things on them that you've never heard before, such as the "ting" of the triangle or even the soloist breathing; this is because you are hearing the higher frequencies for the first time. Now as well as the recorded noises, the needle will register the noise of its own passage over the surface, which also contains high frequencies, and you are going to hear these as well; you can't have one without the other, and you've got to decide how much needle hiss you are going to put up with. You will find that some makes of records hiss more than others, that dust can be heard as well as seen, and that records which have been played with a steel needle are ruined.

If your radio unit is for the reception of a.m. (amplitude modulation) it will be of the t.r.f. (straight) type or the superhet variety. If the former, many whistles and other extraneous noises will be reproduced by this amplifier that would not be heard on an ordinary one, and while the latter cuts out most of these, it does so at the expense of the higher and lower frequencies. If you are fortunate enough to be within the range of the B.B.C. f.m. (frequency modulation) broadcasts, however, you can obtain superb reproduction and the drawbacks are few.

To be continued

Autumn Audio Fair 1957

It was your correspondent's first visit to Harrogate, the venue of the First Northern Audio Fair from the 25th to 27th October, and it seems likely that the same might apply to many of the visitors to the Grand Hotel. Reliable reports indicate that contacts were made with enthusiasts from as far afield as Coventry and Birmingham in the south, Carlisle and Newcastle in the north. Enthusiastic also were the organisers, who were able to report a total of 18,000 visitors by the end of the show.

In spite of the attendance, the wide corridors allowed easy access to the various demonstration rooms, even if it was impossible to get into them! As "one of the crowd," it was noted that quite apart from the ready assistance available from the thirty-two exhibitors, the organising committee were to be congratulated on the excellent staffing and other arrangements together with the attractive and comprehensive catalogue.

There can be no doubt that the cult of "Hi-Fi" has caught the public imagination, and in consequence it is pleasing to see a new range of equipment being established. Such equipment (should one call it "Mid-Fi"?) while not of the very highest quality in terms of performance, will, nevertheless, give good results and for a modest outlay. It must be stressed that examination showed no deterioration in the quality of the workmanship and materials used. This, surely, will be the future trend. While there will always be a demand for the best, the layman is becoming audio-minded, and he will require reasonably priced apparatus which need not be superlative in performance.

A leaflet from the Dulci stand modestly describes the H4PP as a radiogram chassis, but it is actually a useful combination of a.m./f.m. radio with a 6 watt push-pull amplifier operating under distributed load conditions. Independent bass and treble controls are provided, and there is provision for tape record and replay and disc reproduction. The frequency response is claimed to be 40 to 18,000 c/s ±1 db. Under £30.

The Pye "Mozart" amplifier has full controls and measures only 10½in x 3½in x 5in, yet is said to have an undistorted output of 10 watts from a single EL34. A 12 watt speaker, designed to fit on a bookcase, would seem to be a worthy companion. 41 gns. for the pair.

E.A.R. offer the "Triple-Four" ultra linear amplifier at 11 gns. This unit gives 6 watts output, with bass and treble controls, and has a frequency response within 1 db from 50 c/s to 15 kc/s. Again of small size, the "Triple-Four" does, however, require external power supplies.

The writer was then prompted to look for a suitable record player, and saw the Garrard TA/Mark II. This is a four-speed single record player which, though not claimed to be a transcription unit, gives the impression that it would serve its owner well. £9 15s. 8d. including tax.

While it is impossible to mention more than a few of the interesting products displayed, space must be found for a note on the Trix "Everyman" system which is comprised of two units. The one contains a 6 watt amplifier and Garrard turntable, the other is a three-speaker reproducer of convenient size. Trix are renowned for the attractive styling of their products and the "Everyman" is no exception. A visit to the demonstration room showed that the performance is equally pleasing.

It was hoped to pass comment on the Connoisseur system of stereophonic sound on disc, but on the three separate occasions that their demonstration room was visited, too many other visitors had the same idea!

There can be no denying that Audio Fairs are here to stay, providing as they do a unique opportunity both to hear the best in audio equipment under favourable conditions and to meet the technical brains of the various manufacturers.

Can Anyone Help?

Requests for information are inserted in this section free of charge; subject to space being available

B. Blackburn, 30 Greenlea Avenue, Westfield, Yeadon, Leeds, urgently requires the manual of the T1154/R1155 combination. Please state price required.

* * *

H. V. McEvoy, 90 Buersil Avenue, Rochdale, Lancs, asks if any reader can supply details of the power pack and/or any other data of the Admiralty receiver type 394G, Admy. Pat. No. 361. Any expenses gladly met.

* * *

R. Pollock, 32 Worley Drive, Bradford Moor, Yorkshire, is in need of the service sheet for the 38 Walkie-Talkie, and would like lists of other service sheets available.

* * *

J. M. Aspinall, 97 Mayfield Road, Dagenham, Essex, would be grateful for the loan of the manual and/or circuit of the R.C.A. Aircraft Receiver AVR-20.

* * *

K. B. Levitt, 55 Old Winton Road, Andover, Hants, wishes to know if any reader can advise on any improvements to the output stage of the R.109 Set, or any other modifications.

* * *

Peter Short, c/o P.O. Box 6226, Johannesburg, South Africa, asks if anyone can help him get a comprehensive book or reprint from a magazine covering modifications and improvements to the R.1155 and RF24, RF26 Units.

* * *

W. Markham, 12 Harcourt Close, Linslade, Leighton Buzzard, Beds, would like to beg, borrow or buy the circuit diagram of a tape recorder made by Audigraph Ltd. (Tamsa Products); valve line-up: Recorder, A.F. Amp. into 6SC7; Playback, A.F. Pen into 6J5. All letters answered.

* * *

P. Wright, 111 Yew Tree Road, Birchencliffe, Huddersfield, W. Yorks, will pay gladly for the service manual, circuit and/or any other information on the Eddystone 358X receiver. He would also appreciate advice on where to get a faulty coil repaired, and is also searching for information on the R.109.

* * *

H. Groves, 28 Elmwood Road, Chiswick, London, W.4, telephone CHI 6040, is in need of information on an Infra Red Telescope. Expenses paid.

* * *

J. Long, 254 Princes Avenue, Kingsbury, London, N.W.9, would like to purchase the service manual for the Ekcovision TV model TSC.113.

N. A. B. Plumb, 43 Galsworthy Square, Whipton, Exeter, telephone Exeter 67969, wishes to purchase or borrow an instruction manual, also a circuit, of the AVO Valve Tester with Separate Base Unit.

* * *

W. Winter, 10 Siding Street, Stacksteads, Bacup, Lancs, is seeking, and is willing to pay for, information, circuit, manual, etc., on the Admiralty receiver G.25 Marconi 1945.

* * *

G. H. K. Mitchell, 22 Landale Road, Peterhead, Aberdeenshire, wishes to purchase a copy of "Building and Operating the Sound Master Tape Recorder."

* * *

P. Bidhell, 61 Banbury Road, Stratford-on-Avon, Warwicks, wishes to purchase information on the Receiver Unit type 6A (10P/13014).

* * *

N. Hales, G2DTO, 165 Longley Road, Tooting, London, S.W.17, seeks information on the ex-R.N. receiver RL85, 28-85 Mc/s, believed i.f. 5.25 Mc/s. Can anyone help?

CONSIDERATIONS IN THE PRACTICAL USE OF . . TRANSISTORS

By E. G. Bulley

To-day, the triode type of transistor is readily available to the constructor and experimenter from many advertisers in this magazine. Nevertheless, the price of such devices is still quite high for the average pocket, especially since they can be so easily damaged or destroyed. It is necessary, therefore, to familiarise oneself with these components, and with care it will be possible to construct equipment without any undue worry.

As in radio valve practice, it is essential that the maximum ratings are never exceeded. Such ratings, however, depend a great deal on the ambient temperature, and they can in certain circumstances be increased as long as the temperature rating is decreased. Reference should therefore be made to the manufacturer's data for such information or advice on the transistor in question.

The types that are currently available are termed p-n-p transistors, and with these it must be remembered that the collector should be connected to the negative battery termination so that positive "holes" are attracted.

The maximum dissipation is an extremely important characteristic of the transistor, as any increase in this factor will cause a sharp rise in the temperature of the device. Overheating will either destroy or severely damage the transistor, and it is therefore important, when designing or constructing transistorised equipment, to ensure that the collector voltage and current ratings are not exceeded.

Whilst on the subject of overheating, it must be emphasised that extreme care must be taken when soldering the transistor into circuit. The act of soldering should be carried out as quickly as possible. Furthermore, protective devices such as heat shunts should be used when soldering, so as to ensure that the heat from the iron is not allowed to be conducted up the leads to the transistor. Failure to take such precautions will result in the conducted heat destroying the transistor. Another important point which should be borne in mind is that many manufacturers recommend, particularly in the case of higher dissipation transistors, that these should be mounted in contact with a specified minimum area of metal to conduct away generated heat, much in the same way as contact cooled metal rectifiers.

So much for temperature considerations; next we must look at the matter of polarity. It is essential that the specified polarity of the power supplies is adhered to, and once again the constructor is referred to the manufacturer's data. By "polarity of the power supplies" is meant the relative polarities of the collector, base and emitter.

The greater number of transistors, the exception being power types, have leads which are in the order of 10 to 20 thousandths of an inch in diameter. Care must obviously be taken when bending these leads to fit into the circuit, and it is advisable to leave them as long as is possible. Where necessary, thin sleeving may be used to prevent adjacent leads shorting.

Another point to remember is that the battery should always be disconnected before a transistor is inserted into or removed from the circuit. Otherwise, damage may be caused by surges.

AN INEXPENSIVE IMPEDANCE COMPARATOR

by S. LOUGHLIN

The determination of values of resistance, capacitance and inductance is generally thought to be an expensive business, involving direct-reading instruments well beyond the average enthusiast's junk box or pocket. Here's one way round the problem—an extremely simple and inexpensive little instrument which will measure the impedance of any component at a known frequency directly in ohms. Using this figure, conversion (when required) to values of capacitance or inductance is an easy matter by means of a cheap set of ABAC tables. This instrument requires very little calibration, is compact and economical of components, and you will soon find it indispensable in your shack or workshop. (Particularly if, like the writer, you take an insane pride in the use of "unknown" ex-W.D. components!)

Uses

The instrument performs the following functions:

1. The direct measurement of unknown resistors.
2. The direct measurement of the impedance of any component at any audio frequency.
3. The indirect measurement (via ABAC tables) of unknown capacitors and inductors.
4. The indirect measurement of unknown frequencies in the audio range.

In addition, the instrument has proved particularly useful for the creation of resonant conditions in the audio range.

Principle of Operation

The circuit of the instrument (less power supplies) is shown in Fig. 1. In all essentials it is balanced about the earth-line and closely resembles a pair of valve voltmeters working in opposition. Unbalance between the two halves of the circuit is shown on the centre-reading meter M_1 connected between the anodes of V_{2a} and V_{2b}.

In operation the instrument is first balanced with toggle-switch S_2 at "normal" (shorting points A and B). Adjustment of R_8 then corrects any discrepancies in components or valve parameters between the two networks.

A component of unknown value is connected between the X terminals, and a known input frequency (50 cycles) injected into the comparator networks by means of the low-impedance transformer T_1. R_1 is then adjusted until a centre-reading on M_1 is obtained with the toggle switch S_2 depressed. The comparator circuits will then be balanced, and the voltages developed across R_1 and the unknown will be equal. This means that the impedance of the unknown at 50 cycles must be equal to R_1, and can, therefore, be read off from the instrument. If the unknown is a resistor this will be its value in ohms; if it is a capacitor or an inductor, the reading from the comparator will require conversion on ABAC tables.

Circuit in Detail

A d.p.d.t. switch allows the selection of a 50 cycles frequency at 6.3v. from the heater line, or of any unknown frequency where this has to be measured. Input to the comparator is by way of T_1, a 1 : 1 ratio low-impedance transformer, for application to the calibrated resistance R_1 and any unknown component connected between the X terminals. R_L is a current limiter which prevents damage when the component to be tested is of very low impedance.

The alternating voltages appearing at points A and B are rectified by the two diodes V_{1a} and V_{1b}, and the negative-going d.c. voltages developed across the load resistors R_3 and R_4 are applied to the grids of V_{2a} and V_{2b}. C_3 and C_4 short to earth any ripple frequencies reaching the grids through the stoppers R_2 and R_5, and also maintain a small negative charge on the grids. C_1 and C_2 complete the diode networks by isolating the d.c. voltages from the comparator input.

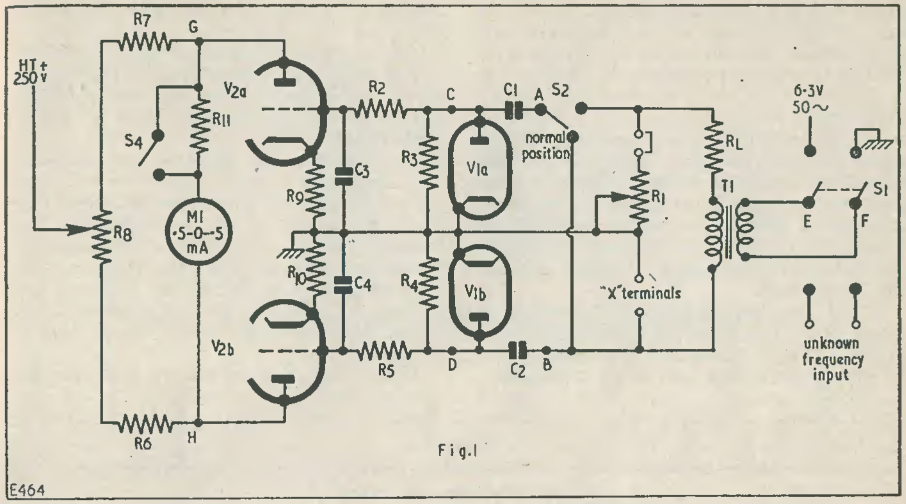


Fig.1

Components List (Prototype)

RL	10Ω	C_1, C_2	0.1μF
R_1	See text. 50kΩ var.	C_3, C_4	0.01μF
R_2, R_5	See text. 10MΩ	T_1	See text. 1 : 1 low impedance
R_3, R_4	See text 10MΩ	S_1	D.P.D.T.
R_6, R_7	See text. 33kΩ	S_2	See text. S.P.D.T.
R_8	10kΩ var.	S_4	SP "on-off"
R_9, R_{10}	See text. 50Ω	Terminals	8
R_{11}	250kΩ	V_1	EB41, B8A base
M_1	0.5–0–0.5mA (see text)	V_2	6SN7, IO base
M_2	1mA (see text)	Jack and socket	1
Shorting link	1 piece of wire		

In the anode circuits of V_{2a} and V_{2b}, R_7 and R_6 are the triode loads, and R_8 the balancing potentiometer. R_{11} protects M_1 from overload before approximate balance is achieved, and S_4 cuts R_{11} out of circuit for final balancing.

