Published in Great Britain by the Proprietors and Publishers
Data Publications Ltd 57 Maida Vale London W9
Printed by A. Quick & Co. (Printers) Ltd 125 High Holborn London WC1 England *also at* Clacton-on-Sea
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)

UNDERSTANDING TELEVISION, contd.

VOLUME 13
NUMBER 6
JANUARY
1960

The RADIO Constructor

RADIO · TELEVISION · AUDIO · ELECTRONICS

Easily Constructed FM Tuner Unit

Included in this issue

- BUILDING AN AC MAINS MINIATURE RECEIVER
- THE LAZY MAN'S WAVEMETER CONVERSION
- VERY HIGH STABILITY FREQUENCY MARKER
- TRANSISTOR TOP-BAND TRANSMITTER
- COOPER-SMITH STEREO CONTROL UNIT, Part 2

DATA Publications 1/9

THE MODERN BOOK CO

Servicing Transistor Radios. By L. D'Airo **23s.** *Postage 1s.*

TV Fault Finding. A Data Publication. **5s.** *Postage 6d.*

How to Get the Best out of Your Tape Recorder. By P. J. Guy. **8s. 6d.** *Postage 6d.*

Electronic Hobbyists' Handbook. By R. P. Turner. **20s.** *Postage 8d.*

Quality Amplifiers for A.C. Mains. A Data Publication. **4s. 6d.** *Postage 6d.*

Brimar Valve and Teletube Manual, No. 8. **6s.** *Postage 9d.*

Radio Valve Data. Compiled by "WW". 6th Ed. **5s.** *Postage 9d.*

Mullard Circuits for Audio Amplifiers. **8s. 6d.** *Postage 1s.*

Television Servicing Handbook. By G. J. King. **30s.** *Postage* **1s. 3d.**

The All-in-One Tape Recorder Book. By J. M. Lloyd. **12s. 6d.** *Postage 8d.*

Radio Engineering Formulae and Calculations. By W. E. Pannett. **17s. 6d.** *Postage 8d.*

A Beginner's Guide to Radio. By F. J. Camm. **7s. 6d.** *Postage 6d.*

Guide to Mobile Radio. By L. G. Sands. **22s.** *Postage 9d.*

Elementary Telecommunications Examination Guide. By W. T. Perkins. **17s. 6d.** *Postage 9d.*

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

Smith's of EDGWARE ROAD

THE COOPER-SMITH

HIGH FIDELITY

STEREO CONTROL UNIT

COMPONENT PRICE LIST

Buy direct from the Designers to ensure 100% results

All enquiries promptly dealt with

Carriage free in U.K.

Complete resistor kit	21/6
Complete capacitor kit	37/2
Set of potentiometers	42/6
Set of switches	17/–
Case, tagstrips, valveholders, input panel, control carrier, plugs, rods and spacers, control panel with lens	70/–
Panel light holder and bulb	2/3
Set of knobs	8/6
EF86, pair (inc. P.T.)	34/10
12AT7, pair (inc. P.T.)	28/6
Wire and flex	3/–
Instructions	2/6
Total	£13.7.9

We regret that single components cannot be supplied.

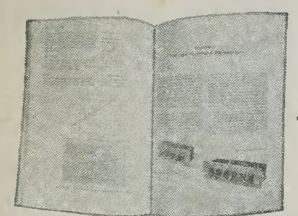
Inclusive price for complete kit	**£12.12.0**
Laboratory built and tested	**£15. 0. 0**

H. L. SMITH & CO. LTD

287/9 EDGWARE ROAD . LONDON W2 *Telephone* Paddington 5891 & 7595

Mullard

CIRCUITS FOR AUDIO AMPLIFIERS



-a book every enthusiast will want!

This new Mullard publication is a practical manual for every audio enthusiast. In addition to describing twelve of the most popular Mullard circuits, it has introductory chapters on many of the theoretical and practical aspects of high quality sound reproduction.

Whether you are interested in disc or tape, monaural or stereo, you will find that "Circuits for Audio Amplifiers" gives just the sort of information you need.

This informative book costs only 8/6d. The demand for it is high, so get your copy now from your local radio dealer.

Mullard

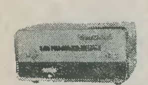
MULLARD LTD • MULLARD HOUSE • TORRINGTON PLACE • LONDON • W.C.1

MVM 422A

Heathkit DAYSTROM

Here are our NEW kits designed to the same high technical standard

HI-FI FM TUNER

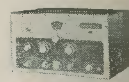


This model is available as two units which, for your convenience, are sold separately. They comprise a Tuner Unit, Model FMT-4U (**£3.2.0** including Purchase Tax) with I.F. output of **10.7** mc/s and an Amplifier Unit complete with attractively styled cabinet, power supply and valves, Model FMA-4U (**10.10.6**) making a total cost for the equipment of **£13.12.6.**

ELECTRONIC SWITCH Model S-3U
(Oscilloscope Trace Doubler)

This extremely useful low-priced device will extend the application of your single-beam oscilloscope by enabling it to give simultaneous traces of two separate and independent signals **£9.18.6**

AMATEUR TRANSMITTER Model DX-100U

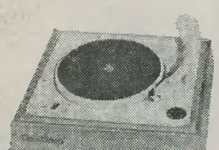


This is the most popular Amateur transmitter in the world and requires no introduction to "Hams" the world over. Covers all bands from 160–10 metres. Self-contained, including power supply, Modulator and V.F.O. **£78.10.0**

DIRECT READING CAPACITANCE METER

Model CM-1U. Full-scale ranges of 100 micro-microfarad, 1,000 micro-microfarad, 0.01 microfarad and 0.1 microfarad. Easily built in a few hours **£14.10.0**

TRANSCRIPTION RECORD PLAYER, Model RP-1U

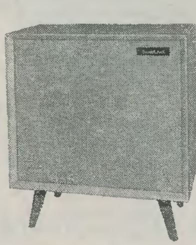


This new RP594 Collaro Transcription Unit has a Ronette Stereo Pick-up, giving excellent results on stereo or mono (33, 45 or 78 r.p.m.) discs. Complete with furniture-grade wooden plinth. **£12.10.0**

THE "GLOUCESTER". It will house Tape Deck and/or Record Player—as well as FM Tuner and Stereo Amplifier, and storage space is provided for records, tapes and power amplifiers. Furthermore, to meet the needs of those with whom room-space is an overriding consideration, provision is made in the cabinet ends for matched Hi-Fi Stereo Speaker Systems

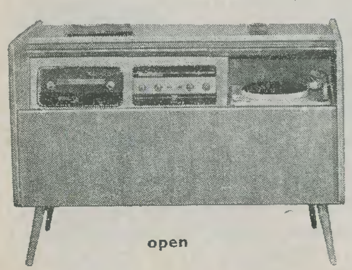
Mk. 1. Tape Deck or Record Player. **£15.18.6**

Mk. 2. Tape Deck and Record Player. **£17.8.6**



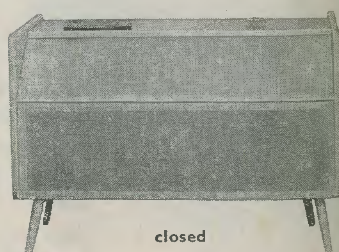
THE "COTSWOLD

THE "COTSWOLD". This is an acoustically designed enclosure 26″ x 23″ x 15½″ housing a 12″ bass speaker with 2″ speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 32–20,000 c/s. Capable of doing justice to the finest programme source, its polar distribution makes it ideal for really Hi-Fi Stereo. Delivered complete with speakers, cross-over unit, level control, Tygan grille cloth, etc. All parts pre-cut and drilled for ease of assembly and left "in the white" for finish to personal taste. **£19.18.6**



open

THE "GLOUCESTER"

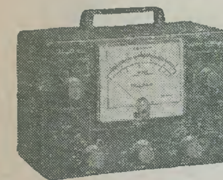


closed

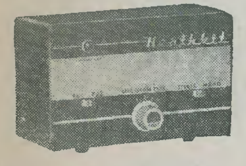
DAYSTROM LTD DEPT. RC1 GLOUCESTER ENGLAND

Heathkit DAYSTROM

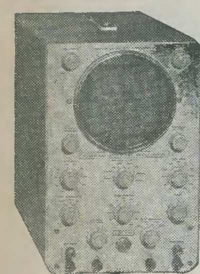
Easily-built instruments of excellent quality at much lower cost



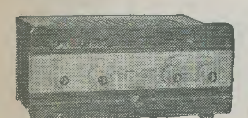
AG-9U



USP-1



O-12U



S-33

AUDIO GENERATOR: AG-9U. 10 volts, 10 c/s to 100 kc/s pure sine-wave. Switch-selected frequencies/attenuation. **£19.3.0**

HI-FI SPEAKER SYSTEM: SSU-1. Ideal twin speaker/ducted-reflex cabinet for stereo/mono. in average room (left "in the white"). Legs **£1.7.0** extra. **£10.5.6**

HI-FI STEREO 6 WATT AMPLIFIER: S-33. Low priced but high quality; less than 0.3% distn at 2½ watts per channel. **£11.8.0**

TRANSISTOR PORTABLE: UXR-1. In elegant solid hide case, with golden relief. Six transistors, dual-wave, fine reproduction, very easy to build. **£15.18.6**

HI-FI STEREO BOOSTER: USP-1. Input of 2 to 20mV gives output adjustable from 20mV to 2V. Negligible distn. Also suitable as a high gain monaural amplifier. **£5.19.6**

HI-FI STEREO 16 WATT AMPLIFIER: S-88. Superb reproduction for the man who wants the best in Hi-Fi. Only 0.1% distortion at 6 W/chnl Many special features. **£25.5.6**

5″ OSCILLOSCOPE: O-12U. "Y" sensitivity 10mV/cm., 3 c/s to over 5 Mc/s. Rise time, 0.08 μsecs. or less. Sweep, 10 c/s to 500 kc/s. Electronically stabilised. **£34.15.0**

VALVE VOLTMETER: V-7A. The World's largest-selling VVM. Measures Volts to 1500 (DC & RMS) and 4,000 pk. to pk.; Resistance 0.1Ω to 1,000MΩ D.C. Sensitivity: 7,333,333 ohms per volt. **£13.0.0**

(Following models not illustrated)

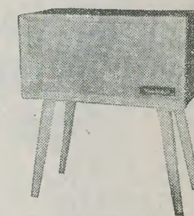
CAPACITANCE/RESISTANCE BRIDGE C-3U Measures capacity, 10pF to 1,000μF. Resistance, 100Ω to 5MΩ; Pwr. F'ctr. **£7.19.6**

"HAM" TRANSMITTER: DX-40U. 75 W. CW; 60 W. pk. c/c phone; 40 W. into Aerial, **£29.10.0**

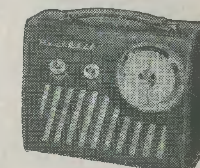
VARIABLE FREQUENCY OSCILLATOR: VF-1U. 10V output; covers 10 to 160 metres. **£10.12.0**

AUDIO WATTMETER: AW-1U. Up to 25 W. continuous, 50 W. intermittent. **£13.18.6**

AUDIO VALVE-MILLIVOLTMETER: AV-3U. 1mV to 300V A.C. 10 c/s to 400 kc/s. **£13.18.6**

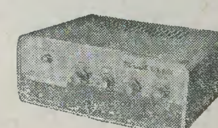


SSU-1



UXR-1

V-7A



S-88

COMPLETE MATCHED STERO OUTFIT

★ comprising record player, amplifier and twin speaker systems. **£42.10.0** ★

All prices include free delivery in U.K. Deferred terms available on orders above £10.