Component Values and Tolerances

Owing to the pre-balancing procedure allowed by R_8, no great accuracy of components is required beyond adhering to the general values specified. The use of resistors of the normal ± 10% range will be found adequate.

M_1 is ideally a centre zero 0.5–0–0.5mA meter, but in the prototype a straight 1mA meter was used. The needle was adjusted to rest at the centre of the scale, and the magnetic shunt (a small piece of iron across the pole-pieces) removed to increase sensitivity. Whatever meter is used, a smooth but "lively" action is essential.

For power supplies, any pack which will deliver 240–280V h.t. at 20mA and 6.3V at 0.9A is suitable; a lower value of h.t. could probably be tolerated if necessary.

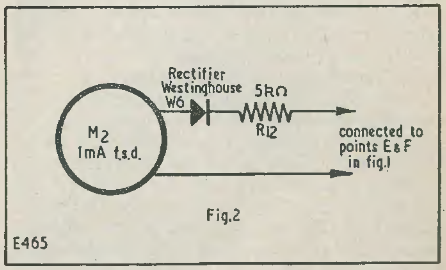


Fig.2

Construction

Almost any handy chassis can be used, as layout is not very critical, but it is a good plan to screen the upper from the lower half of the circuit. In the original model a slight tendency to instability was cured by mounting M_1 in a separate wooden case and running a length of twin screened cable to an output jack on the chassis. All the switches and terminals are brought out to a front panel on the box housing the comparator chassis.

Calibration

The accuracy of the instrument depends on the calibration of R_1. This resistor can either be a resistance box of $50k\Omega$ total resistance or a standard non-reactive potentiometer of the same value with a dial and pointer fitted. The potentiometer should be calibrated with a resistance decade borrowed for the purpose.

A link has been included in the circuit in series with R_1 to allow for the inclusion of a known "ballast" resistor for the measurement of impedances higher than $50k\Omega$, if necessary.

terminals. Inject 50 cycles and balance as in (1).

The reading (in ohms) obtained from R_1 will be equal to the impedance of the capacitor at 50 cycles. Now read off value of capacitor (in microfarads) from a set of ABAC tables.

3. *To measure the value of an unknown inductance*

Follow standard procedure as above, and read off value of R_1 (in ohms). The measurement of an inductance is complicated by its d.c. resistance, and this must now be determined by a quick test with a battery and meter. A 1.5V cell and a milliameter reading up to about 200mA would do all that is required here.

When both the impedance and the d.c.

TABLE 1

Approx. Reactance (ohms)

50 *cycles*				1,000 *cycles*			
L (Henrys)	*ohms*	*C (μF)*	*ohms*	*L (Henrys)*	*ohms*	*C (μF)*	*ohms*
0.001	0.3142	0.001	3,184,000	0.001	6.282	0.001	159,200
0.01	3.142	0.01	318,400	0.01	62.82	0.01	15,920
0.1	31.42	0.1	31,840	0.1	628.2	0.1	1,592
1.0	314.2	1.0	3,184	1.0	6,282	1.0	159.2
10.0	3,142	10.0	318.4	10	62,820	10	15.92
100.0	31,420	100.0	31.84	100	628,200	100	1.592
1,000	314,200	1,000	3.184	1,000	6,282,000	1,000	0.1592

Operation

1. *To measure the value of an unknown resistance*

After warming-up, the instrument is first roughly balanced with S_4 open and toggle switch S_2 in its normal position shorting points A and B. When adjustment of R_8 has given a nearly central reading on M_1, close S_4 and trim again for exact balance.

Open S_4 and connect the resistance to be measured between the X terminals. Inject a 50 cycles frequency via S_1 and T_1, and ascertain, by depressing S_2 for short periods, when successive adjustments of R_1 have brought the whole circuit into balance. S_4 can now be opened and R_1 used to trim for final balance. M_1 should now remain steady whether S_2 is depressed or not.

The setting of R_1 will now correspond exactly with the value of the unknown resistor, and this value can be read off directly from R_1.

2. *To measure the value of an unknown capacitance.*

Balance valve networks exactly as in (1). Open S_4 and connect capacitor to the X

resistance are known, the inductance in henrys is found by the following formula:

$$L = \frac{\sqrt{(Z^2 - R^2)}}{2\pi f}$$

where Z = the impedance in ohms, and R = the d.c. resistance in ohms. The term $2\pi f$ = 314.2 at 50 cycles, the frequency used in this comparator.

4. *To measure an unknown audio frequency*

This is accomplished by reference to a capacitor connected between the X terminals. To obviate the need for a close-tolerance component, the impedance at 50 cycles of any capacitor of convenient value, say $0.1\mu F$, is determined in the normal way on the comparator. S_1 is then switched to select the unknown frequency, and a second reading on R_1 obtained. Use of a simple formula will now give the required frequency value:

$$f = \frac{Z_2 \text{ (at unknown frequency)}}{Z_1 \text{ (at 50 cycles)}} \times 50 \text{ c/s}$$

Care must be taken when measuring external frequencies not to apply too high a voltage to the comparator—6.3V must be thought of as a maximum. As a further refinement, therefore, a small a.c. voltmeter was added to the unit (Fig. 2). With a $5k\Omega$ resistor as shown, 6.3V caused a 1mA meter in the writer's possession to move 1/3rd "up scale." Any similar arrangement could be made up quite quickly and checked against the heater line of the comparator.

5. *The creation of resonant conditions in the audio range*

Used in conjunction with the formulae of a.c. theory textbooks, the prototype comparator has been very useful in audio work of all kinds. One formula is worth noting here; where the impedance of an inductor is equal to the impedance of a capacitor at any particular frequency, the two components will form a resonant circuit at that frequency whether connected in series or in parallel. With the easy testing facilities which the comparator offers, this will be worth remembering when constructing filters and bandstop networks from stock components.

1957 RADIO HOBBIES EXHIBITION

continued from page 335

plete with all valves, speaker and attractive cabinet, was only £9 7s. 6d. A complete range of the well-known Geloso equipment was also on show. Among these were to be seen the Geloso signal shifter, model 4/101, the double-conversion superhet G207-DR, the transmitter G210-TR and a miniature tape recorder type TR175.

Labgear Ltd.

This well-known company has now introduced an oscilloscope kit for the build-it-yourself enthusiast, in which the use of printed circuits eliminates a large proportion of wiring time and also reduces the possibility of wiring errors by the constructor. The kit is supplied with comprehensive step-by-step instructions and when completed is particularly suitable for t.v. waveform examination due to its excellent frequency response and high sensitivity. With a 6in screen of medium persistence, providing a blue trace, the instrument has a sweep frequency range of 20 c/s to 500 kc/s in 5 ranges. Operating either from a 110–115 or a 200–250V a.c. source, the power consumption is 95 watts. The overall dimensions of the oscilloscope are 12in wide by 20in high by 24in deep. The Labgear Signal Generator kit, model E5113, also uses the printed circuit technique for the same reasons as outlined above. The generator covers from 80 kc/s to 110 Mc/s in 7 switched ranges on fundamentals.

Cossor Instruments Ltd.

A range of test instruments, now supplied to constructors in kit form, was on show. The model 1044K Valve Voltmeter employs the printed circuit technique now coming into vogue with kits supplied direct to the public. The electronic d.c. voltmeter portion of this instrument has 7 ranges—1.5, 5, 15, 50, 150, 500 and 1,500 volts full-scale deflection with an accuracy of ±3% on all ranges. The a.c. voltmeter side has 7 r.m.s. ranges as listed above with an accuracy of ±15% of full-scale deflection on the 1.5V range and ±5% on all other ranges. The 7 peak to peak ranges are 4, 14, 40, 140, 400, 1,400 and 4,000 volts full scale. The ohmmeter ranges are ×1, ×10, ×100, ×1,000, ×10,000, ×100,000 and ×1,000,000. Measurements of from 0.1 ohm to 1,000 megohms are made with the internal battery. Power supplies are 100-125V and 200-250V a.c., consumption 10 watts approximately. The model 1045K Single Beam Oscilloscope kit and the Model 1071K Double-Beam Oscilloscope kit were also on display. A further item of interest here was the RF Probe Model 1069.

Panda Radio Company

Here were to be seen, and admired, the famous Panda "Cub" and "Explorer" transmitters which, with the PR-120-V Tx form a well-known trio. An impedance matching unit, priced at £4 19s. 6d., was also to be seen.

Home Radio (Mitcham) Ltd.

A live demonstration of the "Mercury" switched f.m. tuner, coupled with the display of the well-known Eddystone Communication receivers, formed an attractive stand here. The B.B.C. children's 1-valve receiver kit was well laid out on a peg-board backing, and this, together with the range of Eddystone components, formed an interesting counter show.

Mullard

Apart from a large range of valves and t.v. tubes, several items of equipment, capable of being easily constructed by the home hobbyist, and sponsored by the Mullard design laboratories, were on view. The by now universal 3 valve 3 watt and the 5 valve 5 watt amplifiers, together with a 7 watt a.c./d.c. unit, were to be seen. In addition to these were a 5 valve 20 watt amplifier, a 4-channel audio mixer unit, an f.m. tuner unit and a 2-valve pre-amp for the 5-valve 20-watt amplifier.

Taylor Electrical Instruments Ltd.

Of more general interest were the Radio and T.V. Signal Generator Model 68A-100 kc/s to 220 Mc/s on fundamentals; a Sweep Generator Model 92A; an R.F. Oscillator Model 191A, for transformer, amplifier and speaker response tests; and a Portable Multi-Range Tester Model 77A.

Radio Society of Great Britain

The centre of attraction here was the "live" amateur radio station GB3RS/A, which was, at the time the writer was present, busily making contacts with various amateurs, the Hallicrafters SX28A receiver performing extremely well. A large selection of home constructed and designed equipment of all kinds and types were to be seen displayed on the various stands. An Electronic Key by C. Kenny, G3LJK; the winning N.F.D. transmitter "The Mayflower" by J. White, G3XH, and E. Charman, G6CJ; the 1.7/3.5 Mc/s winning N.F.D. transmitter by G. Robertson, G3GXD, and the All-Band Table Top Transmitter by G. M. Stone, G3FZL, were among many other items which R.S.G.B. members had kindly lent for show on the Society stand. All credit is due to all who contributed to this impressive display of constructional ability, and particularly to G8TL and his helpers who organised this assortment of radio equipment.

Clyne Radio Ltd.

Many kits offered by this company to the home constructor were displayed and working for demonstration purposes. The 3–4 watt amplifier, a most compact unit complete with power supply and capable of being constructed by the veriest beginner, was of singular interest. The "Rambler" portable receiver, domestic receivers of several types—both "straight" and superhets, a battery eliminator, transistor receivers and a very interesting printed circuit f.m. tuner unit, all reasonable in price and comparatively easy to construct, were noted. Also to be seen was the new Jason Short Wave Converter—in fact, it was the prototype that was on view—this being the only one in existence at the present time.

continued on page 356

BUILDING A . .

FREQUENCY METER

Test Gear for the Tape Recording and Hi-Fi Constructor—Introduction and Uses

by H. GARLICK

To the A.F. enthusiast, particularly the reader designing his own tape recording equipment, a frequency meter is an invaluable piece of test gear. Simple to construct and foolproof in use, it provides a very reliable direct reading of any single frequency that it is monitoring.

Meters are available on the market which read frequency without any associated electronic circuitry, but their usual range is very restricted, and in fact instrument manufacturers generally confine the scale reading to power frequencies. The instrument about to be described, however, is capable of reading frequencies in the band 0 to 10 kc/s in three ranges. By an extension of the same principles given below, a frequency meter can be designed to cover any required band of frequencies.

Using such a meter when checking tape recorder amplifier characteristics makes the performance analysis an extremely simple task.

A test recording would be made, using either a gliding tone frequency test record, or the output from an audio oscillator; and on playback, the tape amplifier output would be connected both to an output meter and the frequency meter as well as the usual loudspeaker. Changes in output level would then be identified immediately with the frequency at which they occur, providing a direct and straightforward assessment of the gear's performance.

The frequency meter may also be used with the home constructed audio signal generator as an absolutely reliable calibrating device. So often the biggest difficulty encountered in this type of oscillator is an accurate means of calibrating the output frequencies of the instrument—a difficulty solved with the aid of the frequency meter.

Using the technique outlined for tape recorder amplifier analysis, the frequency meter becomes a "must" as an item of test equipment for the hi-fi amplifier constructor.

Principle of Operation

Fig. 1 shows a pulse train that might be generated typically by a conventional multivibrator. In such a circuit the pulse duration t in the figure could be, for example, 100 μsecs and the interval between pulses T might be 1,000 μsecs. The ratio of these times t/T is known as the mark-space ratio, and such a pulse ratio would indicate that current was being drawn by one part of the circuit for 1/10th of the time that the circuit was quiescent. In other words, the average current drawn would be 1/11th of the peak pulse current. The dotted line in Fig. 1 indicates approximately to scale the average current for the current pulse shown.

This effect may be easily produced with the simple meter and battery circuit shown in Fig. 2. When the switch S is closed continuously the meter will indicate current, determined by the battery volts E and the resistance R. If, for example, the battery e.m.f. were 10V and the resistance 100 ohms, the meter would indicate a current of 100 mA. If now the switch is opened and closed at a rate too fast for the meter to follow, the reading will fall from 100 mA to some value determined by the on/off, or mark/space, ratio of the circuit. If, for example, the switch is rapidly made and broken, so that on the average over a period it is closed for only half the time, then the current reading will fall to 50 mA. This is because the inertia of the meter movement prevents the needle from following the rapid fluctuations of current and hence it indicates only the average current flowing.

It is this same simple principle which enables us to use the conventional moving coil meter to monitor frequencies in the circuit described in this article.

Referring again to Fig. 1, it should be obvious that if twice the number of pulses of the same duration t, as already shown, were to occur in the same period of time, then the average value of current would be doubled.

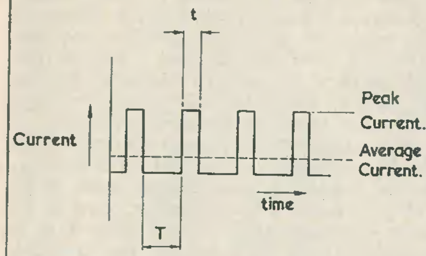


FIG. 1.
Relationship between Peak and Average Current, and Mark-Space Ratio.

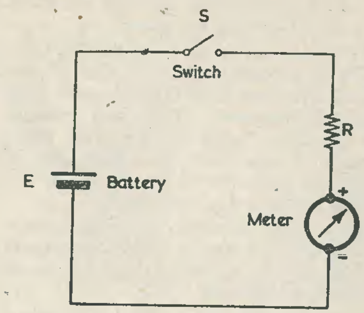


FIG. 2.

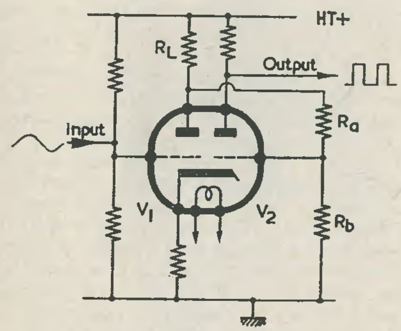


FIG. 3.
Basic Schmitt Trigger Circuit.