★ **SEND THIS COUPON NOW FOR FURTHER INFORMATION**

(Please write in BLOCK CAPITALS)

NAME ....

ADDRESS ....

....

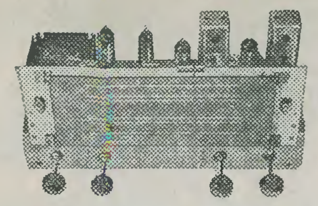
Without obligation please send me (Tick here)

BRITISH HEATHKIT CATALOGUE ....

FULL DETAILS OF MODEL(S) ....

DAYSTROM LTD DEPT. RC1 GLOUCESTER . ENGLAND

A member of the Daystrom Group, manufacturers of the **WORLD'S LARGEST-SELLING ELECTRONIC KITS**



1960 RADIOGRAM CHASSIS

THREE WAVEBANDS — FIVE VALVES
S.W. 16 m –50 m. — LATEST MULLARD
M W. 200 m.–550 m. — ECH81, EF89, EBC81,
L.W. 800 m.–2,000 m. — EL84, EZ80

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 2¼". Glass dial, horizontal or vertical, size 10" x 4½". 2 pilot lamps. Four knobs, walnut or ivory, aligned and calibrated. Chassis isolated from mains. Leaflet S.A.E.

BRAND NEW £9.10.0 Carr. 4/6

TERMS: Deposit **£5.5.0** and 5 monthly payments of **£1**
MATCHED SPEAKERS: 8" **17/6.** 10" **25/–.** 12" **30/–**
New 6 valve AM/FM model. **£18.19.6.**

LATEST "E.M.I." 4 SPEED SINGLE RECORD PLAYER

Acos 73 Hi-Fi Stereo and Normal Xtal Pick-up for 7", 10" and 12" records — Silent Motor, Heavy Turntable

Special offer **£6.19.6** post 3/6

BUILD THIS REPRODUCER BARGAIN

SPECIAL SINGLE PLAYER KIT

COLLARO 4-speed Gram-Pick-up Unit	£4.10.0
Handsome portable case 17½" x 13½" x 7" with room to play 12" records	£2. 5.0
Ready built 3-watt amplifier with two valves and 7" ellip speaker, printed circuit	£3.12.6

or **£9.15.0** complete kit post free

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 Midget I.F.S. 465 kc/s	12/6 pair
Wearite 550 Standard I.F.S. 465 kc/s	12/6 pair

New boxed VALVES 90-day Guarantee

1R5	8/6	6K8G	8/6	EA50	1/6	EZ80	8/6
1S5	8/6	6L6G	10/6	EABC80	10/6	E1148	1/6
1T4	8/6	6N7M	7/6	EB91	6/6	HABC80	12/6
2X2	2/6	6Q7G	10/6	EBC33	8/6	HVR2A	7/6
3S4	8/6	6SA7	10/6	EBC41	10/6	MU14	10/6
3V4	8/6	6SJ7M	10/6	EBF80	10/6	P61	6/6
5U4	8/6	6SN7	8/6	ECC84	12/6	PCC84	12/6
5Y3	8/6	6V6G	7/6	ECF80	11/6	PCF80	11/6
5Z4	10/6	6X4	7/6	ECH42	10/6	PCF82	11/6
6AM6	8/6	6X5	7/6	ECL80	12/6	PCL82	11/6
6B8	5/6	7S7	10/6	ECL82	12/6	PEN25	6/6
6BE6	7/6	12AT7	10/6	EF39	7/9	PL82	10/6
6BH6	10/6	12AU7	9/6	EF41	10/6	PY80	8/6
6BW6	10/6	12AX7	9/6	EF50	5/6	PY81	10/6
6D6	7/6	12BE6	9/6	EF80	10/6	PY82	8/6
6F6	7/6	12K7	8/6	EF86	14/6	SP61	5/6
6H6	3/6	12Q7	8/6	EF92	5/6	UBC41	10/6
6J5	6/6	35L6	9/6	EL32	5/6	UCH42	10/6
6J6	7/6	35Z4	9/6	EL41	10/6	UF41	10/6
6J7G	8/6	80	10/6	EL84	10/6	UL41	10/6
6K6GT	6/6	807	6/6	EY51	12/6	UY41	8/6
6K7G	5/6	954	1/6	EZ40	8/6	U22	10/6

B.B.C. Pocket Transistor. M.W. & L.W. Radio Kit 32/6. 'Phones **7/6.** Ardente deaf aid earpiece with special lead and plug **15/–.**

Our written guarantee with every purchase

C.R.T. ISOLATION TRANSFORMERS

For Cathode Ray Tubes having heater cathode short circuit and for C.R. Tubes with falling emission, full instructions supplied. **Type A.** Low leakage windings. **Optional 25%** and **50%** boost on secondary: 2V, *or* 4V, *or* 6.3V, *or* 10.3V, *or* 13.3V, with mains primaries, **12/6. Our Latest Superior Product. Mains Input Type A2. High quality low capacity 10-15pF. Optional boost 25%, 50%, 75%, 16/6 each. Type B.** Mains input. Low capacity. Multi output 2, 4, 6.3, 7.3, 10 and 13V. Boost 25% and 50%. This transformer is suitable for all TV tubes. **21/–** each.

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 100Ω–10MΩ. Ditto 5% 100Ω–5MΩ **9d.** 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 25k, **3/–** each, 30k, 50k, **4/–.** Ditto ½W Carbon Track 30kto 2 Meg, **3/–.**

3W Lab. Colvern, etc. Standard size Pots, 2¼" Spindle, high grade. All values, 100 ohms to 50k, **6/6**; 100k, **7/6.**

W/W EXT. SPEAKER CONTROL 10Ω, **3/–**

MAINS TRANSFORMERS—200/250 AC

STANDARD 250-0-250, 80mA, 6.3V tapped 4V 4A, Rectifier 6.3V 1A tapped 5V 2A and 4V 2A	22/6
Ditto 350-0-350	22/6
MINIATURE. 200V 20mA, 6.3V 1A	10/6
MIDGET. 250V 45mA, 6.3V 2A	15/6
SMALL. 250-0-250V 100mA, 6.3V 3.5A	19/6
STANDARD. 250-0-250, 65mA, 6.3V 3.5A	17/6
HEATER TRANS. 6.3V 1½A	7/6
Ditto tapped sec. 2, 4, 6.3V 1½A	8/6
Ditto, sec. 6.3V 3A	10/6
Mullard "510" Osram "912" 300-0-300, 120mA, 6.3V 4A c.t., 6.3V 2A tapped 5V	38/6

O/P TRANSFORMERS. Heavy duty 50mA, **4/6.** Multi-ratio push-pull, **7/6.** Miniature 3V4, etc., **4/6.** Small pentode, **4/6.** Hygrade push-pull 7 watts, **15/6.** Heavy duty 10/20W 6k or 8k c.t., **30/–.**

L.F. CHOKES 15/10H 60/65mA, **5/–**; 10H, 85mA, **10/6**; 10H 150mA, **14/-.**

CRYSTAL MIKE INSERT by Acos **6/6**
Precision engineered. Size only ⅞" x 3/16"
ACOS CRYSTAL HAND or DESK MIKE, 35/–

ALADDIN FORMERS and cores. ¼" 8d., ⅜" **10d. 0.3" FORMERS** 5937 or 8 and cans TV1 or 2. ¾" sq. x 2¼" or ¾" sq. x 1¼", **2/–** with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6-1, **2/3.**
TYANA. Midget Soldering Iron. 230V 40W, **16/9.**
REMPLOY INSTRUMENT IRON, 230V 25W, 17/6.
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 TRANS. 50:1, **3/9**; 100:1, potted, **10/6.**
LOUDSPEAKERS. P.M. 3 ohm. 5", Rola **17/6**; 6" x 4" Rola, **18/–**; 4" Hi-Fi Tweeter, **25/–**; 8" Plessey, **19/6**; 6½" Goodmans, **18/6**; 10" R.A., **30/–**; 12" Plessey, **30/–**; 10" x 6" R.A., **27/6**; 12" Baker 15W 3 ohm or 15 ohm models, **105/–**; Stentorian HF1012 10", **95/-.**
CRYSTAL DIODES. G.E.C., **2/–**; GEX34, **4/–.**
40 CIRCUITS FOR GERMANIUM DIODES, 3/–.
H.R. HEADPHONES 4,000 ohms, brand new, **16/6** pr.
SWITCH CLEANER FLUID, squirt spout, **4/3** tin.
TWIN GANG CONDENSERS. 365pF, miniature. 1⅜" x 1½" x 1¾", **10/–**; 0.0005 standard with trimmers, **9/–**; less trimmers, **8/–**; Midget, **7/6**; 50pF single, **2/6.**
SHORT WAVE Single 75pF, 100pF, 160pF, **7/–** each.
TUNING AND REACTION CONDENSERS. 100pF, 300pF, 500pF, **3/6** each, solid dielectric.

HIGH GAIN TV PRE-AMPLIFIERS

BAND I B.B.C.
Tuneable channels 1 to 5 Gain 18dB. ECC84 valve. Kit price **29/6** or **49/6** with power pack. Details **6d.**

BAND III I.T.A.—Same prices
Tuneable channels 8 to 13. Gain 17 dB ECC84 valve.

Volume Controls
Midget size. Long spindles. Guaranteed 1 year. All values 5,000 ohms to 2 Meg.
No Switch 3/– — D.P. Switch 4/9
Linear or Log Tracks

80Ω Coaxial Cable
Post 1d. per yard extra
Semi-air spaced Polythene Ideal Band III **6d yd.**
Losses cut 50%
FRINGE QUALITY Air spaced Coaxial **1/- yd.**

Coaxial Plugs	1/–	**Lead Socket**	2/–
Panel Sockets	1/–	**Outlet Boxes**	4/6

Balanced Twin Feeder, per yd **6d.,** 80Ω or 300Ω.
Twin Screened Balanced Feeder, 1/6 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, 8 colours, single or stranded, 2d. yd. Sleeving 1, 2mm, **2d.,** 2, 3 mm, **3d.,** 6 mm, **5d.** yd.
NEON MAINS TESTER SCREWDRIVERS, 5/-.
SOLDER RADIOGRADE, 4d. yard ¼lb **2/6.**

Aluminium Chassis. 18 s.w.g. Plain, undrilled, 4 sides, riveted corners, lattice fixing holes, 2½" sides. 7" x 4", **4/6**; 9" x 7", **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.**

Miniature Contact Cooled Rectifiers. 250V 50mA **7/6**; 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 D.W.R. 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.**
Speaker Fret. Gold cloth, 17" x 25", **5/–**; 25" x 35", **10/–. Tygan,** 4' 6" wide, **10/–** ft; 2' 3" wide, **5/-** ft. Samples, S.A.E.
Condensers. 0.001µF 7kV T.C.C., **5/6**; ditto 20kV, **9/6**; 0.1µF 7kV, **9/6**; 100pF to 500pF Micas, **6d.**; Tubular 500V 0.001 to 0.05, **9d.**; 0.1, **1/–**; 0.25, **1/6**; 0.1/350V, **9d.**; 0.5, **1/9**; 0.01/2,000V, **1/9**; 0.1/2,000V, **3/6.**
Ceramic Condensers. 500V 0.3pF to 0.01µF, **9d.**
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**; 1,000pF to 5,000pF, **2/–.**

NEW ELECTROLYTICS — FAMOUS MAKES

TUBULAR		TUBULAR		CAN TYPES	
1/350V	2/–	64/350V	5/6	8/500V	3/–
2/450V	2/3	100/25V	2/–	16/500V	4/–
4/450V	2/3	250/25V	2/6	32/350V	4/–
8/450V	2/3	500/12V	3/–	100/270V	5/6
8/500V	2/9	8+8/450V	4/6	2,500/3V	4/–
16/450V	3/6	8+8/500V	5/–	5,000/6V	5/–
16/500V	4/–	8+16/450V	5/–	32+32/350V	4/6
32/450V	5/6	8+16/500V	5/6	50+50/350V	7/–
25/25V	1/9	16+16/450V	5/6	64+120/275V	7/6
50/25V	2/–	16+16/500V	6/-	64+120/350V	11/6
50/50V	2/–	32+32/350V	4/6	100+200/275V	12/6

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

LONG PLAY FAMOUS MAKES
Plastic tape 50% extra 1,700ft 7" reel, **35/–**; 850ft 5" reel, **21/–. MSS** 225ft, 3" reel, **7/6.** Spare reels, **3/–.**
SUPERIOR 1,200ft plastic tape, **24/–,** 7" plastic reel. 600ft plastic tape on 5" plastic reel, **15/–.**
LONG PLAY 1,200ft, 5¾" reel, **28/–.**
INSTANT bulk tape eraser, and Head Defluxer, 200/250V a.c., **27/6.** Leaflet S.A.E.

BRAND NEW AND BOXED
Model UA8
OUR PRICE **£6.19.6**

STEREO MODELS
UA8 £7.19.6.
UA12 £10.10.0.

★ **COLLARO** ★
HI-FI ATUOCHANGER £7.19.6
4 SPEEDS—10 RECORDS
or with Cabinet, Amplifier and Speaker
OUR PRICE £11.19.6 Carr. 5/6

★ **GARRARD 4-SPEED RECORD CHANGERS RC121/D MK II MODELS** ★
With Plug-in Normal Head **£10.10.0**
Stereo Head **£2 extra**

AUTOCHANGER ACCESSORIES

Suitable player cabinets (uncut boards)	49/6
Amplifier player cabinets with cut boards	63/–
2-valve amplifier and 6½" speaker for above	79/6
3-valve amplifier and 6½" speaker for above	95/–

Wired and tested ready for use

★ **GARRARD 4-SPEED SINGLE RECORD PLAYER TA MK II** ★
£8.10s. | **AUDIO PERFECTION** | Stereo wired
with plug in Normal Heads
MODEL 4 HF £18
Stereo Heads £2 extra.

Wavechange Switches. 2 p. 2-way, 3p. 2-way, short spindle, **2/6**; 5p. 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. 2-way, long spindle, **3/6**; wavechange "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/–.**

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, **2/6. Complete Jason FM Kit,** with valves and Jason Chassis with calibrated dial, **£6.15.0,** post free.

Valveholders. Pax. int. oct., **4d.** EA50, EF50, **6d.** B12A, CRT **1/3.** Eng. and Amer. 4, 5, 6 and 7 pin, **1/–.** MOULDED Mazda and int. oct., **6d.,** B7G, B8A, B8G, B9A, **9d.** B7G with can, **1/6.** B9A with can, **1/9.** **Ceramic,** EF50, B7G, B9A, int. oct., **1/–.** B7G, B9A Cans, 1/-; each.
TV Fault Finding, 5/–. Quality Amplifiers, 4/6.
Radio Valve Guide. Books 1, 2 or 3 — **5/–** each
TRANSISTORS. Ediswan Audio XB102, **10/–.** R.F. 2Mc/s **XA103, 15/-.** R.F. 4Mc/s XA104, **18/–.** Continental OC71, **7/6.**
Sub-miniature Electrolytics (15V), 1µF, 2µF, 4µF, 5µF, 8µF, 25µF, 50µF, 100µF, **3/–.**

TELETRON POCKET RADIO
Transidyne Superhet Six 6" x 4" x 1¾"
T.C.C. Printed Circuit, internal Ferrite aerial, Rola loudspeaker push-pull output. All parts, cabinet, 6 Ediswan or Mullard transistors.
£11.19.6 Details 9d.

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD WEST CROYDON — Telephone THO 1665

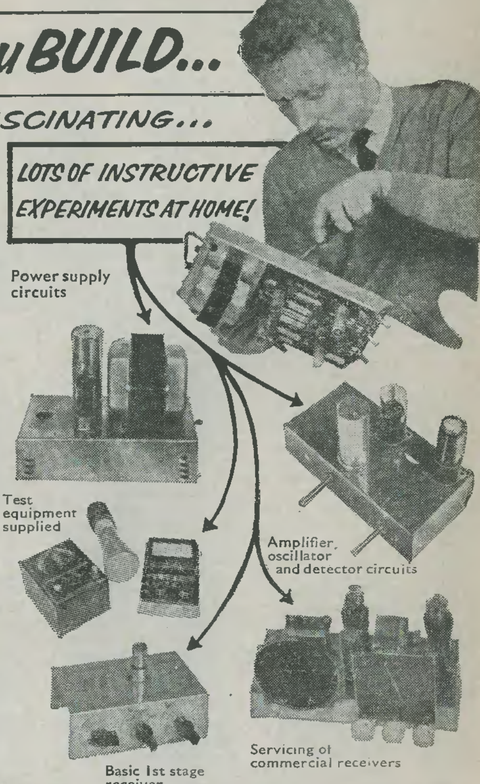
Buses 133 or 68 pass door S.R. Stn. Selhurst.

48 hour postal service 1/–, over £2 post free. C.O.D. 1/6 (Export welcome. Send remittance and extra postage)

NEW! DO-IT-YOURSELF TRAINING TECHNIQUE in RADIO & ELECTRONICS

You LEARN while you BUILD...

SIMPLE...PRACTICAL...FASCINATING...



ANNOUNCING—after many years of highly successful operation in the U.S.A. and in Europe—the latest system in home training in electronics is now introduced by an entirely new British training organisation.

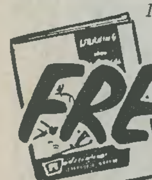
AT LAST—a comprehensive and simple way of learning—by practical means—the basic principles of radio and electronics, with a minimum of theory.

YOU LEARN BY BUILDING actual equipment with the components and parts which we send you. You advance by simple steps using high quality equipment and performing a whole series of interesting and instructive experiments. No mathematics!

INSTRUCTION MANUALS and our teaching staff employ the latest techniques for showing clearly how radio works in a practical and interesting manner. You really have fun whilst learning! *And* you end by possessing a first rate piece of home equipment with the full knowledge of how it operates and—very important—how to service and maintain it afterwards. A full library of magnificent illustrated textbooks is included with the courses.

IN FACT for the "Do-it-Yourself" enthusiast, the hobbyist or those wanting help with their radio career training, or to set up their own full or part-time servicing business—then this new and exciting instructional system is exactly what is needed and it can all be provided at very moderate cost. Easy payments available. Post the coupon now, for full details. There is no obligation of any kind.

BUILD YOUR OWN: • RADIO EQUIPMENT • HI-FI INSTALLATION • TEST GEAR—AND LEARN AS YOU DO IT.



FREE—POST TODAY

RADIOSTRUCTOR

BRITAIN'S LEADING RADIO TRAINING ORGANISATION.

No Mathematics!

To: RADIOSTRUCTOR (Dept. G31)
46 Market Place, Reading, Berks.

Please send full details of your Radio Equipment Courses without any obligation to:

Name..........

Address..........

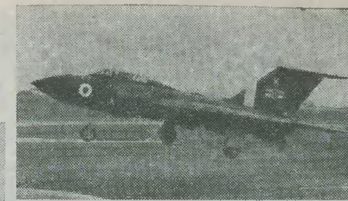
....

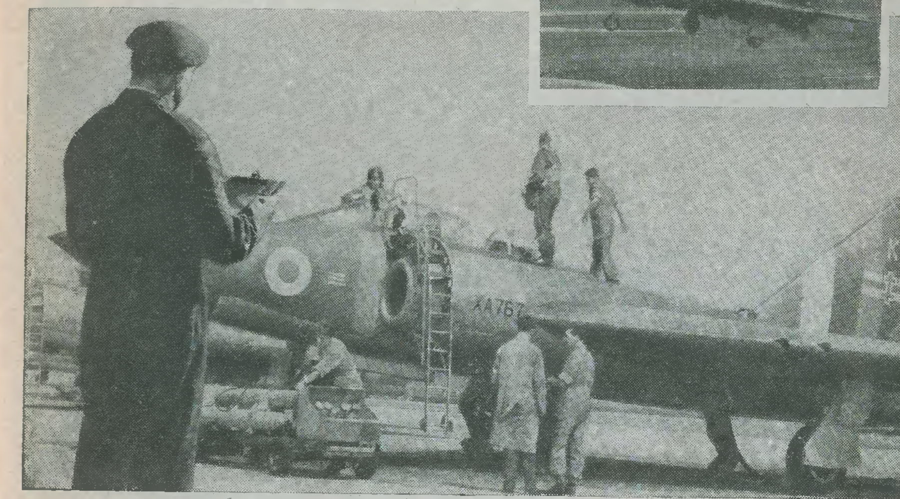
....

BLOCK CAPS PLEASE

(802) *We do not employ representatives* 1.60

Touch-down!





7 minutes to go!