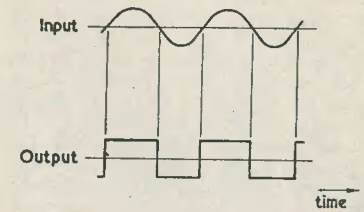


FIG. 4.
Time relationship of input & output waveforms of Schmitt Trigger Circuit.

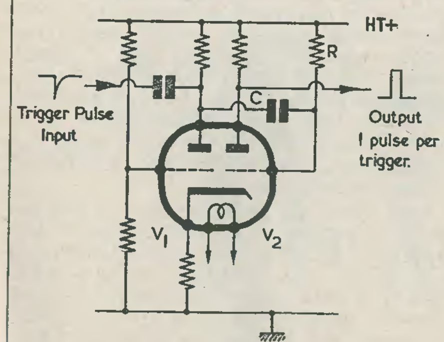


FIG. 5.
Basic Multivibrator Circuit.

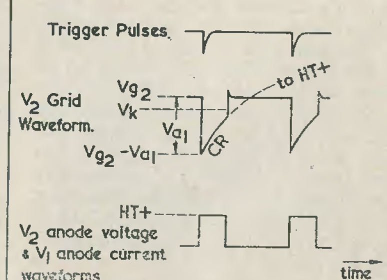


FIG. 6.
Multivibrator Timing Waveforms.

M465

In fact, in a given time the average current will be directly proportional to the number of pulses occurring provided that the duration of each pulse is always the same.

Such a condition is easy to realise in a triggered multivibrator, where a pulse of predetermined duration is produced each time the circuit is triggered. If we can arrange that the circuit is triggered once every cycle of an incoming sine wave, then the pulse of predetermined duration will occur at a rate determined by the input frequency.

The only practical difficulty with such a system is to devise a circuit which will trigger the multivibrator accurately from a sine wave of reasonable amplitude.

A suitable circuit, widely used for such a purpose, is given in Fig. 3 and discussed below.

The Schmitt Trigger Circuit

The circuit uses two triode valves, their cathodes strapped, one valve being directly coupled to the other via the dividing chain R_bR_a. The values of the resistors R_a and R_b in conjunction with that of the anode load R_1 to which they are connected, are so chosen that V_2 grid is at a lower potential than V_1 grid when V_1 conducts, thereby ensuring that V_2 draws no current. If the potential of V_1 grid is reduced slightly by the input signal, then V_1 anode potential, and hence that of V_2 grid, will rise. At the same time the cathode potential, which has been due solely to the current drawn by V_1, will fall—thereby decreasing the bias between V_2 grid and cathode.

If this decrease in bias is sufficient, V_2 will draw current. When this happens the cathode potential will increase due to the additional current flow, thereby increasing the bias on V_1. This in turn reduces the anode current in V_1 still further with a consequent rise in V_1 anode and V_2 grid potentials. The nett effect being cumulative, results in V_1 being cut off and V_2 drawing current. This condition will persist so long as the input is held negative. As soon as it returns to its normal potential the reverse effect takes place, when V_1 conducts and V_2 is cut off. The transition between conduction and non-conduction is extremely rapid, and in a well designed circuit a very small change of input voltage is required to achieve this effect. Consequently if the input signal is a sine wave, the output waveform monitored at V_2 anode will be a square wave and a typical input, output wave train is shown in Fig. 4.

Such a circuit, therefore, will enable us to produce a square wave of constant amplitude and of the same frequency as any input sine wave when the amplitude of the latter is as small as 3V.

The Multivibrator

Most readers will be familiar with the basic multivibrator circuit shown in Fig. 5, the outline of whose operation is given below.

Here again the two valves, V_1 and V_2, share a common cathode load and the biases of their respective grids arrange that only one valve at a time can conduct. Because the grid leak R at V_2 grid is returned to the h.t. rail, then V_2 will be the valve which conducts (the value of R is generally sufficient to prevent excessive grid current flowing), while the circuit remains untriggered. The application of a positive-going trigger pulse at V_1 grid or a negative-going trigger pulse at V_1 anode will result in an instantaneous drop in potential at V_2 grid due to the coupling provided by condenser C. This will result in a fall in cathode potential and V_1 will now be able to conduct due to the reduction in its grid bias. This in turn causes a drop in voltage at V_1 anode and hence a still further drop at V_2 grid. In fact, when V_1 conducts due to this transitional trigger voltage, as in the Schmitt Trigger Circuit, the regenerative action thus initiated results in V_2 being cut off, allowing V_1 to conduct. The period of the latter's conduction, however, is restricted by the time taken for condenser C to discharge through the grid leak R and V_1 anode load. The waveform of the voltage appearing at V_2 grid shown in Fig. 6 shows that the grid is forced instantaneously from a potential V_{g2} by an amount equal to the conveyed drop at V_1 anode (say, V_a volts) to a potential V_{g2}–V_a volts, which is considerably negative with respect to the new cathode potential, V_k.

The potential at V_2 grid starts to rise towards the h.t. potential, as condenser C discharges through resistor R, and V_2 grid, therefore, rises at a rate determined by the time constant CR. When this grid potential has risen to within a few volts of V_k, V_2 is once again able to conduct, momentarily increasing the total cathode current. The consequent increase in cathode potential and hence increase in bias on V_1 reduces the anode current of the latter, and V_1 anode voltage instantaneously rises, lifting V_2 grid voltage at the same time. Once again, therefore, the action is regenerative and V_2 is returned to its original conducting condition.

Nothing further will happen until another trigger pulse occurs.

The lower waveform in Fig. 6 shows the pulse appearing at V_2 anode, and its time relation is indicated with respect to the grid waveform. The duration of this pulse clearly is fixed by the time constant CR and the voltages appearing in the circuit, and will, therefore, be independent of the rate at which the circuit is triggered, provided that the latter is never more frequent than the width of the pulse will allow. The voltage pulse at

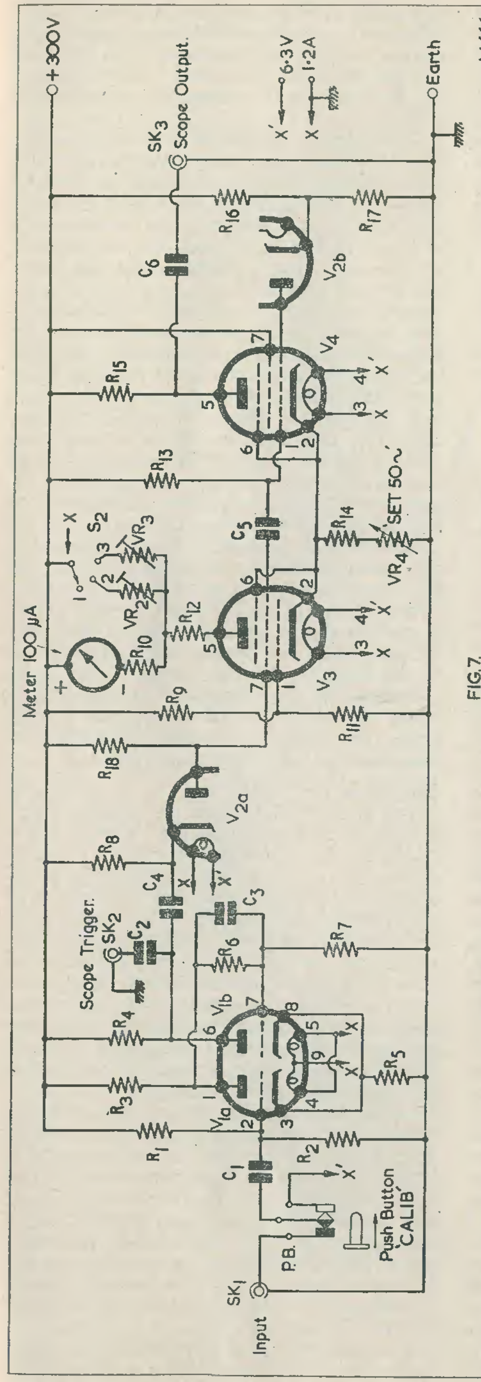


Fig. 7 Circuit of Frequency Meter. All resistors 10% tolerance except R_1—5%

Component List

Resistors

R_1	510kΩ ¼W Erie
R_2	100kΩ ¼W Erie
R_3	8.2kΩ ½W Erie
R_4	4.7kΩ ½W Erie
R_5	4.7kΩ ½W Erie
R_6	270kΩ ¼W Erie
R_7	1.2MΩ ¼W Erie
R_8	150kΩ ¼W Erie
R_9	100kΩ ½W Erie
R_{10}	1kΩ ¼W Hi-stab (see text)
R_{11}	56kΩ ½W Erie
R_{12}	15kΩ 2W Erie
R_{13}	1.5MΩ ¼W Erie
R_{14}	6.8kΩ 1W Erie
R_{15}	1kΩ ½W Erie
R_{16}	150kΩ ¾W Erie
R_{17}	100kΩ ½W Erie
R_{18}	33kΩ ¾W Erie

Variable controls

VR_2	250Ω wirewound pot (see text)
VR_3	25Ω wirewound pot (see text)
VR_4	5k wirewound pot

Capacitors

C_1	0.25µF 250VW paper
C_2	22pF ceramic or mica
C_3	10pF ceramic or mica
C_4	100pF ceramic or mica
C_5	470pF ceramic or mica
C_6	0.1µF 350VW paper

Valves

V_1	ECC81, 12AT7, B152 or B309
V_2	EB91, D77, D152 or 6AL5
V_3	EF91, 6F12, 6AM6 or Z77

Meter

0–100µA M.C. 2½"

Sundries

SK_{1-3}	Pye sockets
S_2	3-way rotary switch
P.B.	S.P.C.O. push button or spring-biased toggle switch

3 B7G valveholders
1 B9A valveholders
Tag-strips, 4 and 6BA nuts and screws
Connecting wire, sleeving, etc.

V_2 anode appears only while V_1 draws current, and hence the current waveform in V_1 is of exactly the same duration as the voltage pulse illustrated at V_2 anode. If, therefore, a meter be connected in series with the anode load of V_1, this meter will read *the average* current drawn by V_1, which in turn is determined only by the rate at which the circuit is triggered, since the pulse duration is constant. In other words, the meter reading will be proportional to the frequency of the triggering source.

From this simplified circuit description, therefore, we can see how the principles outlined in the opening paragraphs can be applied to the design of quite a simple frequency meter. Certain refinements are incorporated in the final circuit to provide more reliable operation as the circuit of Fig. 7 shows. These are discussed later.

Meter Range Restrictions

A reasonably sized meter will have a scale which can be read with reasonable accuracy down to 1/100th of full scale deflection. To be of any practical use, the frequency meter —to cover the audio range at least—must read from 0 to 10 kc/s, a ratio of 2,000 to 1, and hence it is impossible to use the meter directly to cover this range; the range must be covered in a series of readable steps. This is achieved in much the same way as a multi-range ammeter is constructed, using shunt resistors. Reasonable scale readings will result if the anticipated range is covered in three steps, viz. 0–100 c/s, 0–1,000 c/s and 0–10 kc/s. This poses the problem of separate scale calibration for each range, one which, in fact, is quite simply accomplished and is described below. In addition, a basic calibration against some standard and readily available frequency must be effected from which all ranges can be calibrated. The mains supply is the obvious source of a reliable frequency standard, and a simple means of calibrating the meter on one range against the mains frequency is incorporated in this design. The calibration, once set, then covers all three ranges.

To avoid circuit complications, the duration of the pulse produced by the multivibrator is maintained constant over the entire frequency range from 0 to 10 kc/s, rather than changing its value with each range that the circuit reads. Now at 10 kc/s the interval between pulses is 100 μsecs, and, therefore, the longest pulse that can be tolerated is somewhat less than this duration—say 90 μsecs. In this instance, this will result in a mark/space ratio of 9 and current will be drawn by the left-hand multivibrator valve (V_3 in Fig. 7) for 90 of the 100 μsecs period of the pulses. Because the meter connected in this anode circuit responds to the average current drawn, it will read only 9/10 of the anode current flowing in V_3 when the latter conducts. This, then, is the condition for the maximum frequency reading that the meter must indicate, and the deflection produced will be adjusted to give a full scale reading corresponding to 10 kc/s.

Covering the minimum frequency range, the meter must produce a full scale deflection for an input of 100 c/s. At this frequency the period of the pulses is very long—namely 10,000 μsecs, and yet the pulse duration will still be only 90 μsecs or so. In this instance the average current indicated by the meter will be 90/10,000 of the current drawn by V_3 when it conducts. Some idea of the sensitivity required for the meter movement can be gained by noting this fact when it is realised that this average current must produce a full scale deflection corresponding to 100 c/s.

If V_3 draws a little over 11mA when it conducts, then for the meter to read full scale at 100 c/s, it will be drawing an average current of 90/10,000 of 11mA, which is approximately 100 μA. This determines the type of instrument to be used.

Reverting to the highest frequency scale, it was seen that the meter would indicate 9/10 of the anode current drawn which, from the above, will be about 10mA. Obviously, both to protect the meter and to enable such frequencies to be interpreted, the meter will have to be shunted on this range. The same procedure is also necessary on the middle range covering 0–1,000 c/s when, at full scale, the average current in the meter circuit would be approximately 1mA.

Setting up the Meter

The appropriate shunts are adjusted prior to assembling the meter in the unit, and Fig. 8 shows the detail of the meter circuitry ready for setting up. The 1kΩ resistor in series with the meter is the same resistor which is wired in the anode circuit. The two variable resistors VR_2 and VR_3, which comprise the shunts, are also wired in the final arrangement after adjustment described below. If the controls are removed from surplus equipment and are available with locking devices, then the controls, once set, should be securely locked to prevent any subsequent movement which would result in scale errors.

Connect the shunts to the meter via the rotary range-changing switch S_2 as shown in Fig. 8 and connect to the 15kΩ variable resistor VR_1 and 1.5V battery and switch S_1, which should, of course, be open. VR_1 is only required for setting-up purposes, and can be greater than 15kΩ should the latter value not be available in the constructor's kit. If a larger value is used the control is more coarse in operation and a little more care is required of the operator.

Controls VR_2 and VR_3 need not necessarily be those specified either; suitable values may lie in the ranges 150 to 500 ohms and 15 to 50 ohms for the respective controls, should it be more convenient to choose other values.

Having set up the circuit of Fig. 8, make sure that all the resistance of VR_1 is in circuit, and with switch S_2 at position 1, close switch S_1. The meter will then read nearly 100μA (i.e. the needle will be almost at full scale deflection). Now gradually rotate VR_1 until the needle is fully deflected to read 100μA.

Open switch S_1, and switch S_2 to position 2.