Their sortie completed—two Javelins return—only two aircraft—only four men—but it takes a large team of technicians to get them back into the air without delay.

A Javelin's ground crew works at top speed. They can rearm and refuel the aircraft and have it back on the runway fully serviced in seven minutes. Here, the Master Radar Station takes over. Once again a technical team . . . air operations staff, teleprinter operators, radar specialists. In the R.A.F., *every* man counts.

As part of their servicing re-charged batteries are hoisted into the Javelin's fuselage. These provide a reserve source of electric power.

You'll get more out of life in the

R.A.F.

The R.A.F. will train you for a key post and a planned career in electronics, radio, radar or one of many other trades. For full details, post this coupon today.

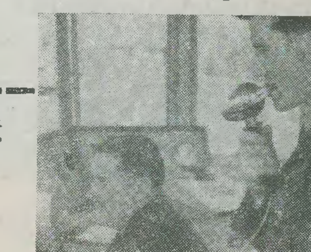
To: Royal Air Force Central Recruiting Office (ECA 18a), Victory House, Kingsway, London WC2

NAME ....DATE OF BIRTH..........

STATE TRADE PREFERENCE..........

ADDRESS ....

....



In seven minutes, two more Javelins are ready on the runway. From the Control Tower, it's . . . "All clear for take-off".

the NEW MOTEK KIO
3 SPEED TAPE DECK

The
Radio Constructor

Incorporating THE RADIO AMATEUR

Vol. 13 No. 6 JANUARY 1960 ANNUAL SUBSCRIPTION 25/– (*including postage*)

Editor
C. W. C. OVERLAND, G2ATV

Associate Editor
A. C. GEE, G2UK

Business Manager
J. H. BURROWS, A C A

Advertising Manager
F. A. BALDWIN, A M I P R E

Offices
57 MAIDA VALE LONDON W9

Telephone
CUNNINGHAM 6141
(2 lines)

Telegrams
DATABUX, LONDON

CONTENTS

NOTICES

ARTICLES appearing in this magazine which describe kits are inserted only on condition that such kits, or special components thereof, are freely available at a trade discount to all retail advertisers.

OPINIONS expressed by contributors are not necessarily those of the Editor or proprietors.

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.

TECHNICAL QUERIES should be submitted in wiriting. 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."

TEST EQUIPMENT

No. 110

A very high stability Frequency Marker

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 data

It is not generally realised that, due to its country-wide coverage and the convenient frequency on which it operates, the B.B.C. Light Programme transmitter on 1500 metres is capable of providing an exceptionally accurate signal source for frequency checking equipment. The carrier frequency of this transmitter is, of course, 200 kc/s, and it is maintained at the high level of accuracy provided by broadcast stations of this kind. In actual fact, the B.B.C. Light Programme signal is currently employed by a number of electronic firms in the U.K. for the purpose of providing sub-standard frequency checks, the signal being picked up and amplified in much the same manner as is employed in this month's suggested circuit.

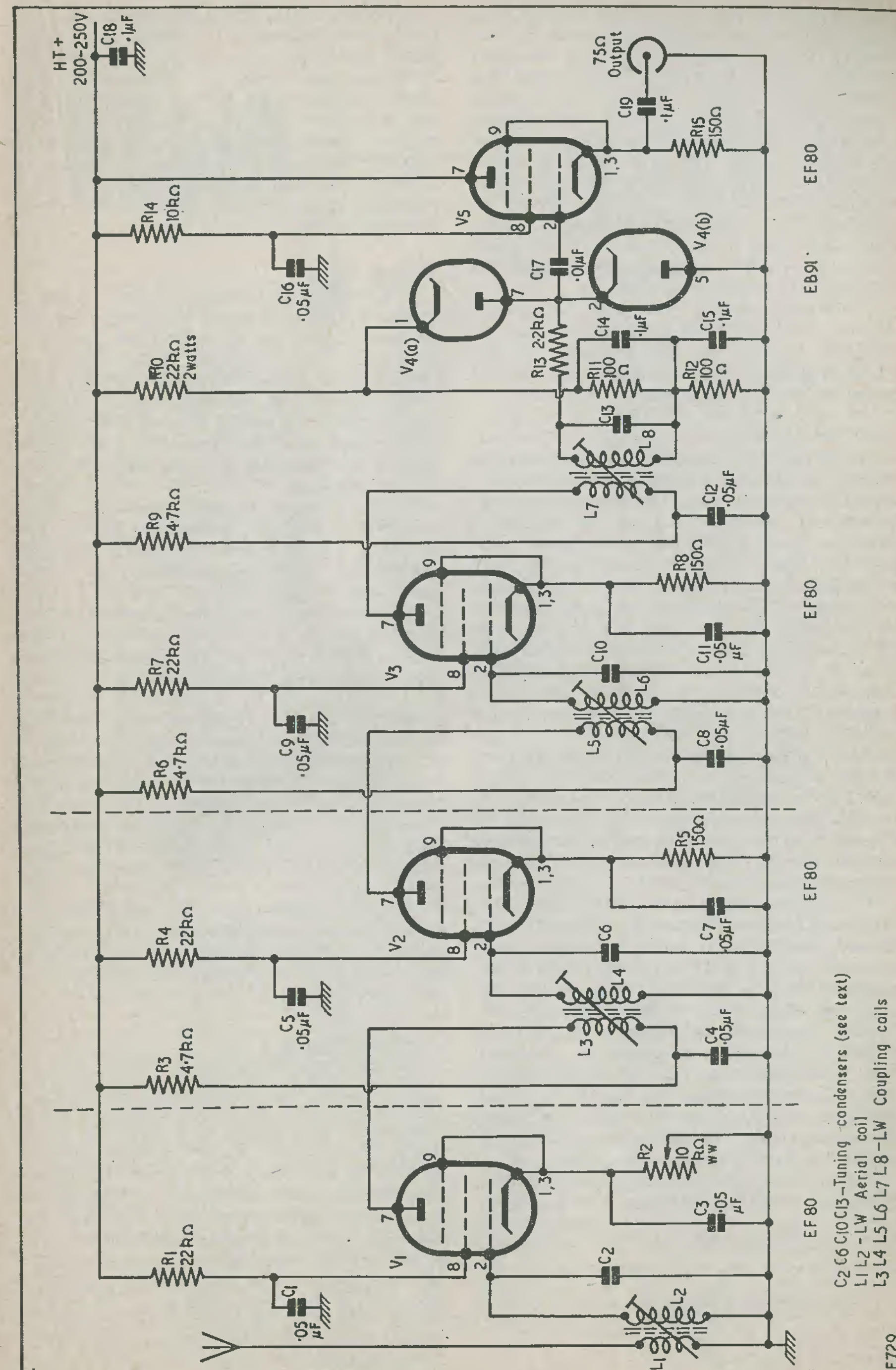
In this month's contribution the writer describes a circuit which provides, at relatively high level, a fundamental at 200 kc/s, together with harmonics of this frequency, all these being derived from the Light Programme carrier. Although the circuit is rather extensive, it has the advantage of being quite flexible in so far as components and valves are concerned. It should be of especial interest to the more serious experimenter who wishes to avail himself of the very high frequency stability and accuracy provided.

The Circuit

The circuit of the frequency marker accompanies this article. Basically, the marker comprises several stages of r.f. amplification whose function it is to raise the carrier frequency of the Light Programme transmitter to a level of, at least, some 12 volts or so. This high level signal is then applied to a limiter which, by passing only the central part of the waveform, converts the carrier to a square wave. This square wave, which is now rich in harmonics of the fundamental 200 kc/s, is next fed to a cathode follower. The cathode follower provides, finally, an output at 75Ω impedance.

The operation of the circuit is very simple. V_1, V_2 and V_3 are fairly high-slope r.f. pentodes providing an amplifier tuned to 200 kc/s. A gain control, R_2, is inserted in the cathode circuit of V_1.

V_3 couples, via L_7, L_8, into the limiting circuit given by diodes $V_{4(a)}$ and $V_{4(b)}$. These diodes function in the following manner. If no voltage happens to be present across L_8, the cathode of $V_{4(a)}$ is maintained positive of its anode by the delay voltage developed across R_{11}. Under the same conditions, the cathode of $V_{4(b)}$ is held positive of its anode by the delay voltage dropped across R_{12}. Thus, neither diode conducts. Should a voltage greater than that dropped across R_{11} and having a polarity such that the top end of L_8 becomes positive, appear across this coil, then the anode of $V_{4(a)}$ becomes positive with respect to its cathode and it conducts.



Similarly, if a negative voltage greater than that dropped across R_{12} appears at the top end of L_8, the cathode of $V_{4(b)}$ becomes negative with respect to its anode and this diode conducts also. When either diode conducts, the voltage across L_8 which is in excess of the appropriate delay voltage becomes dropped across R_{13}, and is not passed to the cathode follower V_5. The delay voltages provided by R_{11} and R_{12} are of the order of 1 volt, with the result that the square wave appearing at the junction of $V_{4(a)}$ and $V_{4(b)}$ will have a peak-to-peak amplitude somewhat in excess of 2 volts.

The square wave is passed to V_5 via condenser C_{17}. V_5 functions as a cathode follower having, in the presence of the 150Ω cathode resistor R_{15}, an output impedance of approximately 75Ω.*

Practical Details

As may be imagined, a circuit of this nature, consisting mainly of a simple r.f. amplifier, does not require component values, or valves, which are to any great extent critical. The more experienced constructor will doubtless be able to take advantage of components which may already be on hand without departing from the basic requirements of the circuit. Valves type EF80 have been specified in the diagram, but these may be replaced by almost any other reasonably high-slope r.f. pentodes which happen to be available. EF50s should, for instance, cope quite satisfactorily. V_4 may, in the same manner, be replaced by any similar double-diode, or pair of single diodes. It should be pointed out that, due to the high inverse voltages which may be applied to the diodes, germanium diodes should not be employed in the $V_{4(a)}$ and $V_{4(b)}$ positions.

The coils used in the circuit are conventional long wave receiver types. L_1, L_2 should be a long wave aerial coupling coil, such as the Teletron HA1. The remainder should be long wave inter-valve coupling coils, such as the Teletron HF1. Specific values for condensers C_2, C_6, C_{10} and C_{13} have not been given, as these will vary according to the type of coil which they tune. These condensers should have values, experimentally determined, which enable the appropriate coil to resonate at 200 kc/s within the tuning range of its core.

A point of particular importance is that, due to the considerable amount of amplification provided at a single frequency, care will be needed to prevent feedback and consequent instability. It will be very desirable to screen the three r.f. stages from each other, as illustrated by the dashed lines in the diagram. Due to its action, the components in the limiting circuit are liable to "spray" a considerable amount of energy at fundamental and harmonic frequencies, and judicious screening may be advisable around this part of the circuit as well.