Now close S_1 and carefully adjust VR_2 until the meter reads exactly 10μA. The accuracy of the meter readings will subsequently depend on the care with which this adjustment is made, and great pains should, therefore, be taken over this process. Having completed this adjustment, lock VR_2 spindle in position (if this is possible), and then increase the meter reading to full scale by adjustment of VR_1.

Open switch S_1, and switch S_2 to position 3.

Close S_1 and repeat the process outlined in the paragraph above, but this time with VR_3. When the meter is reading exactly 10μA, control VR_3 should be locked in position and switch S_1 should be opened, and the test rig disconnected. This procedure now completes the calibration from range to range, and when connected in circuit the meter will be set to read from 0–100 c/s on range 1, from 0–1,000 c/s on range 2 and from 0–10 kc/s on range 3.

If it is decided to write the calibrations on the scale of the meter, the case should be carefully removed, and using the existing scale as a master, make up a crescent-shaped piece of stiff paper marked out with the appropriate scale frequencies to match up with the 0 to 100μA markings. This piece of paper must then be secured accurately in position over the current scale. Throughout this operation the greatest care must be taken not to disturb the very delicate meter movement.

Circuit Details

The Schmitt trigger circuit and multivibrator can be clearly identified in the circuit of Fig. 7. Extra apparent complications exist only to make the frequency meter more reliable in operation. For example, the double diode V_{2a} and V_{2b} has been included both to facilitate accurate triggering and freedom from irregular timing, and each in turn thereby guarantees the generation of a pulse of constant width and stable periodicity.

For the same reasons the multivibrator uses two pentode valves, the coupling being made between the screen rather than the anode of V_3, and the following grid. By doing this the operation of the multivibrator is less affected by the manner in which the circuit is laid out and by the changing characteristics of the valves as they age.

It will be seen that the anode circuit of V_3 includes the arrangement of meter and shunts that have been previously set up in the manner already described, and illustrated in Fig. 8.

The cathode resistance chain R_{14} and VR_4 includes the variable resistance to facilitate calibrating the frequency meter in conjunction with the push button or spring-biased toggle switch at the input to the circuit. Their function is described below.

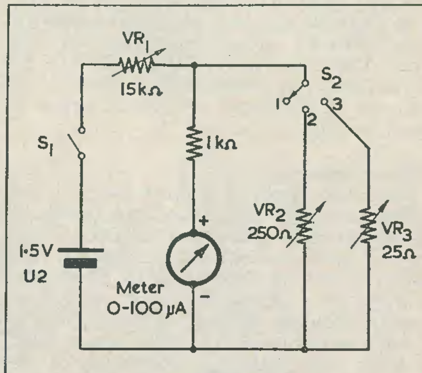


FIG.8.
Circuit for adjusting pre-set Meter Shunts.
M467

Oscilloscope Monitoring Points

Two optional sockets are shown on the diagram of Fig. 7—namely SK_2 and SK_3. These have been included for the benefit of those readers possessing an oscilloscope. The output from SK_2 is a differentiated pulse suitable for triggering or synchronising the average 'scope timebase, while the second SK_3 provides an output pulse representative of the current pulse which operates the meter, and thereby provides a means of checking the operation of the frequency meter. A pair of phones connected across this point and earth will give an audible indication of satisfactory circuit operation.

Neither of these outputs is really essential, and can, therefore, easily be omitted. If this is done, then C_2 and C_6 can likewise be omitted together with R_{15}, for which a direct connection to the h.t. rail of 300V must be substituted.

Wiring the Circuit

The circuit should be laid out so that the output is kept clear of the input. Although no internal screening is required, care should be taken with the arrangement of the components about the appropriate valve bases, and a layout that involves long leads from valve base to a component on a tag board should definitely be avoided. The components are for the most part of such a size to permit direct connection to the pins on the valve bases, a practice it is best to follow. All the controls and sockets should be mounted in an accessible place on the front panel, except the pre-set controls VR_2 and VR_3, which once having been adjusted in the initial setting-up phase should require no further attention.

No power supply has been shown in the circuit diagram, but the instrument will obviously be far more versatile if the h.t. and l.t. is available as a built-in feature. Quite a straightforward circuit, providing 300V at about 30mA h.t., and 6.3V at 1.2A l.t. will be adequate, while smoothing on the h.t. line need not be elaborate. A typical circuit is shown in Fig. 9.

Initial Checking

When the wiring is complete, plug in the valves, and connect a pair of high resistance phones via an isolating condenser (C_6 if this has not been omitted) across the load R_{15}. Switch on and leave the circuit for 10 minutes to warm up. During this time, and subsequently, nothing should be heard in the phones, except perhaps a slight mains hum, provided that nothing is connected to the input socket SK_1. Furthermore, the meter should read zero on all three ranges.

Now with VR_4 all "in"—that is, at maximum resistance, and rotary switch S_2 in position 1, which is the 0–100 c/s range, press the push-button. In the "normally-closed" position the contacts on this push-button connect the input socket to C_1, thereby passing any incoming signal to V_1. However, when the button is pushed, the 6.3V heater supply is connected in circuit, thereby injecting 50 c/s to the grid of V_1. This signal should trigger the multivibrator and consequently cause the meter to indicate some value.

Set this deflection to the "50 c/s" reading by adjusting VR_4, which controls the current drawn by the multivibrator.

This extremely simple operation is all that is required to calibrate the meter on all ranges, once the preliminary setting-up of the meter shunts has been completed.

It is advisable to check the calibration from time to time as the instrument warms up, since local heating can cause the timing of the multivibrator to drift slightly. It is for this reason that the "calib" and "set 50 c/s" controls should be mounted on the front panel. In this respect it is advisable to take care in the positioning of the timing components C_5 and R_{15}, ensuring that they are kept clear of any "hot spots" on the chassis.

To test the frequency coverage of the circuit, either an audio oscillator or frequency test record and associated amplifier will be required. In the latter instance an amplifier is necessary to give an input signal of the correct minimum amplitude for satisfactory operation of the Schmitt trigger stage. In any event a variable, single frequency source must be used.

With this source connected to the input socket, then a steady increase in frequency should cause a smoothly rising deflection of the meter needle.

When working on range three it may be found that the meter reading, and the tone heard in the phones, suddenly falls off before a frequency of 10 kc/s has been reached. This will almost certainly be due to the timing combination C_5 and R_{13}, and the cure consists of reducing the value of R_{13}. At present its value stands at 1.5MΩ. In the first attempt, reduce this to 1.2MΩ. Having made this change, it will then be necessary to recalibrate the meter on range 1 to set 50 c/s. Thereafter the meter should read up to 10 kc/s.

The oscilloscope owners have a distinct advantage here in that they can actually "see" what is happening by monitoring the output from SK_3. For satisfactory operation the width of the pulse at the ouput should be approximately 90 μsecs. The result of reducing the value of R_{13} is to decrease the width of the pulse, thereby increasing the limit to which the frequency may be set without eliminating the space in the mark-space train. Unfortunately, reducing the pulse width also reduces the mean current drawn by the meter, and in consequence this must be increased by re-adjustment of VR_4.

If the trouble is still not cured by reducing R_{13} to 1.2MΩ, then 1MΩ should be tried and so on down to 680kΩ. At too low a value of R_{13} it will be found that the meter can no longer be calibrated on range 1, and it is highly probable that some other fault exists in the wiring. The importance of a clean and tidy layout cannot be stressed too greatly here, as the adverse effects of unduly large stray capacities will almost certainly restrict the range of the meter.

In actual fact no difficulty should be experienced by the reader if a fairly intelligent layout is used, as the one outstanding advantage of this electronic frequency meter is its simplicity of setting up and operation.

Modifications

The average price for the 100μA meter used in this design is about £2. To some constructors this may present too big an investment, and they may, therefore, be cheered by the prospect of being able to use a less sensitive type of moving coil movement. It is possible to use a 0–500μA movement in a slightly modified circuit, but electronically the price to pay is that of a greatly increased h.t. drain and the need to use power output pentodes for the multivibrator valves. In addition, the three variable controls and the anode and cathode loads will need to be changed.

In the modified multivibrator the pentode valves will now have to conduct approximately five times the current that they previously passed. Some 55mA anode currents will, therefore, be required. The screen current of V_3 will also be greater by roughly the same amount; without specifying the valves, no hard and fast rule can be laid down about circuit values. However, the following list itemises those component numbers that will require replacing, and their approximate values are indicated. The reader will probably also find that the timing components, C_5 and R_{13} will need changing, but substitution here will have to be done on an experimental basis, rather along the lines already indicated.

R_{10}, 220 ohms	VR_2, 50 ohms w.w. pot.
R_{12}, 3.3kΩ, 10 watt	VR_3, 5 ohms w.w. pot.
R_{14}, 1.2kΩ, 5 watt	VR_4, 1kΩ, 4 watt w.w. pot.
R_{15}, 220 ohms	R_{18}, 6.8kΩ 1 watt

Of course, if the reader is content to build a frequency meter with only two ranges, namely the 0–1,000 c/s, and 0–10 kc/s ranges, then it is possible to use the circuit as it stands with a 0–500μA meter, merely omitting all the existing circuitry for range 1. If this is done, then R_{10} should be reduced 150 ohms, and VR_1 in Fig. 8 should be about 5kΩ.

The frequency meter may be made more sensitive to inputs of low amplitude by the incorporation of a variable control between resistors R_1 and R_2. If a 25kΩ potentiometer is connected between R_1 and R_2, and the slider connected to both the grid of V_1 and the coupling capacitor C_1, it will be found that the amplitude of a test signal at the input can be gradually reduced as this variable control is adjusted, to give a condition of maximum sensitivity. Once this working point has been found, the control should be locked.

Another modification which can be incorporated to give neater operation concerns the calibration push-button. If a double-pole version of this switch is available, then the second pair of "normally made" contacts should be connected in series with range switch S_2, breaking the present circuit at the point marked X in Fig. 7. When the push-button is now operated, the meter will automatically be switched to range 1, as required for calibration purposes.

The uses of the frequency meter have already been covered in the opening paragraphs, but in conclusion the discriminating reader will have seen that the circuit has wider applications than just the coverage of the audio frequency band.

In fact, with no other modifications to the present circuit than changes in values of C_5 and R_{13}, it is possible to design this frequency meter to cover an entirely different band o frequencies up to some hundreds of kilocycles. By arranging both for range switching and timing component switching, it is, therefore, possible to design an instrument only slightly more involved than the version described which will cover an extensive frequency band.

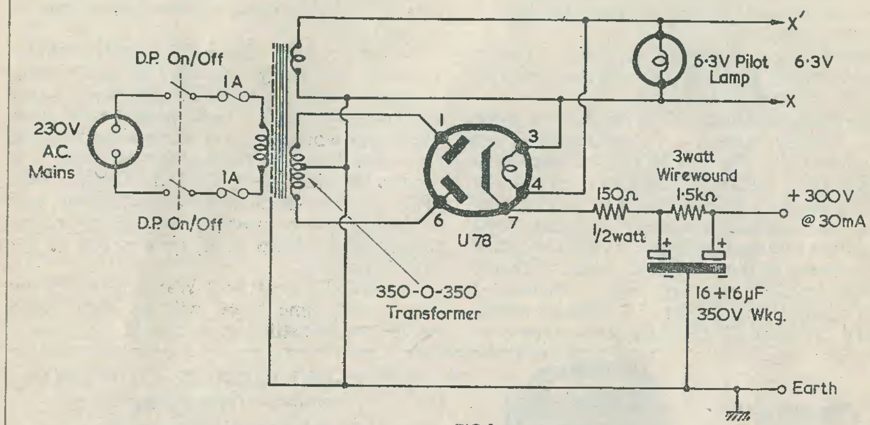


FIG.9.
Power Supply Suitable for Frequency Meter.

M468

Radio Miscellany—*continued from page 325*

will be able to undertake the management of it for 1958. It is to be earnestly hoped he will find himself able to take care of the organisation. He certainly struck the right note—plenty to interest the beginner, while at the same time fully covering the needs of the advanced and transmitting amateurs.

I spent several short periods at the *Radio Constructor* Stand, where many of our readers foregathered, hoping to spot one or two of the old timers. Not a greybeard was to be seen. Maybe the hobby keeps them young in appearance as well as in spirit. Should this, indeed, be so, if that Veteran Club *is* formed the secretary may have to insist on inspecting birth certificates before accepting ages!

The thing that impressed me most. The big manufacturers' growing interest in the amateur market—especially Mullards.

The liveliest display. The British Amateur T.V. Society Stand. Congratulations to 3CVO, 2DUX, 2WJ and 2KOK. Twice when I went near the stand the latter turned the camera on me. Maybe it was to shoo me off—I'm not all that photogenic! Earlier I had a shock at finding myself occupying the centre of the screen at the Pye Stand, where the most impressive thing was my shirt. I wonder I wasn't snapped up for an ITV Tide advertisement! Perhaps 2KOK was only trying to prove his camera was 100% OK on white.

Items I played with longest. The aluminium solder on the Enthoven Stand. I soldered numerous bits of wire on all the aluminium within reach. The chap in charge of the stand didn't actually say so, but I could tell by the way he looked that he felt if I wanted to carry on I had better go and fetch my own aluminium. Thereupon I bought a sixpenny sample which I felt entitled me to play with the Vibroscope Etching tool, and doodled happily on a strip of virgin foil I managed to cajole.

Most likely future purchases. The G8KW multi-band doublet with traps (I hear a ground plane is also in the offing) and a vibroscope.

Popularity Poll. On the Thursday evening I asked six likely looking up-and-coming youngsters to look at the amateur-built items displayed on the R.S.G.B. stand to see what ideas they would be most likely to copy when they got home. Three of them said the chassis bending jig (by G8TL). One of them didn't return—perhaps he thought there was a catch in it—or possibly, as one invariably finds in the Gallup Polls, he was one of the "don't knows."

Verdict. The best post-War Amateur Show yet. Next time there will be even more exhibitors and still bigger crowds.

1957 RADIO HOBBIES EXHIBITION

continued from page 347

Jason Motor and Electronic Company

This company, busily engaged in two exhibitions at one and the same time, the other one being the Audio Fair at Harrogate, exhibited the new switched f.m. tuner (The "Mercury), the "Prefect"—another switched f.m. tuner unit; the "Argonaut," a very fine a.m./f.m. receiver complete with audio and power sections, and the well-known Jason f.m. tuner unit in two versions that for local and that for fringe area reception.

Data Publications Ltd.

The complete range of current publications was on show here, and great interest was shown in the items of equipment displayed which were either being featured in present numbers of *The Radio Constructor*, or were to be described in forthcoming issues. The photograph of the stand does not, unfortunately, give a true impression as it was taken before the stand was completed.

Wireless World

On this stand were to be seen copies of the well-known range of Iliffe publications, including *Wireless World, Electronic and Radio Engineer*, and books such as *Foundations of Wireless* by M. G. Scroggie, B.SC., M.I.E.E., which has now gone into its sixth edition.

* * *

This Radio Hobbies Exhibition, was well worth a visit by all radio hobbyists, and particularly by J. Smith, G2DUG, of Cheltenham, who was lucky enough to win the Eddystone Communication receiver. The Silver Trophy was won by S. A. Denny, G3CIM, of Romford, and cash prizes offered by members of the Exhibition Committee were awarded to C. Kenny of Hove, C. H. F. Hubbard of Chatham, and G. B. Neale of Sheffield. The Clyne Award went to E. Yeomanson of Sydenham.

A.J.T.

TELETRON Type FX.25

Self-tuned, dual wave Ferrite rod aerial. **15/– each**

Specified for the "Companion" 3 Transistor regenerative pocket receiver.
Type 24 Inductor ... ... **3/6 each**

TRANSISTOR I.F. TRANSFORMERS

High Q "potted" construction, with Ferrite screw cores. Mounted in screening cans 1″ x ¾″ dia., **6/6** each. Oscillator coil, **6/6**. Transistor type Ferrite rod aerial for MW band, **10/–**. Selective crystal diode coil type HAX, **3/–** each. Type HAX.L (for LW band), **3/6**. Dual wave TRF coils, type A/HF, matched pair, **7/–**, with adjustable iron dust cores.

FERRITE ROD AERIALS

Wound on high permeability Ferroxcube rod. No external aerial required. Full sensitivity. Ideal for battery portable receivers. Medium wave, type FRM 4″ x 5/16″, **8/9**. Dual wave type FRD, 8″ x 5/16″, **12/9**. Miniature R.F. Chokes, wound on iron dust cores, with wire end terminations. 2.5 and 5mH, **3/–** each; 10mH, **3/6**. 200mH top lift Inductors, **6/6** each. Bias rejector coils, **4/6** each. Tape oscillator coils for push-pull operation, **8/6** each.

Send 5d. in stamps for complete data and circuits. All types available from advertisers in this Magazine and local component stockists

THE TELETRON COMPANY LIMITED
266 Nightingale Road . London N9
Telephone HOW 2527

Trade enquiries to sole distributor
S. Mozer Ltd 288 Hedge Lane N13 *Telephone* PAL 1748 *or* EDM 7707

DB5 TV FAULT FINDING

Profusely illustrated with photographs taken from a televisor screen depicting the faults under discussion, and containing a wealth of technical information, with circuits, enabling those faults to be eradicated. Both B.B.C. and I.T.A. transmissions are covered.
PRICE 5/- **Postage 5d.**
Data Publications 57 Maida Vale London W9

G2ACC offers you . .

Quality Components for the **Radio Constructor** *by the leading makers*

All goods new and Guaranteed

For a square deal and prompt service remember

SOUTHERN RADIO and ELECTRICAL SUPPLIES
SORAD WORKS REDLYNCH SALISBURY
Telephone Downton 207

BAND 3 T/V CONVERTER
185 Mc/s—199 Mc/s
Suitable London, Birmingham, Northern and Scottish ITA Transmissions
Mk. 2 Model, Latest Cascode circuit using ECC84 and EF80 valves giving improved sensitivity (12 db) over standard circuits, built-in Power Supply A.C. 200-250V. Dimensions only 6½″×3″, ht. 4″. Simple and easy to fit—only external plug-in connections. Wired, aligned and tested ready for use. State Channel required. Guaranteed. Bargain offer—good results or full refund, only **£3.19.6** Carr. and Pkg. 2/6

CONVERTER ACCESSORIES. Band 1-Band 3 Cross-over Unit, **7/6**. Var. Attenuators 6db-36db, **6/9**. BBC Pattern Filter, **8/6**. Band 3 Aerials—outside single dipole with 4 yds. coax., **13/9**. 3 element Beam, **27/6**. 5 element, **35/–**, etc., etc.

MULLARD "3-3" QUALITY AMPLIFIER

An ideal companion unit to the JASON Tuner. A really first-class 3-valve 3W Amplifier giving Hi-Fi quality at a reasonable cost. Mullard's latest circuit. Valve line-up: EF86, EL84, EZ81. Extra h.t. and l.t. available for Tuner Unit addition. Variable treble cut and bass boost controls, sensitivity 100mV for 3W output. Frequency response+ or — 1db, 40 c/s to 25kc/s. Complete kit (as illustrated) **£6.19.6**, carr. 3/6. Ready Built **8 gns.**

F.M. TUNER-UNIT (87 mc/s–105 mc/s) by **Jason.** Designer Approved Kit of Parts for only **5 gns., post free.** Set of 4 spec. valves **30/–**, post free. Illustrated handbook with full details, **2/–**, post free. 48-hr. Alignment Service, **7/6, P. & P. 2/–.**

CONDENSERS. Mica or S. Mica. All pref. values. 3pF to 680pF, **6d.** each. Ceramic types, 2.2pF to 5,000pF, **9d.** each. Tubulars, 450V, Hunts and T.C.C. 0.0005, 0.001, 0.005, 0.01 and 0.1, 350V, **9d.**; 0.02, 0.05, 0.1, 500V Hunts, T.C.C., **1/–**; 0.25 Hunts, **1/6**; 0.5 Hunts, **1/9**; 0.001 6kV T.C.C., **5/6**; 0.001 20kV T.C.C., **9/6.**

TRANSISTORS. Mfrs. surplus PNP Junction type. **Audio Type,** 800 kc/s 250mW, **9/6**; **R.F. and L.O. Mixer Type,** 2.5 Mc/s, **19/6.** All tested and guaranteed.

TRANSISTOR COMPONENTS. Midget i.f. transf., 315 kc/s, **5/–**; Ferrite Slab Aerial (dual range), **13/6**; M. and L.W. Osc. and 1st I.F., **11/6**; Push-pull interstage transf., **8/6**; Push-pull output transf., **8/–**; M/coil phone inserts dia. 2″, **4/6**; M/I dynamic inserts dia. 1⅛″, **3/9**

RESISTORS. Pref. values 10 ohms 10 megohms, 20% tol., ¼W, **3d.**; ½W, **5d.** 1W, **6d.**; 2W, **9d.**; 10% tol., ½W, **9d.**; 5% tol., ½W, **1/–**; 1% hi-stab., ½W, **2/–**

PRE-SET W/W POTS. TV knurled slotted knob type. 25 ohms to 30,000 ohms, **3/–**; 50,000 ohms, **4/–**; 50,000 ohms to 2 Megohms (carbon), **3/–**

S.T.C. RECTIFIERS. E.H.T. types, K3/25 2kV, **5/–**; K3/40 3.2kV, **6/9**; K3/45 3.6kV, **7/3**; K3/50 4kV, **7/9**; K3/100 8kV, **13/6,** etc. Mains types: RM1 125V 60mA, **4/9**; RM2 125V 100mA, **5/6**; RM3 125V 120mA, **7/6**; RM4 250V 250mA, **16/–**; RM4B type 250V 275mA, **17/6**, etc.

LOUDSPEAKERS. P.M. 3 ohm. 2½″ Elac, **16/6**; 3½″ Goodmans, **18/6**; 5″ R & A, **17/6**; 6″ Celes., **13/6**; 7″× 4″ Goodmans, **18/6**; 8″ Rola, **20/–**; 10″ R. and A., **25/–**

SPEAKER FRET. Expanded bronze anodised metal: 8″×8″, **2/3**; 12″×8″, **3/–**; 12″×12″, **4/3**; 12″×16″, **6/–**; 24″×12″, **8/6**, etc. **TYGAN FRET** (Murphy pattern): 12″×12″, **2/–**; 12″×18″, **3/–**; 12″×24″, **4/–**, etc.

RECORD PLAYER CABINETS
Contemporary style rexine covered cabinet in two tone grey and green. Size 18¼×13½× ht. 8¼″, fitted with all accessories, including speaker baffle board and plastic fret. Space available for all modern amplifiers and autochangers, etc. Uncut record player mounting board 14″×13″. Cut mounting boards available.
Cabinet Price £3.3.0 Carr. and ins. 3/6

2 VALVE AMPLIFIER (to fit above cabinet), modern circuit with EL84 output, ready built, with 6″ speaker and output transformer, **£3.12.6**, carr. and ins. 2/6.

RECORD PLAYER BARGAINS
SINGLE PLAYERS—3 sp. **BSR** (TU8), **92/6.** 4 sp. **BSR** (latest model, TU9), **99/6.** 4 sp. **COLLARO, 5 gns.** 4 sp. **GARRARD** (4 S.P.), **£7 10.0.** Carr. and ins., 3/6.
AUTO CHANGERS 3 sp. **COLLARO** (RC54), **£7.19.6.** 4 sp. **BSR** (UA8), **£8.15.0.** 4 sp. **COLLARO** (RC456), **£9.15.0.** 4 sp. **GARRARD** (RC120/4H), **9½ gns.** Carr. and ins., 4/6. All above models Brand New and Guaranteed. Fitted latest style l'weight Xtal. P.U. with turnoverhead and twin sapphire stylii.

VOLUME CONTROLS
Log. ratios, 10,000 ohms–2 Megohms. Long spindles. 1 year guarantee. Midget Ediswan type.

No Sw.	S.P.Sw.	D.P.Sw.,
3/–	**4/–**	**4/9**

Linear Ratio, **10,000** ohms –2 Megohms. Less switch, **3/–**each. **Coax Plugs ,1/2. Coax Sockets, 1/–.** Couplers, **1/3.** **Outlet Boxes, 4/6.**

80 *ohm cable* COAX
STANDARD ¼″ diam. Polythene insulated. Grade "A" only. **8d.** yd.

Special. Semi-air spaced polythene. 80 ohm. **Coax** ¼″ diam. Stranded core. Losses cut 50%. Ideal Band 3, **9d.** yd.

MAINS TRANSFORMERS. Made in our own workshops to Top Grade spec. Fully interleaved and inpregnated. **RADIO AND AMPLIFIER TYPE** 250V 60mA, F.W. sec., 5V or 6.3V 1A rect. 6.3V 2.5A set Htrs., **22/6**, etc. **C.R.T. HTR. ISOLATION TYPE.** Low leakage with or without 25% sec. boost voltage. Ratio 1 : 1 or 1 : 1.25, 2V., 4V, 6V or 13V, **10/6** each. Ditto with mains primaries 200/250V, **12/6.** etc.

L.F. CHOKES—10H 65mA, **5/–**; 15H 100mA, **10/6**; 10H 120mA, **10/6**; 20H 150mA, **15/6.**

OUTPUT TRANSF.—Standard pentode, **4/6**; push-pull 12 watt, **13/6** Small pentode, **3/9.** Midget battery pentode (1S4, etc.), **4/6.**

I.F. TRANSFORMER 465 kc/s
Brand new ex-manufacturer's midget I.F.T., size 2½″×¾″×¾″, dust core tuning. Litz wound coils, High Q. Bargain offer, **7/6** pair.

ELECTROLYTICS—ALL TYPES—NEW STOCK

Tubular Wire Ends		Can Types, Clips 3d. each	
25/25V, 50/12V	**1/9**	8+8/450V T.C.C.	**4/6**
50/50V, 4/500V	**2/–**	8+16/450V Hunts	**5/–**
100/25V, 2/450V	**2/–**	16+16/450V T.C.C.	**5/6**
8/450V B.E.C.	**2/3**	32/350V	**4/–**
8/500V Dub.	**2/9**	32+32/275V Hunts	**4/6**
8+8/500V Dub.	**4/6**	32+32/450V T.C.C.	**6/6**
8+16/450V T.C.C.	**5/–**	250/350V B.E.C.	**8/6**
16/450V B.E.C.	**3/6**	100+200/275V	**12/6**

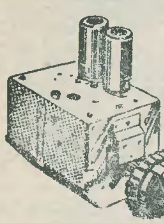
MIDGET TRANSISTOR TYPES. 2μF, 4μF, 8μF 6V, **3/6**; 6μF, 10μF, 16μF 3V, **3/6**; 32μF 1½V, **3/6.**

8″ P.M. SPEAKER (3 ohms)
Ex. Mfrs'. Units: Rola, W.B., Celestion, etc. All reconditioned and guaranteed. Ideal Ext. Unit. Bargain, **7/6.** Carr. 1/6.

VALVES—NEW BOXED—ALL GUARANTEED
1R5, 1T4, **7/6**; 1S5, 1S4, **7/6**; 3S4, 3V4, **8/–**; 5Z4, **9/6**; 6AT6, **8/6**; 6K7, **6/6**; 6K8, **8/6**; 6Q7, **8/6**; 6SN7, **8/6**; 6V6, **7/6**; 6X4, **7/6**; 6X5, **7/6**; 7C5, **9/–**; 7Y4, **8/6**; DAF96, **9/–**; DF96, **9/–**; DK96, **9/–**; DL96, **9/–**; 35L6, **10/6**; EABC80, **9/6**; EB91, **6/6**; EBC41, **10/6**; EVC33, **8/6**; ECC84, **12/6**; ECH42, **10/6**; ECH81, **10/6**; ECL80, **10/6**; EF41, **10/6**; EF80, **10/6**; EF86, **12/6**; EF91, **8/6**; EY51 **10/6**; EZ40, **8/6**; EZ80, **8/6**; MU14, **9/6**; PCC84, **10/6**; PCF80, **10/6**; PCF82, **10/6**; PCL83, **12/6**; PL81, **11/6**; PL82, **10/–**; PL83, **11/6**; PY80, **9/6**; PY81, **9/6**; PY82, **8/6**; U22, **8/6**; U25, **11/6**; UY41, **8/6**
SPECIAL—1R5, 1T4, 1S5, 1S4 or 3S4 or 3V4 per set **27/6**

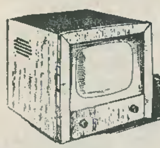
TRS RADIO COMPONENT SPECIALISTS
70 Brigstock Road
Thornton Heath Surrey
THO 2188. Hours 9 a.m.-6 p.m., 1 p.m. Wed. Terms: C.W.O. or C.O.D. Post and packing up to ½lb **7d.**, 1lb **1/1**, 3lb **1/6**, 5lb **2/–**, 10lb **2/9.** Bargain lists **3d.**

TURRET TUNER



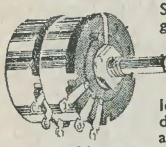
Brand new stock, not surplus, with coils for Bands I and III, complete with valves PCC84 and PCF80—I.F. Output 33/38 Mc/s with circuit diagram **79/6.** With knobs **3/6** extra, post and ins. 2/6

14″ TV CABINET



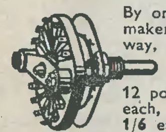
14″ TV cabinet of the latest styling made for one of our most famous firms—beautifully veneered and polished—limited quantity. **19/6** each. Carr. and pkg. 3/6 extra

MORGANITE POTENTIOMETERS



Single and 2 gang types available standard size with good length spindle, all new and boxed. Gang type **3/-** each—values available: 5K+5K, 100K+100K, ½meg. +½ meg. Single types **1/-** each, values available: 10K, 25K, 50K, 100K, 250K, 1 meg., 2 meg.