Setting Up

If a modulated signal generator having an output at 200 kc/s is not available, it should be possible to align the r.f. tuned circuits by means of aerial signals. Final alignment should, in any case, be carried out with the aerial signal. A suitable signal strength indicating device would be given by connecting a pair of headphones to the output socket, a crystal diode being inserted in the non-earthy lead.

The aerial (or signal generator) should initially be applied to the grid of V_3, and L_7, L_8 adjusted for maximum response (either of Light Programme or signal generator modulation) at 200 kc/s. The aerial (or signal generator) should then be applied to the grid of V_2 and the process repeated with L_5, L_6. The aerial (or signal generator) should next be applied to the top end of L_1, coils L_3, L_4 and L_2, L_1 being finally lined up. If, as is very probable, signal strength is excessive at this stage of alignment, the gain of V_1 should be reduced by adjusting R_2. Further reduction in signal strength may be achieved, if necessary, by loosening the coupling between the aerial and L_1. A final adjustment of all cores should then be carried out on the aerial signal.

After alignment has been completed, the aerial should be connected up in correct manner, and R_2 advanced such that the basic 200 kc/s is accompanied by harmonics of adequate strength.

Excessive Signal

Before concluding, it should be pointed out that the gain at 200 kc/s provided by the marker may be excessively high if the equipment is situated at a location where Light Programme signal strength is high. If this is the case, it may be possible to dispense with one of the r.f. amplifiers and still obtain sufficient r.f. level across L_8 for effective squaring by the limiter diodes. The modifications involved are quite straightforward: V_1 and its immediate components should be removed, coil L_1, L_2 should replace L_3, L_4 and the variable resistor R_2 should be fitted in the cathode circuit of V_2 in place of R_5.

* The impedance at the cathode of V_5 is equal to $\frac{R_k}{1+g_m.R_k}$, where R_k is the cathode load resistor. Assuming a mutual conductance in V_5 of 7 mA/V (=0.007 mhos), the output impedance becomes $\frac{150}{1+1.05} \simeq 75.\Omega$

RADIO Topics

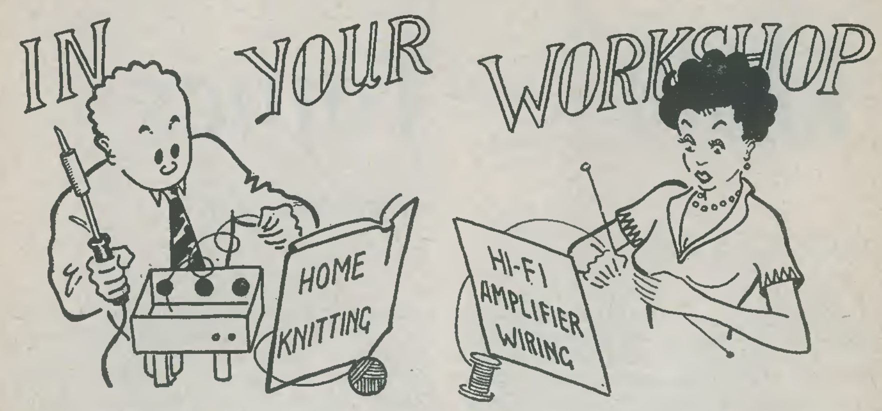
By Commentator

Writing this feature is really quite fun. Of course, we got into lots of trouble for singling out motorcyclists for their noise-making propensities! Our apologies to those who have silenced their mounts; may the rest do likewise. We collected a number of excellent pictorial QSL cards. Our views on this topic seemed to be generally accepted. We were surprised, however, to receive some letters from readers who did not agree with out remarks on kits. Some apparently still love chassis bashing, but it seems the majority welcome the appearance of the present-day style of kit with as much enthusiasm as does your Commentator.

One point made was that with cramped living quarters and lack of workshop facilities which modern housing standards enforce on the majority, kitchen table-top construction is now more necessary than ever, these kits lending themselves particularly to this form of inconvenience. One of the most interesting things that came out of the correspondence about this subject was a letter and brochures describing the **Lektrokit** chassis construction system. Your Commentator had an opportunity of seeing this at the recent Radio Hobbies Exhibition, and for the constructor who likes experimenting, but at the same time does not care to spoil the appearance of his equipment with lots of misplaced or unused holes and so on, this system is ideal. It consists of a number of components which can be built up into chassis, rack-mounting units or cabinets to accommodate any type of circuit one wishes to try out. The heart of the system is a series of specially perforated aluminium alloy chassis plates designed to provide the maximum flexibility in the positioning of components. These plates can be mounted on two chassis rails which will accommodate four plates, enabling the mounting of a maximum of twenty-four valves in an area of 5in x 17in. End plates, panels and covers in grey hammertone stove enamel are available from which a unit can be built up to disguise the most casual mock-up. Small feed-through insulators, bushes, an ingenious tagstrip system, component clips and brackets, spacers, hinges and latches, transistor mountings, soldering pins; in fact, everything required to mock-up any electronic assembly is available. This system is quite the most complete chassis assembly system we have come across, and will be a boon to all those who like experimenting but do not want their radio gear to be shot through with unused holes, cut up panels and altered cabinets. We give *Lektrokit* full marks for this idea.

Talking of the Radio Hobbies Exhibition, this year's event appeared to be as popular as ever. The appearance "in the flesh" of popular American amateur radio equipment drew much admiring attention. The almost complete use of radio teletype by the Army and Navy Communication Reserves was interesting to note, as were the crowds around the British Amateur Radio Teletype Group's modest display. Some well-known personalities were observed at the show, too. Mr. Carl Mosley, of Mosley electronic aerials fame, was a welcome U.S.A. visitor, having made the crossing in the inaugural jet air passage in—was it?—six hours! His camera was equally dramatic, producing as it did an excellent black-and-white paper print within a minute of taking the picture! From the cheerful smile on Mr. Len Newnham's face, just back from the Geneva band allocating meetings, things may not have gone too badly for amateur radio frequency allocations. As we predicted in these notes a couple of months or so ago, we gather that the R.A.E.N. type of amateur radio activity carried great weight with many non-amateur delegates during discussions on amateur allocations. The Japanese transistorised pocket personal receiver, which Mr. Arthur Milne of the International Amateur Radio Union was showing to his friends, was pretty unique.

Continued on page 426



This month Smithy the Serviceman and his able assistant, Dick, discuss recent transistor output circuits

When Dick entered the workshop, one cold wintry morning, Smithy suspected at once that his assistant was in a very disgruntled mood. Smithy's assumption grew to a cast-iron certainty as he watched Dick take off his mackintosh and hang it on the wall.

"Morning, Dick," called out the Serviceman, in an exploratory tone of voice.

But his assistant merely grunted and shuffled over to his bench, whereupon he applied himself to his work with a grim ferocity which surprised even the Serviceman.

Smithy knew that Dick's more sultry moods rarely persisted for very long, and he decided to wait patiently until the cloud about his assistant dispelled.

Distorted Output

As Smithy had anticipated, Dick's ill-humour was soon forgotten as be became engrossed in his work. After some fifteen minutes had passed his voice rang cheerfully across the Workshop.

"Have we got a matched pair of OC72s, Smithy?"

"Matched OC72s? Why on earth do you want matched OC72s?"

"It's this transistor portable I'm fixing," replied Dick. "It gives distorted output, and I suspect the OC72s in the output stage."

Smithy got up to look at the offending receiver.

"Well," he said ruminatively. "I suppose it *could* be the output transistors. Nevertheless, I don't think we should go to the trouble of swapping them without first checking other parts of the circuit. I see that this is one of those receivers whose output circuit has no speaker transformer. (Fig. 1.) It's essential, with a circuit of this type, for the two sections to be adequately balanced: transistors, resistors and all."

Smithy peered closely at the output stage components.

"Hmm," he said. "Everything *looks* all right. What is the history of the fault?"

"Well," said Dick. "The set originally came in suffering with crackly reception. I soon found that the wavechange switch was the cause of the crackles. The contact pressures in the switch seemed to be O.K., so I gave them a squirt of the old Electrolube. With the result that the crackles cleared up very nicely, and that was that. The next thing I found was that the set seemed rather weak, and so I decided to have a shufti around the batteries. One of these was down, so I changed it. This brought the volume up, but I'm now getting distortion."

"I see," remarked Smithy. "Did you check the batteries on-load or off-load?"

"Off-load," replied Dick. "I tested them with the set switched off."

"Which means," said Smithy mildly, "that you haven't a clue, really, as to what their

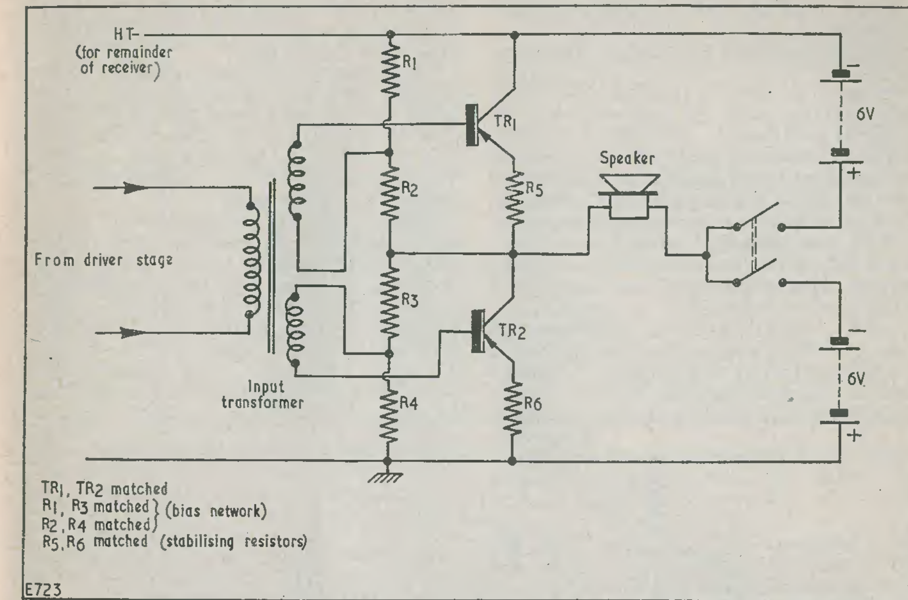


Fig. 1. The basic circuit of the transformerless push-pull output circuit discussed by Smithy and Dick. (All transistors in this and subsequent diagrams are p.n.p. types)

terminal potentials on load are at all. I don't want to go into great detail with a geyser of your advanced heddification about how you can show the internal resistance of a battery as a separate resistance in series with it, but I think the point is worth making. (Fig. 2.) If the internal resistance of a battery is high, then you may still get a healthy voltage reading from it when you connect a testmeter to it, because the meter draws very little current. When you increase the current by putting the battery on load then the volts drop across the internal resistance goes up and you get less voltage at the terminals."

"Ah, yes," said Dick, a little impatiently, "but all this is elementary theory."

"Elementary it may be," said Smithy severely, "but you don't seem to have taken it into account in this particular instance. Small dry batteries are especially liable to run up high internal resistances as they grow old, and you should always check batteries of this type on load. What voltages did you get from the batteries when you measured them off-load?"

"The two original ones," said Dick, "measured 5.8 volts and 4.5 volts off load, instead of the 6 volts they were supposed to be. I swapped the 4.5 volt one."

"O.K.," said Smithy briskly. "Let's switch on the set, with volume full back. Now, what do the batteries read?"

"The new one," said Dick, "reads 6 volts

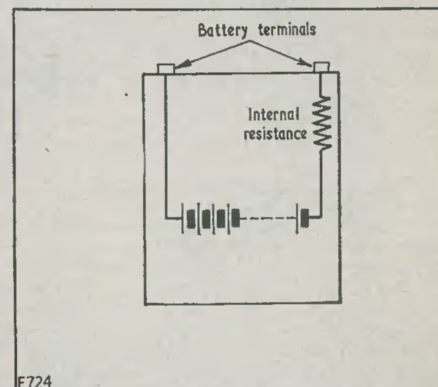


Fig. 2. Every battery has an internal resistance, and this may be considered as a separate resistor in series with a "perfect" battery. Because of this internal resistance the voltage appearing across the battery terminals is liable to drop as current drawn from the battery increases, the effect being especially noticeable if the internal resistance is high

spot-on. The old 5.8 volt one now reads 4.2 volts."

Smithy's assistant sounded a little crestfallen.

"Right," said Smithy remorselessly. "Now let's turn the wick up and see what the batteries read then."

The distorted sound of a symphony concert filled the Workshop as Dick applied his test prods. As he took his readings, his expression became even more woebegone.

"The new battery," he announced in a chastened voice, "is still running at 6 volts spot-on. The old one has now sunk to 3.5 volts."

"O.K.," remarked Smithy. "I suggest that the very next thing to do is to slam in a second new battery straight away. *Then* let's see what the set sounds like."

Anyway, if it *hadn't* been the batteries my diagnosis of a faulty transistor would surely have been a good one."

"Not necessarily," replied Smithy. "Transistors, these days, aren't like valves, you know, they're much more reliable. Provided you don't over-run them they should go on and on for ages. I would, myself, have suspected such things as resistors before I tackled the transistors."

"I see," said Dick thoughtfully. "I must admit that, from the reliability point of view, there would seem to be less things to go *mechanically* wrong in a transistor than there are in a valve. And there's nothing to wear out, so far as I can see, like cathode emission. You know, Smithy, there are a lot of things I'd like to ask you about transistors. It seems that my education is incomplete in that particular sphere."

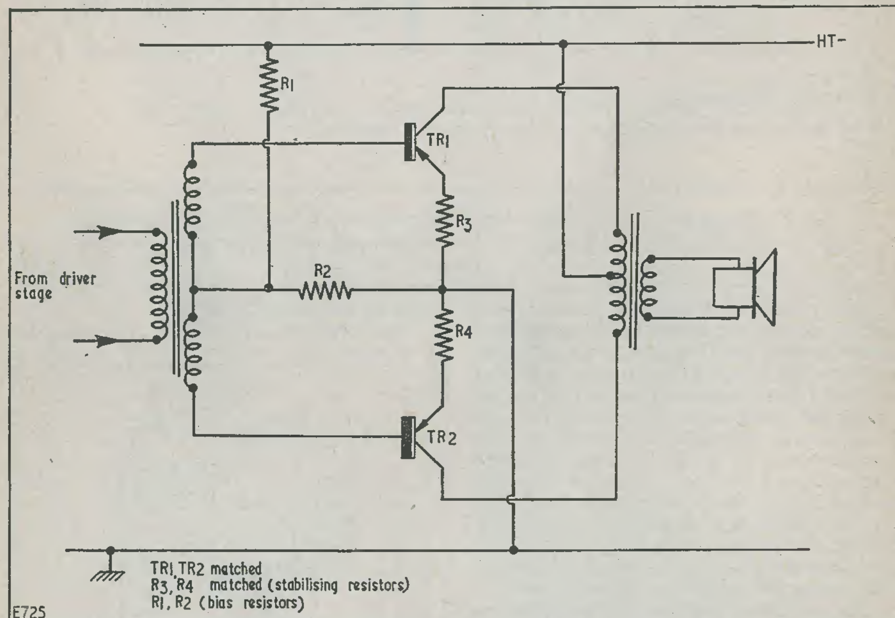


Fig. 3. A simple transistor output circuit which has been used successfully for a number of years

Dick switched off the set and quickly fitted a new battery. He switched on again, and cautiously advanced the volume control. This time the sound from the speaker was free from distortion.

"There you are," said Smithy triumphantly. "Another set cured. And all that was wrong was a run-down battery! But *you* wanted to change two transistors instead!"

"I'm sorry, Smithy," said Dick apologetically. "I'll promise to be a good boy in future and check all batteries on load.

"Later on, perhaps," said the Serviceman hastily. "If you like, we'll have a session when we have our tea. In the meantime I'll leave you to get on with your work, now that I've cleared the distortion out of your signals."

Signals

At the mention of the word "signals," Dick's face immediately assumed the surly expression it had worn when he entered the Workshop. Observing this, Smithy decided that the time was ripe to discover the cause of Dick's sense of grievance.

"For goodness' sake, what's biting you?"

"You may very well ask," said Dick bitterly. "All I can say is that I hope you realise that you've ruined my cinema-going entertainment for the rest of my natural life."

"What on earth do you mean?"

"Look," continued Dick, aggressively. "As you know, last night was my usual night for the flicks. There was a lovely double-feature show on: "Teenage Werewolf' and 'Sex-Fiend in Suburbia.' Both of them, I might add, in glorious Prismacolor and stupendous Astigmascope. I'd been looking forward," Dick finished regretfully, "to that show for ages."

"Apart from any disapproval I may have of your choice of entertainment—and I consider, quick frankly, that it lowers the tone of this establishment—I fail to see how I could have spoilt your enjoyment in any way whatsoever."

"You spoilt it," said Dick, angrily, "because you told me yesterday that there are two signals in the top right-hand corner of the picture at the end of every part of a film. One signal appears ten seconds before the end of the part, and tells the operator to start his other projector; and the second appears at the end itself, to tell him to carry out the actual change-over. Do you know that I spent all last night looking for those darned signals!"

"Did you see them?"

"See them—I just couldn't miss them! Whacking great circles like sunsets some of them were! How on earth I've avoided seeing them before I just can't imagine."

"Then you've learned something new."

"That may be so; but at what a terrible price! I was so fascinated looking for those signals that I completely missed the scene where the Sex-Fiend pounces out on his final victim. And, as for the Werewolf thing, I never even saw the bits where the monster plunders the grave . . ."

"Please, please, *please*," interrupted Smithy. "I just couldn't stand the gory details this early in the morning. Anyway," he added censoriously, "I hope this will teach you that you would be better occupied by the technical matters of the cinema rather than in assuaging those depraved tastes of which you appear to be not at all ashamed, and for the gratification of which the cinema industry provided such a cynical vehicle."

Dick looked impressed by this grandiose sentence. Even Smithy seemed a little surprised at his own eloquence.

"Well, perhaps you're right," said Dick, "but I'm still quite certain that you've spoilt me for films for ever. From now on I'll be looking for signals only."

Smithy laughed.

"You'll get over it," he chuckled. "Now, how about looking for some signals in a few faulty receivers."

Back to Transistors

Dick returned obediently to his bench and resumed his work. The time soon passed by and it was not very long before the battered Workshop kettle was boiling away on its ring, to be followed by the energetic stirring of the equally battered Workshop teapot.

"Right," said Dick briskly, as he poured out Smithy's cup. "How about this transistor business then?"

"What do you want to know?"

"Several things. First of all, why did the battery voltage in that transistor portable drop to a lower figure when the volume was increased?"

"Because," said Smithy, "the two output transistors work in Class B. When you increase their audio input they draw more current."

"I see," said Dick. "Another thing is that I'm not quite certain exactly how that output stage works. How is it that you can get what is, I presume, push-pull operation without a speaker transformer?"

"That one's fairly easy," replied Smithy, "and it *is* a push-pull circuit. But I think I'll go back a little in theory before I answer your question directly. Now, a simple and obvious way of running two output transistors in push-pull consists of connecting them up into circuit just like valves. (Fig. 3). In an arrangement of this type you have a phase-splitting input transformer, and an output transformer with a centre-tapped primary. In order to get a bit more power into the speaker without exceeding the ratings of the output transistors, it is usual to run them in Class B."

"You mean, run them near cut-off point?"

"That's right. In actual practice you don't run them *too* close to cut-off, because transistors tend to get a little non-linear around this point, and you would get rather bad distortion—especially at low a.f. levels. So you run them at a point, *fairly* near to cut-off, which gives you the best compromise between efficiency and distortion. As a result of your Class B operation one transistor mostly handles negative half-cycles of audio and the other mostly handles positive half-cycles. The two lots of half-cycles then become recombined in the output transformer.

"Now, although this arrangement gives very good results, and has been used with excellent results commercially, it is still capable of improvement. One significant improvement consists of ditching the output tranny altogether. Since the output impedance of the transistors is pretty low you can do this by feeding them directly into a specially-designed centre-tapped speech coil. (Fig. 4). However, the most popular commercial idea seems to be to use the circuit we looked at earlier on. The one in your portable."

"Fair enough," commented Dick. "But I cannot, for the life of me, see just exactly how that circuit works. How on earth can you get a push-pull action when both of the output transistors connect to one end of a single speech coil?"

"What about R_5 and R_6?"

"Ah, those are stabilising resistors. You can ignore them for the time being, as they don't affect the present explanation. Just assume that they have negligible values and don't seriously alter circuit operation.

"Now, both the output transistors are p.n.p. types which means that, when connected as earthed-emitter amplifiers, their collectors need to go to a negative h.t. line. And I must remind you that the collector current of an earthed-emitter transistor increases as the base goes more negative. Or rather," added the Serviceman, hastily,

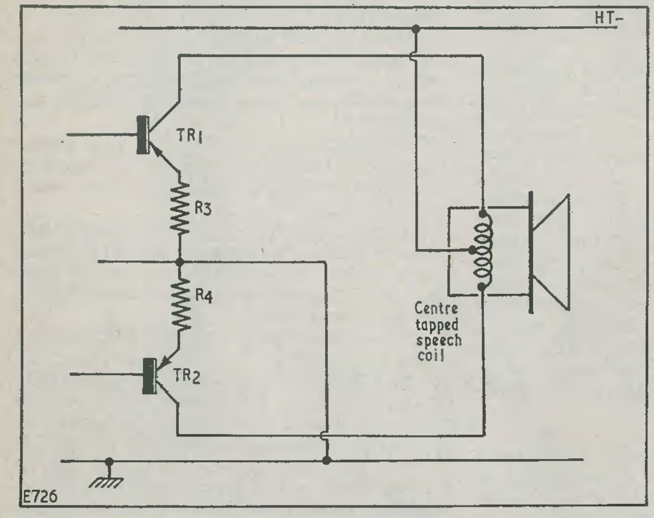


Fig. 4. It is possible to dispense with the speaker transformer of Fig. 3 by connecting the two output transistors directly to a speaker having a centre-tapped speech coil of the requisite impedance

"when the potential on the base changes such that more *current* flows into the emitter."