CERAMIC SWITCHES



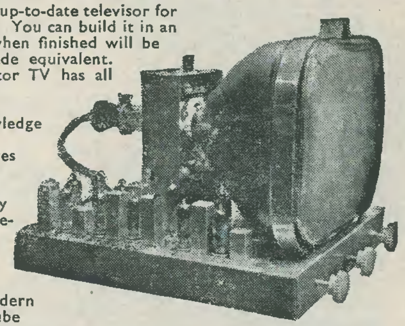
By one of our best makers, 3 pole, 3 way, **2/6** each, also **standard type** switches 12 pole, 2 way, **1/6** each, 6 pole, 3 way, **1/6** each, 3 pole, 6 way, **1/6** each, 6 pole, 4 way, **2/6**

ELECTRIC BLANKET WIRE

Waterproof P.V.C. covered so blanket washable. 16½ ohms per foot, 14 yds ideal for average blanket. **15/-** post free with data

Build this in *ONE* evening

Undoubtedly the most up-to-date televisor for the home constructor. You can build it in an evening and the set when finished will be equal to a factory-made equivalent. What other constructor TV has all these eatures?



- ★ No technical knowledge required
- ★ All miniature valves
- ★ Metal rectifier
- ★ Turret tuner
- ★ 12-channel circuitry
- ★ Multi-vibrator time-bases
- ★ Ferroxcube, e.h.t. and scan coils
- ★ 34/38 Mc/s I.F.
- ★ Suitable for any modern 12″, 14″ or 17″ tube

The building cost (less tube) is only **£29.10.0**, plus 10/– carriage and insurance, or **£16** deposit and 12 monthly payments of **27/–**. All parts guaranteed 12 months. **Full information and data, price 3/6**

THIS MONTH'S SNIP

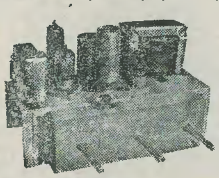
Tape Deck—Made by the famous Truvox Company. This contains exactly the same essentials as the current model. Only the styling is different. It also takes the stereophonic head.

Specification: 3 B.T.H. shaded pole motors with silent friction drive eliminating wow and flutter. Push-button controls, electrically and mechanically interlocked. Patented electric type push-button controlled brake. Tape loading on the drop-in principle, accommodation for reels of 7″ diameter. Tracking sense to British and American standards. Playing time: up to 3 hours with L.P. Tape or 2 hours with L.P. Tape or 2 hours with Standard Tapes. Two tracks side by side with safety gap. Positive Azimuth adjustment of Record/Player head. High impedance heads. Overall size 14½″ x 12¾″ x 5″ approx. 120 only of these fine decks offered at non-repeatable price of **£17.10.0** or **£3.10.0** down and eight monthly payments of **£3.** Non-callers add 10/– carriage and insurance.

"CRISPIAN" PORTABLE RADIO

A 4-valve truly portable battery set with very many good features as follows: Ferrite rod aerials, low consumption valves, superhet circuit with a.v.c., ready-built and aligned chassis if required, beautiful two-tone cabinet covered with I.C.I. rexine and Tygan. Guaranteed results on long and medium waves anywhere. All parts, including speaker and cabinet, are available separately, or if all ordered together the price is **£7.15.0** complete, post and ins. 3/6, ready-built chassis **30/–** extra. Instruction booklet free with parts or available separately, price **1/6**

HIGH FIDELITY AMPLIFIER



3-valve 4 watt with frequency response better than 40-15,000 c.p.s. Control panel size 8″ x 2½″ comes fixed to chassis but is intended for independent mounting. Separate bass and treble controls giving fullest variation of cut and lift. Separate switch, absolutely no mains hum. Remarkable value at **£4.19.6**

ELECTRONIC PRECISION EQUIPMENT LTD

POST ORDERS SHOULD BE ADDRESSED TO DEPT. 34 66 GROVE ROAD EASTBOURNE

Personal shoppers, however, can call at

266 LONDON ROAD CROYDON
Telephone CROydon 6558 Half-day Wednesday

42/46 Windmill Hill Ruislip Middlesex
Telephone RUIslip 5780 Half-day Wednesday

152/3 FLEET STREET EC4
Telephone FLEet 2833 Half-day Saturday

29 Stroud Green Road Finsbury Park N4
Telephone ARChway 1049 Half-day Thursday

◄◄◄ TV TUBES ►►►

BRENTWOOD ELECTRONICS LTD

(The TV Tube Specialists)

10 Victoria Road Brentwood
(2 minutes from Brentwood Station)

Offer the Following

RECONDITIONED TV TUBES

Free postage, packing and insurance in all areas, except Eire. 12 months guarantee on all tubes. 10/– allowed on your old tube.

9″	TV Tubes	£3.10.0
10″	„ „	£5. 0.0
12″	„ „	£5. 0.0
14″	„ „	£5. 0.0
15″	„ „	£6. 0.0
17″	„ „	£7. 0.0

The above includes the latest 14″ and 17″ rectangular tubes

Business Hours
9 a.m.—8 p.m.
Saturdays
9 a.m.—6 p.m.

★ Mail order terms
Cash with order

The Walk-around Shop

FOR THESE FINE BARGAINS

ELECTRIC TIME SWITCH. Beautifully made clockwork mechanism automatically wound by 6 volt solenoid. The time switch can be set for any period between 30 minutes and 44 days. This robust unit is housed in strong bakelite case 4″ in diameter. Price **12/6** post paid.

ANTENNA RELAY UNIT. U.S. manufacture, containing change-over relay, 2½″ panel mounting meter (measuring aerial current) with separate thermo-couple. Meter movement 2mA basic contained in metal case 3½″ x 4¼″ x 3½″ with ceramic stand-off terminals. **12/6** post paid

WALKIE TALKIE TRANSMITTER-RECEIVERS. Type 38. Frequency 7.4 to 9 Mc/s. Valved with 4 VP23's and 1 ATP4. Brand new and complete with 2 pairs of earphones, 2 throat microphones, whip aerial, junction box and canvas satchel. Price **65/–** plus 5/– postage and packing.

TRANSMITTER-RECEIVER. No. 19 Mark 2. Frequency coverage 2–8 Mc/s for R/T.MCW. C.W. Superhet receiver 465 kc/s i.f. B.F.O., etc. Receiver line-up: 6K7 r.f., 6K8 mixer, 2 6K7 i.f.s 6B8 det. Transmitter line-up: 6K8 mixer, VFO EF50 buffer, EB.34 ADC, 807 P/A. This unit incorporates a TX/RX 229 to 241 Mc/s with a local range of 1 mile. Valve line-up: CV6, 2 6K7's and 6V6, also intercom set 2 valve a.f. amplifier 6K7 and 6V6. As new condition and of American manufacture, fully valved, **£3 . 5 . 0,** plus 10/– packing and carriage.

PROOPS BROS. LTD. *Open all day Saturday*
Dept. R, 52 Tottenham Ct. Rd. W1
Hours 9-6 p.m. Thursday to 1 p.m. LANgham 0141

COMMUNICATION RECEIVER R.1155. This magnificent receiver covers 5 ranges: 75–200 kc/s, 200–500 kc/s, 600–1,500 kc/s, 3–7.5 Mc/s, 7.5–18.5 Mc/s. Fully tested before despatch. Complete with circuit and instruction booklet. **£8 . 10 . 0,** carriage 10/–

WHEATSTONE BRIDGE. Consisting of four stud switches: 0–10 ohms, 0–100 ohms, 0–Inf. Galvanometer centre zero F.S.D. 2.5mA. Ranges easily extended. Housed in oak cabinet 16″ x 7½″ x 6″. Complete with instructions, **40/–**. P. & p. 4/–

HIGH RESISTANCE HEADPHONES. Type No. 2. 4,000 ohms. Brand new **12/6** ea. P. & p. 2/–

R109 RECEIVERS. 8 valves 5 APR12's, 3 AR8's covering 1.8–8.5 Mc/s on two frequency bands. Contains 6V vibrator pack and built-in 3½″ Goodman speaker, operates from 6V battery, consumption 1½A. Housed in metal case 13″ x 12″ x 11″. Designed for mobile or ground station. Operates with any normal aerial. Complete and tested, including circuit. Very good condition. Only **80/–**, carriage 7/6

PYE 45 Mc/s I.F. STRIPS. Complete with 7 valves: 6 EF50, 1 VR92, 6 tunable i.f. transformers. Only **30/–** post paid.

POCKET VOLTMETERS. Read 0–25V and 0-250V. D.C. Brand new. In leather case. Only **15/–**. P. & p. 2/6

INDICATOR UNIT SLC No. 5. Ideal for conversion into an oscilloscope using 139A or ACR 10 tube. Unit consists of 2 VR65's, 1 VR66, various resistors, condensers and pots. Size 11″ x 6″ x 3″. Brand new, complete with modification circuit. **20/–**. P. & p. 4/–

MUIRHEAD VERNIER DRIVES. Scaled 0/180 deg. Ratio 25 to 1, 3″ dia. **10/6. P. & p. 1/6**

BENDIX RECEIVER MN26.C. Covering 150–1,500 kc/s in 3 bands. Valves used 5 6K7, 2 6N7, 2 6J5, 1 6F6, 1 6L7. Complete with switching motor and dynamotor. This superb unit has been modified for 12V operation. The ideal Car Radio. With circuit. Only **80/–**, carriage 8/6

R.F. UNITS. R.F.25, 40–50 Mc/s, **8/6** each; R.F.26, 50–65 Mc/s, **25/–** each. All valved. With circuit. Postage 3/6 on each

PARMEKO CHOKES. 8H 100mA. **7/6.** P.& p.1/6

VIBRATOR PACKS. 6V input, 250V output at 100mA: complete 4-pin vibrator, OZ4 rectifier. Fully smoothed **25/6** each. P. & p. 2/6

12V Input, 300V output at 150mA. As a bridge rectifier will handle 450V r.m.s. at 120mA. Pack consists of 12V vibrator, 4 metal rectifiers, chokes and smoothing condensers. Only **30/–**, carr. 5/–

No. 38 TRANSMITTER/RECEIVER WALKIE TALKIE. Range approx. 5 miles. Covering 7.4–9 Mc/s. Absolutely complete with junction box, headphones, microphones, webbing, haversack. Brand new only **60/–**, carr. 7/6

MONITOR TYPE 28. Consists of VCR138, 6 SP61, 1 5U4 1 VU120, 3 EA50. 1mA meter scaled 100-0–100 volts. Incorporates Y shift, X shift in µ/secs, focus, sync, bias. Input to X plates switched x20, x5, direct, requires only suitable power pack for use as oscilloscope. **60/–**, carr. 10/–

WAVEMETER TYPE W1433. Frequency 154–260 Mc/s, with crystal check and calibration chart. Mains 50 cycle. **50/–**, carr. 10/–

R.T.-7/APN-1 ALTIMETER TRANSCEIVER. Brand new complete with 14 valves: 3 12SJ7, 4 12SH7, 2 12H6, 1 VR150, 2 9004, 2 955. Famous wobbulator unit, dynamotor, relays 3500 ohms and 6500 ohms. A.F. amplifier. Receiver section covers 400-450 Mc/s. Transmitter sweeps 418 to 462 Mc/s. With manual. Only **35/–**, carr. 10/–

Relda Radio Ltd.

(Dept. 'C') 32A Coptic St London WC1
Telephone MUSeum 9607

HENRY'S
(RADIO) LTD

5 Harrow Road Edgware Road
Paddington London W2

Opposite Edgware Road Station

PADdington 1008/9

OPEN MONDAY to SAT. 9–6 THURS. 1 o'clock

SEND 3d. FOR 28-PAGE CATALOGUE

TRANSISTORS
JUNCTION TYPE P-N-P
(British Manufacture)

RED-SPOT 800 kc/s Audio Frequency ...	10/–
BLUE SPOT 1.6 Mc/s Mixer and Frequency Changer	15/–
WHITE-SPOT 2.5 Mc/s R.F. and I.F. Amp.	20/–

All Transistors are Tested and Guaranteed

N.B.—The Red-Spot is similar to Mullard OC71

Transistor Bases 9d. each

TRANSISTOR PUSH-PULL AUDIO AMPLIFIER
(200 Milliwatts Output)

Build this Push-Pull Amplifier which is ideal for Crysta or Magnetic Pick-up Amplification, Baby Alarm, Microphone Amplifier, etc. Powered by 6-volt Dry Battery lasting for months. **Complete Kit of Parts including 4 Transistors and all Components with Circuit (less Speaker), £4 . 10 . 0**

COLLARO RC456
4 speed auto-changer. Latest type with crystal turnover pick-up **£9 . 15 . 0**

TRANSISTOR SIGNAL TRACER
Complete Kit with 2 Transistors, components, phones, with circuit and plastic case **42/6**

TRANSISTOR SQUARE WAVE GENERATOR
Complete Kit with 2 Transistors, Components, Circuit and plastic case **25/–**

DIODES

B.T.H. Germanium	1/6
Mullard OA74	2/6
IN21	3/6
1N22, 1N23, 1N21A	5/–

MODEL-MAKERS' MOTORS
Two types available, 12 or 24V with ¼″ spindle, 10/– each

6V VIBRATOR PACKS
Output 120V 30mA. Brand new **12/6**

Valves — Valves — Valves
We have over 300 different types of British and American valves in stock. Send for 28-page Catalogue for further details of valves, components, etc.

TRANSMITTER RECEIVER
Army Type 17 Mk. II

Complete with valves, high resistance headphones, hand-mike and instruction book and circuit.

- Frequency range 44.0 to 61 Mc/s
- Range approximately 3 to 8 miles
- Power requirements: Standard 120V h.t. and 2V l.t.

Ideal for Civil Defence and communications

BRAND NEW **59/6**

Calibrated Wavemeter for same, **10/–** extra

5-VALVE A.C./D.C. PORTABLE RADIOGRAM CHASSIS THREE WAVE BAND SUPERHET
200/250V A.C./D.C.
(With Internal Aerial)

Short Wave 160–50m. Medium Wave 187–575m. Long Wave 900–2,000m. (With Gram. switching) Well-known manufacturer's product complete with five Marconi valves, type: X109, W107, DH107, N108 and U107, and 7″ x 4″ elliptical speaker. Ideal for Portable Radiogram. Chassis size 10″ x 4″ x 4″

£7.12.6 P.P 7/6

Also available as above at the same price, similar chassis with following specifications: Short Wave 11.27–31.9m. Short Wave 31.2–91m. Medium 187–575m. and gram. switching.

WALKIE-TALKIE TRANSMITTER/ RECEIVER ARMY TYPE "38"
Brand new, complete with valves, 2 pair headphones, 2 microphones, junction box, canvas carrying bag, 4-section aerial and spare set of valves and circuit. Frequency range 7–4.9 Mc/s. Range approximately 5 miles.
BRAND NEW **65/–** P.P. 5/–

"373" MINIATURE 9.72 Mc/s I.F. STRIP
The ideal FM Conversion Unit as described in P.W. April/May 1957. Complete with 6 valves: 2 EF91, 2 EF92 and EB91. I.F.T.s, etc., in absolutely new condition. With circuit.

12/6 (less valves) **42/6** (with valves)

Postage 2/6 on either type

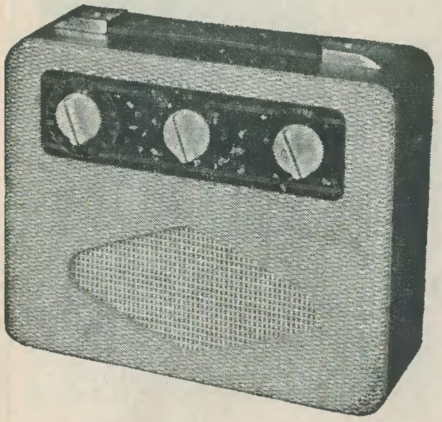
METER FOR TRANSISTOR TESTS
Moving coil 2½″ meter reading 0–3V and 0–30V. Centre zero. Basic movement 5mA. Ideal for checking voltages or could be basis for transistor tester. **12/6** p.p. 2/6

"HOMELIGHT"
2-TRANSISTOR PERSONAL PORTABLE
No Aerial or Earth required
Variable Tuning

We can supply all components including 2 transistors, diode, resistors, condensers and miniature hearing aid and plastic case, size 4½″ x 2⅞″ x 1⅜″, and 1½V battery for 52/6. All items sold separately

COLLARO RC/3/554
3-speed single player with crystal turnover pick-up type "T," **£6.19.6**, carr. 3/6. Brand new in original carton

The *NEW* "TRANSISTOR - 8"
Push-Pull Portable Superhet



Can be built for £11/10/–

TEN STAR FEATURES

★ 8 specially selected Transistors
★ 250 Milliwatts output push-pull
★ Medium and Long Waves
★ Internal Ferrite Rod Aerial
★ 7″ x 4″ elliptical Speaker
★ Drilled plastic Chassis 8½″ x 2½″
★ Point to point wiring and practical layout
★ Economical. Powered by 7½V battery
★ Highly sensitive
★ Attractive lightweight contemporary case

This Portable 8-Transistor Superhet is tunable for both Medium and Long Waves and is comparable in performance to any equivalent Commercial Transistor Set. Simplified construction enables this set to be built easily and quickly into an attractive lightweight cabinet supplied.

We can supply all these items including cabinet for **£11.10.0**. All parts sold separately

Send for circuit diagrams, assembly data illustrations and instructions, and full shopping list FREE, post 3d.

N.B.—Pair of OC72's supplied at additional cost of **40/–**

Call and hear demonstration model

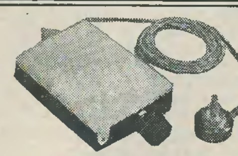
As featured in August issue and described on page 28

ALL PARTS FOR "CONTESSA" TRANSISTOR PORTABLE IN STOCK

"EAVESDROPPER"
THREE-TRANSISTOR POCKET RADIO
(No Aerial or Earth required)

Variable tuning—medium wave. Total cost, as specified including Transistors, Transformers, Coils, Condensers and Battery, etc., with circuit, plastic case and battery.

All items sold separately	**77/6**	POST FREE
With miniature hearing aid		90/–
With balanced armature		82/6



MINI-TWO
2-TRANSISTOR MINIATURE POCKET RADIO
(No Aerial or Earth)

The smallest transistor set offered on the market. Variable tuning. Drilled chassis, plastic case size 3″ x 2″ x ¾″, miniature hearing aid, 2 transistors and all components including 1½ volt battery, circuits and full practical layout diagrams.

Total cost **49/6** complete

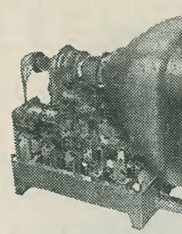
N.B.—Transistor Holders are supplied free with all kits and we would respectfully suggest you use same, both in order to protect the Transistors and to simplify testing, and only those sets using these Holders will be accepted for inspection and testing.

HENRY'S RADIO LTD · 5 HARROW ROAD · LONDON W2

TERMS AVAILABLE

17″ TV CHASSIS **£19.19.6**

Latest improved circuits. Higher E.H.T. (brilliant picture). Improved sensitivity (for greater range). Chassis easily adapted to any cabinet. 17″ rectangular tube on adapted chassis. All channels. 12 months guarantee on tube, 3 months guarantee on valves and chassis. Valve line-up (5 valves): 6SN7, 6V6, EY51, 2 6D2. Others: 6L18, EL38, 7 6F1. With 5 valves **£21.19.6.** With all valves **£25.19.6. Turret Tuner 50/–** extra. Ins. carr. (incl. tube), 25/–. State B.B.C. channels (and I.T.A. if Turret Tuner required).



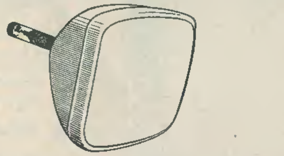
14″ TV CHASSIS, TUBE & SPEAKER **£13.19.6**

As above with 14″ round tube. Less valves. 3 months guarantee. With 5 valves, **£15.19.6.** With all valves, **£19.19.6. Turret Tuner 50/–** extra. Ins. carr. 25/– (incl. tube).

TELEVISION TUBES

12 MONTHS GUARANTEE

17″ £7.10.0

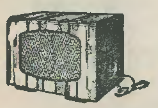


TV RECTANGULAR TUBES

14″ £5.10.0

6 months full replacement 6 months progressive. Made possible by the high quality of our tubes. Ins. carr 15/6. **Special offer of 14″-15″-16″ TV Tubes at £5.** Convert YOUR 9″-10″-12″ to our SPECIAL OFFER of 14″-15″-16″ Round Tubes at £5. Details of how to "Do-it-Yourself" in our FREE catalogue. **12″ TV Tubes £6.** 3 months guarantee on all Round Tubes. 15/6 ins., carr.

MIDGET Ever-Ready BATRYMAX 1/9 "B" type battery, 22½V No. B155. Ideal for midget or personal radio, hearing aid or photography flash. Size ½″ x 2″. Post 3d. 6 for 7/–, post 6d. 12 for 12/–, post 9d.



BEAUTIFUL EXTENSION SPEAKERS 29/9

Fitted with 8″ p.m. speaker. W.B. or Goodmans. Highest quality. Matching to any receiver. (2-5 ohms.) Switch and flex included. Unrepeatable at this price. Money back guarantee if not completely satisfied. Ins. carr. 3/6

8″ P.M. SPEAKERS, 8/9. At this price you can have one in every room. Let the lady of the house listen to that radio or TV programme! P. & p. 1/9

TV CONSTRUCTOR CHASSIS

SOUND AND VISION STRIPS, 25/6. Tested working, complete less valves. I.Fs 16-19.5 Mc/s. P. and p. 2/6. Drawing 2/6 or free with order.

POWER PACK, 29/6. 6-10kV R.F. E.H.T. unit included. Tested working, less valves. Drawing 2/6 or free with order. Ins. carr. 5/–

TIME BASE, 15/6. Tested working. Inc. focus unit, etc. Less valves. P. and p. 3/6.

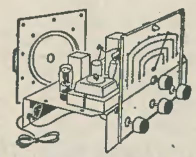
ELECTRIC CONVECTOR HEATERS, 99/6

Winter isn't over yet so you will still need a convector heater. Cleaner, cheaper, safer than paraffin. A.C./D.C. switched for 1 or 2kW. 200-250V. Illuminated grille. Size 26″ x 18″ x 7½″ deep. Ins. carr. 10/6

ELECTRIC FIRES, 17/6. Hammered finish. A.C./D.C. 200-250V. Post 3/6

INSULATING TAPE, 1/6 75ft x ½″ wide, finest quality. Large roll in metal container. P. & p. 9d.

TV AERIAL, 25/6. For all I.T.A. and FM channels. For outdoor or loft. 3-element type. P. & p. 2/6



SUPER CHASSIS, 99/6

5-valve superhet chassis including an 8″ speaker. 4 control knobs (tone, volume, tuning), w.c. switch; 4 waveband, with position for gram. p.u. and for extension speaker. A.C. only 97/6 P. & p. 5/6

DENCO RADIOGRAM CHASSIS, £4.19.6

3 and 4 waveband turret tuned. Superhet, A.C./D.C. chassis, with 6″ or 8″ speaker. Size 8½″ x 10″ x 12″. Valve line-up CCH35, EF39, EBC33, CL33 and CY31 (C1C or dropper). Ins. carr. 7/6

BOXED **VALVES** 3 MONTHS GUARANTEE

SP61	4/9	6N7GT	4/9	CV18	3/9	EF37	4/9
1S5	4/9	6SG7	3/9	EB34	1/9	ECH81	10/9
3A8	3/9	77	3/9	EB91	6/9	EF50	2/9
4D1	2/9	8D2	3/9	ECC81	8/9	EL32	6/9
6B8	3/9	8D3	7/9	ECH42	8/9	EL91	3/9
6F12	7/9	12AU7	5/9	EF39	6/9	PEN45	6/9
6D2	6/9	12BE6	6/9	EF41	8/9	TT11	6/9
6H6M	1/9	2C22	3/9	EF91	7/9	RL37	1/9
6K7M	3/9	12SJ7	1/9	DF66	5/9	Z77	7/9

American Types UX All at **3/9** each

18	75	80	25RE	42
78	1D6	6A7	6D6	6C6

Barrettors 301 and 302 also at **3/9** each

POPULAR RADIO OR R/GRAM CHASSIS 39/9

3 w/band and gram, s/het. 5-valve international octal. Ideal table gram, but still giving high quality output. 4 knob control. 8″ p.m. speaker, **7/9** with order. Set of knobs, 2/–. Chassis 15″ x 6″ x 9″. Less valves. Ins. carr. 5/6

CAR RADIO AERIALS, 6/9. Whip antennae, 50″ long, collapsing to 11″. One-hole fixing. Post 1/–

Send for FREE 1958 Catalogue Liverpool St. to Manor Park Stn.—10 mins. OPEN SATURDAY ALL DAY

DUKE & CO (Dept. 1) **621/3 Romford Road Manor Park E12** *Telephone* ILF 6001/3

SMALL ADVERTISEMENTS

Readers' small advertisements will be accepted at 3d. per word, including address, minimum charge 2/–. Trade advertisements will be accepted at 9d. per word, minimum charge 6/–. If a Box Number is required, an additional charge of 2/– will be made. Terms: Cash with order. All copy must be in hand by the 8th of the month for insertion in the following month's issue.

PRIVATE

FOR SALE. 66 copies *The Radio Constructor* January 1952 to June 1957, complete and perfect. What offers? Nicolls, 33 Berengrave Lane, Rainham, Kent.

AMATEUR discontinuing hobby. Valves, meters, c.r.t., etc., £2. Genuine bargain. Grange Hotel, Southport Road, Southport.

TRANSMITTER from 18 Set Mk. III. Excellent condition, tested, in working order. Bargain, 40/–. G. M. Morris, 1 Percival Road, Bristol 8.

R.F. TRANSISTORS white spot, 15/– each. Valves, MH4, SP61, 6K7, 3/– each. 5Y3, 6AM6, 7/6 each. Condensers, 0.1μF 350V, decoupling chassis mounting, 6d. each; 0.1μF 400V, coupling, 3d. each. Post 6d. each order. J. Cooper, 45 South East Crescent, Scholing, Southampton.

BARGAIN PARCEL. Electrolytic condensers, two 32μF 275V wkg; two 32+32μF 350V wkg; two 16+8μF 350V wkg; six 8μF 450V wkg; two 250μF 6V wkg; volume control pots, two ½Meg with switch; two ½Meg with switch; two 2Meg with switch; six germanium diodes. All new and unused components, £1 post paid. Box No. E147.

FOR SALE. Avometer No. 7, five months old, very little used, as new, £12.10.0. M. W. Higgs, 33 Velsheda Road, Shirley, Solihull, Warks.

SALE. Signal generator, Taylor type 650, 100 kc/s–160 Mc/s, £7.10.0. Erskine Laboratories oscilloscope portable model 1B, 1½ in. tube, circuit available for oscilloscope also wobbulator. 18 Knapmill Road, Bellingham, London, S.E.6.

AVO METER (heavy duty model), leather case, resistance extension unit, £12. Immaculate condition. Morrell, 65 The Bungalows, New Kyo, Stanley, Durham.

FOR SALE. Valves: 5U4G, 7/6; 6AG5, 3/6; 6AG7, 10/–; 6AT6, 7/6; 6BA6, 7/6; 6BW6, 7/6; 6B4G, 5/6; 6B8, 1/6; 6J5, 3/6; 6K7, 5/–; 6L6, 7/6; 6F6, 7/6; 6F6G, 5/–; VR91, 3/–; VT136, 3/–; VT62 (RCA 8019), 10/–; VR150, 3/–; KT61, 5/–; 6SA7, 7/6; 6SJ7, 7/6; 6SK7, 5/–; 6X5GT, 5/–; 12AT7, 7/6; 801, 10/–; 807, 3/–; 830B, 10/–; T20, 7/6; RG1-240, 10/–; CV1193, 7/6; DAC1, 5/–; 955 and base, 7/6; DL92, 12/6; post and packing 9d. per valve. Crystals in holders, 7/6, QCC 7127 kc/s, 7154 kc/s, 7171 kc/s, G.E.C. 7097 kc/s. Speakers, 6 in. p.m. with transformer, 10/–; speakers in polished wooden cabinets, 12″ x 12″ x 6″, £1. Postage extra. Rotary converters, 12V at 3.8 amps input, 400V at 0.04 amps output, 10/–; 12V input, 275V at 110mA plus 500V at 50mA output, £1. Packing and post extra. Coils, Labgear p.p. P.A. Tx coils CCL and DSL for 14 and 28 Mc/s, 10/– each. Morse key G.P.O. type, 7/6. "East Keal," Romany Road, Oulton Broad, Lowestoft, Suffolk.

WANTED Woden UN4 Multimatch Modulation Transformer, or similar. Box No. E148

continued on page 367

NEW SURPLUS . . .