"It's quite easy," said Smithy, "once you get the basic idea. Before finally embarking on the explanation, however, I must ask you to remember that, when I talk about current flow, I shall be referring to *electron* current."

"You mean current which flows from negative to positive?"

"That's it. The explanation is just as easy with 'conventional' current, which is supposed to flow from positive to negative, incidentally; but "conventional' current is best dismissed as being a little old-fashioned these days.

"Right! Now let's have a look at our circuit again. As you can see, each of the two output transistors has a family of identical components around it. Both transistors are given a slight bias, because the voltages applied to their bases by the potentiometer network, R_1, R_2, R_3 and R_4, are a wee bit negative of the voltages applied to their emitters."

"In other words," commented Dick. "An increase in current through the base and emitter causes increased current in the collector circuit."

"Exactly," said Smithy. "Now, let's see what happens in our push-pull output circuit during alternate half-cycles of a.f. Let's first of all take the case when the half-cycle applied to the lower transistor is negative. (Fig. 5 (*a*).) Now this negative half-cycle applied to the base will cause an increase in base-emitter current, and a consequent increase in collector current. At the same time the upper transistor will have a positive half-cycle applied to its base, with the consequence that it becomes cut off. The final result is that the upper transistor draws negligible current whilst the lower transistor draws an increased current. This increased current has to come from the lower battery and, since we are

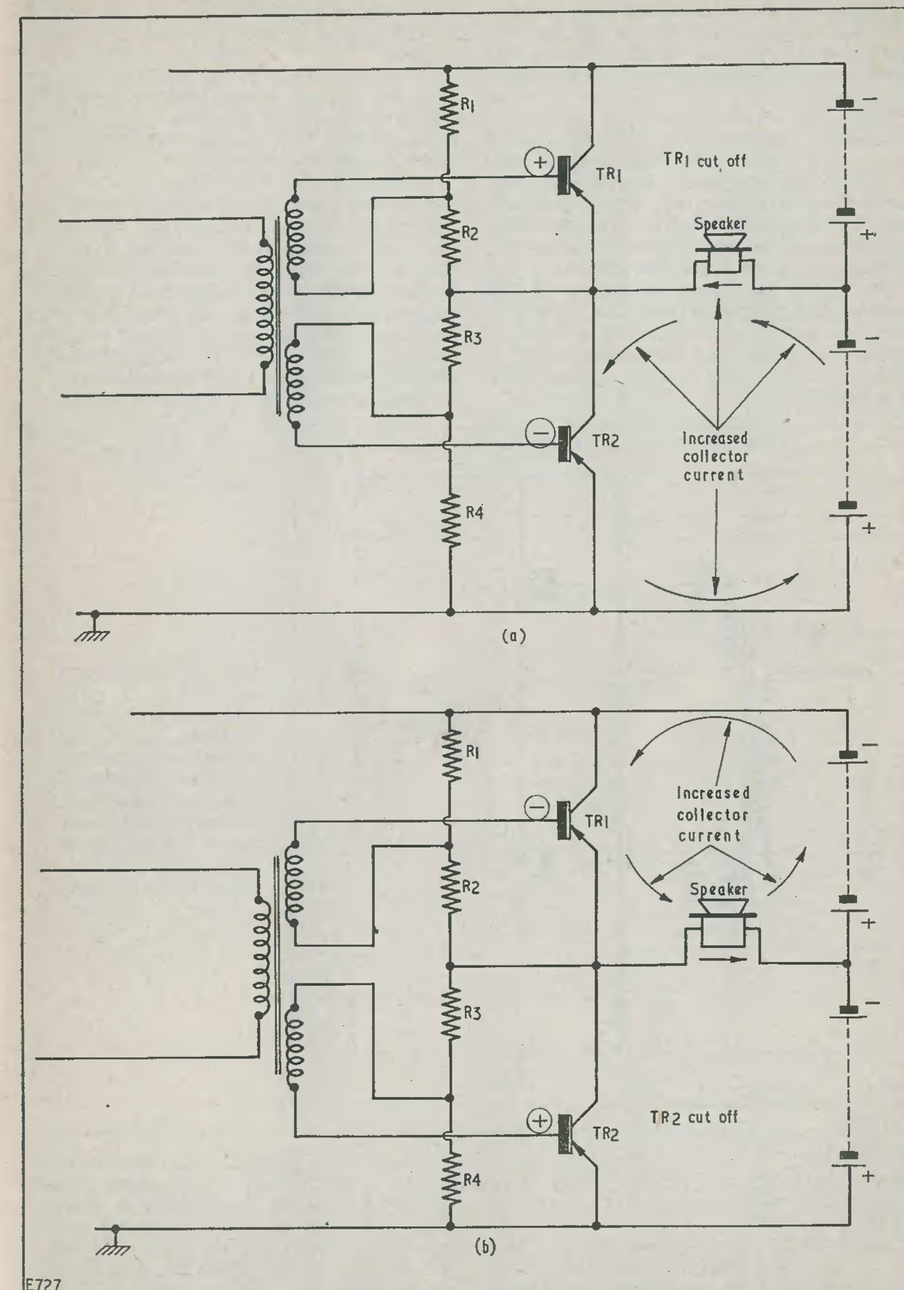


Fig. 5. Illustrating the push-pull action of the circuit of Fig. 1. When the lower transistor conducts, collector current flows through the speech coil as shown in (a). When the upper transistor conducts, its collector current flows through the speech coil in the opposite direction

talking in terms of electron current, it flows from the negative terminal of the battery through the speech coil of the speaker and, thence, into the collector of the lower transistor."

"Well, that seems easy enough to follow."

"Good," beamed Smithy. "So let us now get on to the next half-cycle. (Fig. 5 (*b*).) This time we have a positive half-cycle applied to the lower transistor, and a negative half-cycle to the upper transistor. It is the lower transistor which now becomes cut off, whereupon it loses all further interest in the proceedings. The upper transistor, on the other hand, is compelled to draw an increased collector current, because it has a negative half-cycle bashing away at its base."

Smithy stopped and looked expectantly at his assistant.

after which it returns to the positive terminal of the upper battery in approved orderly manner."

"I notice," said Dick reflectively, "that this increased current flows through the speech coil in the opposite direction to that which flowed when the bottom transistor was conducting."

"Exactly."

"Now, that really *is* cunning," said Dick, admiringly. "And it explains the bit I couldn't understand: how you got the push-pull action without any centre-tapping. Because of the change in direction of current in the speech coil you get the effect that, when one transistor conducts, the speech coil goes forward whilst when the other transistor conducts, the speech coil goes backward."

"You're a good boy," approved Smithy.

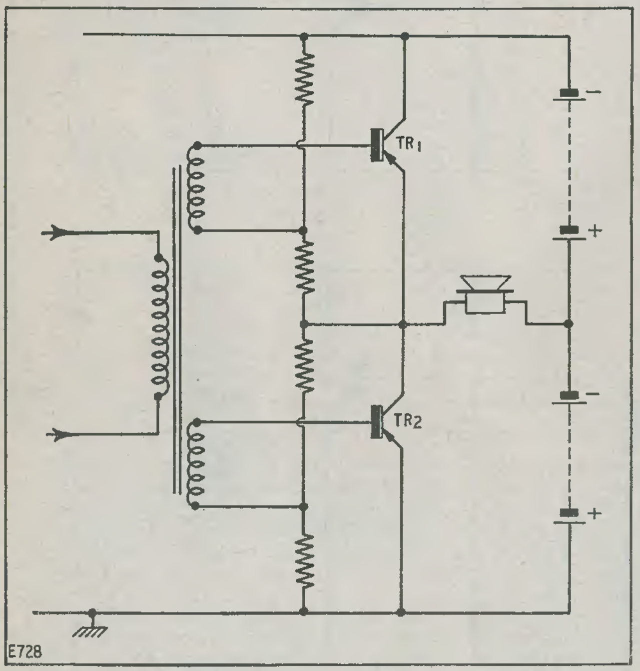


Fig. 6. The circuit of Fig. 1 is often shown in service manuals with the input transformer secondaries connected as shown here, giving thereby the incorrect impression that a.f. is applied to the two bases in phase

"But where," asked Dick, frowning, "does the increased collector current come from? Come to that, what route does it follow?"

Smithy grinned.

"Ah!" he exclaimed dramatically. "We now come to the fiendishly clever bit of the whole circuit. The increased collector current flows from the negative terminal of the upper battery into the collector, and it comes out again via the emitter. It next passes through the speech coil of the speaker,

"There's one thing I've just remembered, though," said Dick. "I've seen output circuits of this type in some service manuals wherein the driver transformer appears to supply both bases in phase. (Fig. 6). Do I presume that these circuits are incorrect on this point?"

"Yes, you do," said Smithy. "I think you can assume that it is 'draughtsman's licence' which causes the connections to the bases to be drawn as though they were, apparently, in

phase. I suppose that this method of presentation prevents lines crossing over and makes a neater diagram."

Stabilising Circuits

There was silence for a few moments as Dick replenished their cups. As so often happened, Dick, having had a point explained to him very carefully by Smithy, commenced to behave as though he had known the answers all along.

"I suppose it all goes to show," said Dick, airily, "that all this transistor business is really dead easy once you care to apply your mind to it."

"Most things are easy," replied Smithy, nettled, "once they're explained to you."

"Ah, yes," continued Dick, condescendingly, "but you must admit that the circuit we've just considered is very simple basically. Although, I must say I *do* appreciate your efforts in explaining it to me."

smoothly the operator carries out his change-over. And you must, *especially*, listen for any change in volume and tonal quality on the sound as the film changes from one projector to the other. Incidentally, you don't always get a change-over at every set of signals. Sometimes the operator sticks two parts together and they then go into the one projector. That's something else you can look for!"