1A3	2/6	6SA7M	7/6	1616	7/6	EZ40	8/6
2A3	8/6	6SG7M	7/6	1629	4/–	EZ80	8/6
2X2	3/6	6SJ7M	7/6	EA50	1/6	HK24G	25/–
3A4	7/–	6SK7M	6/6	EABC80	10/–	KT33C	9/6
3A5	9/6	6SL7GT	7/6	EAC91	4/6	PCC84	10/6
3B7	6/–	6SN7GT	6/6	EAF42	10/6	PCF80	12/6
3D6	5/–	6SQ7M	7/6	EB34	2/6	PCF82	11/–
3Q4	8/6	6X4	6/6	EB91	7/–	PL82	9/6
5B/254M	21/–	6X5GT	7/6	EBC33	7/6	PL83	10/6
5R4GY	10/6	7B7	9/–	EBC41	10/6	PCL83	12/6
5U4G	8/6	7C5	9/–	EBF80	10/–	PY80	9/6
5Y4G	6/6	7C6	9/–	EBF89	10/–	PY81	10/–
6AC7M	5/–	7S7	10/–	ECC82	9/6	PY82	9/6
6AG5	3/6	7Y4	8/6	ECC83	9/6	PY83	11/6
6AK5	5/–	12A6M	7/6	ECC84	11/–	R19	12/6
6AL5	7/–	12AT6	8/–	ECC85	10/6	SP61	3/–
6AM6	7/6	12AT7	9/–	ECF80	13/6	TT11	4/–
6AQ5	8/6	12AU6	9/–	ECF82	11/6	U25	12/6
6AT6	8/–	12AU7	8/6	ECH42	10/6	UAF42	10/6
6AU6	8/6	12BE6	8/6	ECH81	10/–	UBC41	10/6
6B8G	4/6	12C8M	7/6	ECL80	10/–	UBF89	10/6
6BA6	8/6	12Q7GT	9/–	ECL82	13/6	UCC85	10/–
6BE6	7/6	12K7GT	9/–	EF36	4/–	UCH42	10/6
6BR7	11/6	12SC7M	2/6	EF37A	8/6	UF41	10/6
6C4	5/–	12SK7M	7/6	EF39	5/–	UF89	10/6
6C5M	5/6	12SQ7M	8/6	EF41	10/6	UL41	10/6
6F6M	6/6	35L6GT	9/6	EF50	3/6	UY41	8/–
6F8G	4/6	35Z4GT	8/6	EF50(S)	5/6	UY85	10/–
6G6G	4/6	35Z5GT	8/6	EF55	7/6	UABC80	10/6
6J5GT	5/–	42	7/6	EF80	9/–	VU39	9/6
6J5M	6/–	50L6GT	9/6	EF85	10/–	VR150/30	7/6
6J6	4/–	80	8/6	EF89	10/–	VR116	4/–
6K7G	5/6	446A	12/6	EF91	7/6	VS70	3/–
6K8G	9/6	801A	10/6	EL32	4/–	XP1.5	3/–
6K8M	10/6	803	20/–	EL41	10/–	Z77	7/6
6H6M	3/6	808	25/–	EL84	10/6		
6L7M	7/6	830B	15/–	EL91	7/6		
6Q7GT	9/6	866A	12/6	EM80	10/–		
		959	8/6	EY51	11/6		

SPECIAL OFFER

Performance Meters No. 2. Comprising 230V 50 c/s mains trans. 250-0-250V 30mA 6.3V 1½A 5V 2A (60mA h.t. may safely be drawn), 20H choke, 5Z4, Y65 magic eye, 2 EF50, 1 EC52, 1 EA50, dozens of components all in smart grey louvred case 10″ x 9″ x 9″. Made by Parmeko. Brand new and boxed. Unrepeatable component value at only **37/6** each plus 5/– carriage (U.K. only)

Special Valve Offer. 6J6, 6AG5, EL32, TT11, EF39, 6G6G, 6B8G, EF50, **37/6** doz. 12SC7M, **21/–** doz.

Command Receivers BC454B. 3-6 Mc/s. Brand new in maker's cartons with 6 valves, **45/–** each. Few only used, good condition, 1.5-3 Mc/s, **55/–** each

RF24 Units, 20-30 Mc/s. New with 3 SP61, **12/6** each, post paid

Collaro RC4/456. Latest 4-speed record player with Studio 'O' head (single player). New, boxed. Limited quantity **£7.15.0** each, plus 3/– carriage. Model TRE Junior 4-speed with separate Acos Hi-G T/O Head **5 gns.** plus 3/– carriage.

M.C. Meters. 3½″ rd. fl. mtd. (2½″ dial), 0-1mA, **26/–**; ditto but with very lightly damped movement and scaled 0-10, **18/6** each; 0-30mA, 0-200mA, 0-500mA, 0-2A, **13/6** each; 0-150V a.c. (1mA Basic with Rect.), **28/6**; 2½″ rd. fl. (2″ dial), 0-500μA, **17/6** each; 0-1mA, **21/–**. All post paid

Midget Mains Transformers (same size as std. spkr. o/p). Input 230/250V, o/p 220V 20mA, 6.3V 0.6A Ditto but 175V 25mA, both types **11/9** each, post paid

Transmitter/Receivers. Army Type 17 Mk. 2 Complete with h.r. phones, hand mike and valves. 44-61 Mc/s. In good used condition, **45/–** each or two for **79/6.** Carriage paid

"PANL" Crackle Paint, 3/9 tin, post paid

Post 9d. *Free over £2 except where stated*
S.A.E. Enquiries

JOHN ANGLIN

385 CLEETHORPE ROAD GRIMSBY LINCS
Telephone 56315

SMALL ADVERTISEMENTS

continued from page 365

PRIVATE—*continued*

WANTED. Oscillator Avo all-wave mains type. Wave change switch for Philips 650A receiver. 19 High Street, Puddletown, Dorset.

WANTED. R1155N. 21 Thrissell Street, Easton, Bristol 5.

WANTED. Radio Amateur's Handbook 1937 or earlier, good condition. Litherland, 20 Orchard Crescent, Chippenham, Wilts.

TRADE

CONTACT COOLED RECTIFIERS. 20mA type 10/8, 60mA 12/6. Transistors, OC70 21/-, OC71 24/-, OC72. 30/- each. C.W.O. please. D. J. Morris, 88 Prescott Street, Birmingham, 18

IDEAL CHRISTMAS PRESENT. Transistor Amplifier at 57/6, post free. Will amplify your crystal set or one valve set to give loudspeaker results, 4½ volt battery only required. Details and notes on transistors, 8d. Stamps to Morco Experimental Supplies, 8/10 Granville Street, Sheffield 2.

A.M.I.P.R.E. For details of suitable study courses (only a limited number of students accepted), send for free Syllabus of Instructional Text. I.P.R.E. Conditions of Membership booklet 1/-. *The Practical Radio Engineer* journal, sample copy 2/3. 6,000 Alignment Peaks for Superhets 6/-. All post free from Secretary, I.P.R.E., 20 Fairfield Road, London, N.8.

PANL, recognised for many years as the unique one-coat black crackle finish. Brush applied, no baking. Available by post in ⅛th pint cans at 3/6 from G. A. Miller, 255 Nether Street, London, N.3.

ILLUSTRATED CATALOGUE No. 13 containing over 450 items of Government Surplus and Model Radio Control Equipment, 2/2. Refunded on purchase of goods, 2/6 overseas seamail—Arthur Sallis Radio Control Ltd., Department R.C., 93 North Road, Brighton. *Telephone* 25806.

LEARN as you do it—we provide practical equipment combined with instructions in Radio, Television, Electricity, Mechanics, Chemistry, Photography, etc. Write for full details to E.M.I. Institutes, Dept. RC47, London, W.4.

JOIN THE INTERNATIONAL S.W. LEAGUE. Free Services to members including Q.S.L. Bureau Translation, Technical and Identification Dept.—both Broadcast and Fixed Stations. DX Certificates contests and activities for the SWL and transmitting members. Monthly magazine, "MONITOR," containing articles of general interest to Broadcast and Amateur SWL's. Transmitter page and League affairs, etc. League supplies such as badges, headed notepaper and envelopes. QSL cards, etc., are available at reasonable cost. Send for League particulars. Membership, including monthly magazine, etc., 15/- per annum.—Secretary, ISWL, 86 Barrenger Road, London, N.10.

COILS, COILS, COILS. We can supply coils for all frequencies, r.f. chokes, etc. Send s.a.e. for circuits and data.—The Teletron Co., 266 Nightingale Road, London, N.9.

MORSE CODE TRAINING. Special course for Beginners. Full details from (Dept. RC), Candler System Company, 52 Abingdon Road, London, W.8.

FREE. Brochure giving details in Home Study Training in Radio, Television and all branches of Electronics. Courses for the hobby enthusiast or for those aiming at the A.M.Brit.I.R.E., City and Guilds, R.T.E.B., with other Professional examinations. Train with the college operated by Britain's largest Electronics organisation. Moderate fees. Write to E.M.I. Institutes, Dept. RC28, London, W.4.

Forrest Transistor Transformers for Quality Equipment

H. W. FORREST (TRANSFORMERS) LTD.
349 Haslucks Green Road Shirley Solihull Warwickshire Telephone SHIrley 2483

GUARANTEED VALVES — Over 3,000 in stock

EF92, EAC91, 6J6, 6C4, 4/6; 6K7, EC91, 5/6; 6AL5, 6SK7, R10, 3A4, 807, 6/–; 6AM6, EL91, 6X4, 6/6; 6BE6, 6CH6, 6F17, 6F33, 7/6; 12AT7, 12AX7, 12AU7, 6BA6, 6BW6, 8/–; 6BR7, 12E1, 85A2, 2D21, 10/–; EF86, 6L6M, 5B/225M, 5B/251M, 11/6

A. A. W. SKILLMAN
79A FRANCHISE STREET WEYMOUTH

BRASS, COPPER, DURAL ALUMINIUM, BRONZE
ROD, BAR, SHEET, TUBE, STRIP, WIRE
3,000 STANDARD STOCK SIZES
No Quantity too Small *List on application*

H. ROLLET & CO. LTD
6 Chesham Place SW1 Telephone SLOane 3463
Also at Liverpool Birmingham Manchester Leeds

H.A.C. THE ORIGINAL SUPPLIERS OF SHORT-WAVE KITS

One-valve Kit, price 25/–. Two-valve Kit, price 50/–. Improved designs with Denco coils. All kits complete with all components, accessories and full instructions but less valves. Before ordering, call and inspect a demonstration receiver, or send stamped envelope for catalogue.

H.A.C. SHORT-WAVE PRODUCTS (DEPT. R)
11 OLD BOND STREET LONDON W1

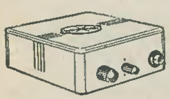
TRANSISTORWISE

"RECO" ALL-WAVE 1 TRANSISTOR KIT

A low cost beginner's radio. Kit includes all parts, transistor, diode, and super sensitive Bell-Phone for private listening, neat plastic case and 1.5V battery for months of dependable listening. Only 29/6.

Parts Price List, Wiring Diagram, 1/– P.O.

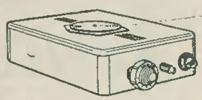
"RECO" TRANSISTOR 2 PORTABLE



Receives home and Continental stations. Ferrite rod aerial. Attractive plastic case, 4½" x 4½" x 1½", balanced armature output unit and all parts. 55/– inc. battery

Parts Price List, Wiring Diagram, 1/– P.O.

"RECO" PORTABLE TRANSISTOR 3



Similar specification to the "Reco" 2, but uses high gain frame aerial mounted on metal chassis. Has variable gain control. 65/– buys all parts, case and battery.

Parts Price List, Wiring Diagram, 1/– P.O.

All parts sold separately

RADIO EXCHANGE CO
(Dept. RC) 27 HARPER STREET BEDFORD

BOUND VOLUMES

A limited number of bound volumes (Vol. 10 only) are available, price £1.5.0. post 1/9

DATA PUBLICATIONS LTD

INDEXES

for Volume 10, August 1956—July 1957 are now available, price 6d. post free.

READERS' OWN COPIES

can be bound by us for **10s. 6d.** postage and packing 1s. 9d. extra (Index supplied free).
This offer does not apply where readers wish to remove pages.

57 MAIDA VALE LONDON W9
Telephone CUN 6141 (2 lines)

If you require a stockist of High Grade Components, we are the people for the job.

We are specialists in the stocking of precision components, resistors in high stability (British Grade 1) in 1%, 2% and 5% in ½ and 1W; carbon compound and high stability resistors (British Grade 2 standard) in 5%, 10% and 20% stocked in wide range of values ⅛W to 3W. Wire wound resistors, pots., large precision pots. for bridges, 1% standard capacitors for bridges, 1% standards of resistance from 1 ohm to 10M in 1%—up to 100M in 5%.

Components by McMurdo, Colvern Lab, Hunts, Elstone, T.S.L., available from stock. Send for Catalogue.

The High Fidelity Co
18 MELVILLE ROAD EDGBASTON BIRMINGHAM 16
(Proprietors Kendall & Mousley Ltd)

SCOTTISH INSURANCE CORPORATION LTD **62-63 Cheapside London EC2**

TELEVISION SETS, RECEIVERS AND TRANSMITTERS

Television Sets, Receivers and Short Wave Transmitters are expensive to acquire and you no doubt highly prize your installation. Apart from the value of your Set, you might be held responsible should injury be caused by a fault in the Set, or injury or damage by your Aerial collapsing.

A "Scottish" special policy for Television Sets, Receivers and Short Wave Transmitters provides the following cover:

(*a*) Loss or damage to installation (including in the case of Television Sets the Cathode Ray Tube) by Fire, Explosion, Lightning, Theft or Accidental External Means at any private dwelling-house.

(*b*) (i) Legal Liability for bodily injury to Third Parties or damage to their property arising out of the breakage or collapse of the Aerial Fittings or Mast, or through any defect in the Set. Indemnity £10,000 any one accident.

(ii) Damage to your property or that of your landlord arising out of the breakage or collapse of the Aerial Fittings or Mast, but not exceeding £500.

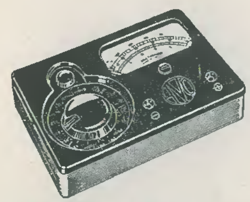
The cost of Cover (*a*) is 5/– a year for Sets worth £50 or less, and for Sets valued at more than £50 the cost is in proportion. Cover (*b*) and (ii) costs only 2/6 a year if taken with Cover (*a*), or 5/– if taken alone.

Why not BE PRUDENT AND INSURE your installation—it is well worth while AT THE VERY LOW COST INVOLVED. If you will complete and return this form to the Corporation's Office at the above address, a proposal will be submitted for completion.

NAME (Block Letters)..
If Lady, state Mrs. or Miss
ADDRESS (Block Letters)..
.... /JB

YOU CAN RELY ON US

We specialise ONLY in radio and electronic components, a comprehensive stock of which are held by us, to supply Government, educational and commercial laboratories. Can we be of some help to you, the experimenter and constructor? ?



The New
AVO MULTIMINOR
A first quality pocket instrument

Sensitivity 10,000Ω/V 0 to 1A in five ranges, 0 to 1,000V in 7 ranges. A.C. volts 0–1,000 in 5 ranges. Resistance 0–2 Meg in two ranges.

PRICE £9.10.0 *Leather Case 32/6*
or 63/4 Deposit and 6 Payments of 22/2 or 9 monthly payments of 23/3

ALL AVO INSTRUMENTS IN STOCK

All specified new components stocked for G.E.C. 912, Mullard 510, Pre-Amps, 20W, 3W, 7W, and Tape Amplifiers. High Stabs., P.F.'s, T.C.C., Hunts, Colvern, J.B., Denco, Taylor, Osmor, Teletron, S.T.C., Westinghouse, Bulgin. All Erie range in 20%, 10%, 5% and 5% High Stabs. Vast ranges of Capacitors, Resistors, Potentiometers, Transformers and Wire-wound Resistors.

82 SOUTH EALING ROAD
LONDON W5 Telephone **EAL 5737**

RADIO SERVICING CO