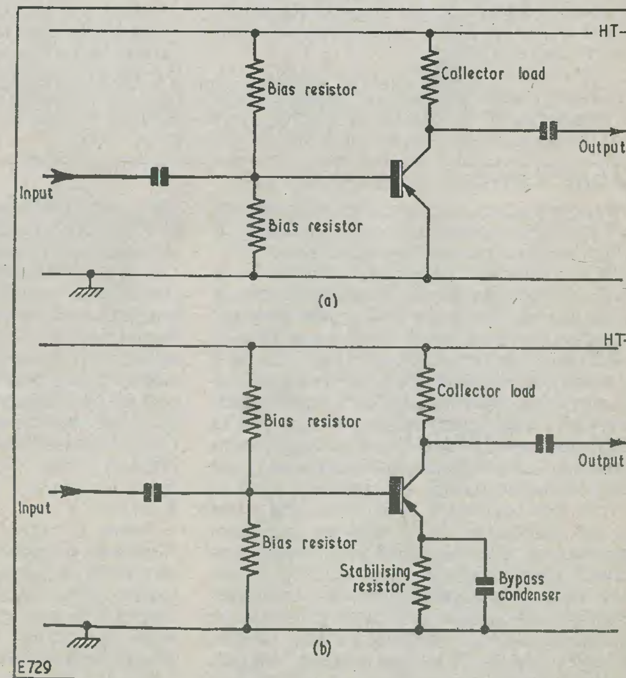
"Please, Smithy, please!" entreated Dick. "After ruining my cinema enjoyment, don't start trampling on the ashes as well! Just tell me more about transistors."

"Right," said Smithy, satisfied. "What do you want to know next?"

"Well, what about those stabilising resistors?"

"Their function," said Smithy, "is merely that of preventing the individual transistors from being too adversely affected by temperature.

Fig. 7 (a) An earthed-emitter amplifier without stabilising components. (b) A stabilising resistor, as shown here, protects the transistor from excessive current flow due to temperature increases



Smithy looked as though he were about to blow a gasket. He drew a deep breath.

"When you get used to the signals at the cinema," he said, very clearly, "there's another little thing which I'm certain you won't want to miss. When the second signal appears you should look carefully to see how

"If you were to have an earthed-emitter transistor running without a stabilising resistor you would have a circuit like this. (Fig. 7 (*a*).) An arrangement of this type doesn't allow for the fact that, as the temperature of a transistor increases, so also does the current flowing in its collector circuit. The increased current has to flow through the base emitter junction, whereupon it causes the collector to pass even more current. This increased current will increase heat dissipation in the transistor, with the result that temperature increases yet once more. The final result is that you are liable to get a vicious spiral which may, under certain circumstances, cause so much over-heating of the transistor that it becomes permanently ruined.

"If you put a stabilising resistor in the emitter circuit (Fig. 7 (*b*)) you overcome this effect, because an increase in emitter current due to temperature rise causes a higher voltage to be dropped across the resistor. The emitter then rises closer in potential to the base and collector current is reduced in consequence. The stabilising resistor thereby prevents the build-up of the vicious temperature-and-current spiral."

"I see," said Dick, thoughtfully. "I notice that you put a bypass condenser across your stabilising resistor. However, there are no bypass condensers across R_5 and R_6 in the circuit of the portable receiver we bumped into at the beginning."

"That's true enough," agreed Smithy. "A stabilising resistor provides a certain amount of degeneration. Generally speaking, it is usual to bypass it if it has a high value or if you want maximum gain. In the output circuit of the portable, the stabilising resistors have relatively low values."

Old Films

Dick seemed to be satisfied with this explanation, and he proceeded to wash up the cups in the Workshop sink. Smithy watched him pensively.

"I've just remembered something else," the Serviceman remarked suddenly.

"What's that?"

"It's often worth while," said Smithy, "looking out for the signals on some of the older films. Very often these lose a few frames due to wear and tear, with the result that the first signal does not appear the requisite ten seconds before the end of the part. What you often see, then, are signals which the operators put on themselves, these consisting of big scratches in the film emulsion, and all sorts of things like that. You can't miss them, you know!"

But his last words were lost as Dick dropped the cups into the sink with a clatter, rushed to his bench, turned up the volume of the receiver he was repairing, and flooded the Workshop with a deafening and impenetrable 400 c/s tone from his signal generator.

RADIO TOPICS (*continued from p.*417)

If this is the one the Japanese propose making in Eire and exporting to this country, it might well become the "personal portable to end all personal portables." Mr. P. A. Thorogood, manager of this exhibition, is certainly to be congratulated on the standard this show has reached under his guidance.

P.T.F.E.—polytetrafluorethylene—the new "wonder" plastic, is finding its way into many spheres of activity remote from its first uses. Originally used as an insulation material in high quality valveholders made by Siemens Ediswan, for its high insulation and good thermal characteristics, it was found to have a very low coefficient of friction, and firms having difficulties with sticking problems approached S.E. to have their equipment coated with this non-stick material. The material can be applied by a heat treatment process and ovens are now available at Tottenham sufficiently large to take objects as large as a bus. It has been used to prevent ice formation on aeroplane wings, on tyre moulds and in cake tins; bobsleigh runners treated with it slide evenly, and surgical scalpels can still be safely sterilized by boiling when coated with P.T.F.E. and at the same time are prevented from encouraging blood coagulation. When first introduced it was very expensive—£5 per lb. Now, through increasing use, its price has dropped to more usual level for materials of this type.

The Model Engineer Exhibition has changed both its name and its date this year. It is now to be known as the National Models Exhibition and instead of being held in August, as has been the custom, is now to be staged in January. This exhibition is well worth visiting, not only for its examples of superb craftsmanship, but also because radio control enthusiasts will find much of interest. It opens on Thursday 31st December at the New Horticultural Hall, Westminster. It remains open every day (except Sunday) from 11 a.m. to 9 p.m. until Saturday 9th January.

From a report on the Geneva I.T.U. Conference which appears in a recent number of the Australian journal *Amateur Radio*, we gather that more countries may grant amateur operation in the frequency range 1,600 to 2,000 kc/s—the popular "Top Band". Such restrictions as have been imposed on the use of this band have in many cases been due to the operation of Loran services in the band. These have ceased to operate in many areas, thus removing the main difficulty in opening this band to amateur transmissions. Devotees of this band may possibly be able to add several more "countries-worked" to their lists before very long.

UNDERSTANDING TELEVISION

PART 24

By **W. G. MORLEY**

The twenty-fourth in a series of articles which, starting from first principles, describes the basic theory and practice of television.

In the contribution to this series published in last month's issue we described the operation of the blocking oscillator, and illustrated the manner in which it could be made to produce a saw-tooth waveform. We also saw how the sync pulse, passed on to the oscillator by the sync separator, caused the oscillator to commence the flyback part of its cycle. Frequency control, whereby the time occupied by the long (scan) part of the cycle could be varied, was also discussed. We shall now carry on to the multivibrator.

The Multivibrator

A basic multivibrator circuit is shown in Fig. 130. In this diagram we have two triodes, the anode of each being coupled to the grid of the other by a coupling condenser. An important feature of the multivibrator circuit is its inherent mutual amplification, and it will be helpful to consider this particular facet in some detail before embarking on a full explanation of circuit operation. To illustrate the amplifying action let us assume that, with neither valve cut off, the grid of V_1 in Fig. 130 is made to go slightly negative. This small negative excursion on the grid causes the anode of V_1 to go positive by an amplified amount. The positive excursion of V_1 anode is then passed to the grid of V_2 via C_2, resulting in a negative excursion, further amplified, to appear on V_2 anode. This twice-amplified negative excursion is, finally, applied back to the grid of V_1 via C_1. Thus, due to the mutual amplifying action of the two valves, a small negative excursion on V_1 grid causes a much larger negative excursion to be fed back to the same grid. A similar effect takes place for a positive excursion on the grid of V_1. Due to the symmetrical layout of the circuit, small negative or positive excursions on the grid of V_2 cause, in exactly the same manner, a twice-amplified excursion of the same polarity to be fed back to the same grid.

We may now commence to examine the operation of the multivibrator. It would be preferable to start at the moment when supplies to the valves are switched on. As soon as the valves become capable of drawing anode current, voltages commence to be dropped across the anode load resistors, causing negative voltages to be passed to both grids. It would be impossible to have the circuit so exactly balanced that anode voltages drop by equal amounts in the same period of time. One anode voltage must, therefore, drop by a larger amount than the other, causing one grid to go more negative than the other. This discrepancy in grid voltages is immediately amplified by the two valves, with the result that the grid which is slightly more negative becomes biased well beyond cut-off, whilst the other grid has a positive voltage passed to it by its coupling condenser. Thus, one valve becomes cut off, and the other valve becomes fully conductive. Having achieved this state of affairs the valves then become alternately conducting and non-conducting at a regular frequency.

The reasons for the repetitive changeover from one valve to the other will become clearer if we next look at circuit conditions at a time just after V_2 has become conductive. We will find that the following events take place. V_2, on becoming conductive, caused a sudden increase in the voltage dropped across its anode load. As a result its anode went negative, and a negative voltage was passed to the grid of V_1 via coupling condenser C_1. V_1 is, in consequence, now well beyond cut-off; and C_1 commences to discharge into R_3 and the grid leak R_2. After a time, the voltage across C_1 drops sufficiently far to bring the grid of V_1 just within cut-off level. The anode of V_1 commences to draw current, causing the grid of V_2 to go negative by a small amount. At once the amplifier action referred to earlier takes place, and the small negative excursion on V_2 grid builds up to a very large negative swing, causing V_2 grid to be taken well beyond cut-off. Since V_2 is beyond cut-off its anode draws no current and its anode voltage rises to the full h.t. potential, causing a positive voltage to be passed to the grid of V_1 via C_1. Thus V_1 becomes fully conductive and C_1 has applied across it the full h.t. potential, its right-hand plate connecting to the h.t. positive rail via R_3 and its left-hand plate to chassis via the effective diode given by the grid and cathode of V_1. C_1 soon becomes fully charged, and it remains in this condition.

C_2, charged to the full h.t. potential during the previous half-cycle, now commences to discharge into R_1 and R_4. After a period of time C_2 discharges sufficiently far to enable the voltage on V_2 grid to rise above cut-off level. The mutual amplification action between the two valves takes place once more, and it results in the grid of V_2 going positive and the grid of V_1 going well beyond cut-off. A further cycle thus commences, with the fully charged condenser C_1 starting to discharge once more into R_3 and R_2.

As we have seen, each valve of the multivibrator becomes conductive in turn, the period in which it remains conductive being governed by the time taken for the condenser connected to its grid to discharge sufficiently far to initiate the next half-cycle. It is important to note that the time in which the actual changeover from one valve to the other takes place is very short indeed, this being entirely due to the amplifying action in the circuit.

Fig. 131 shows the voltage waveforms given on the anode and grid of the two valves of Fig. 130. It is assumed, in Fig. 131, that both valves remain conductive for approximately equal periods of time. (Such a state of affairs would exist if R_1 equalled R_3, R_2 equalled R_4, C_1 equalled C_2, and both valves had similar characteristics.) All four waveforms in Fig. 131 share the same time axis.

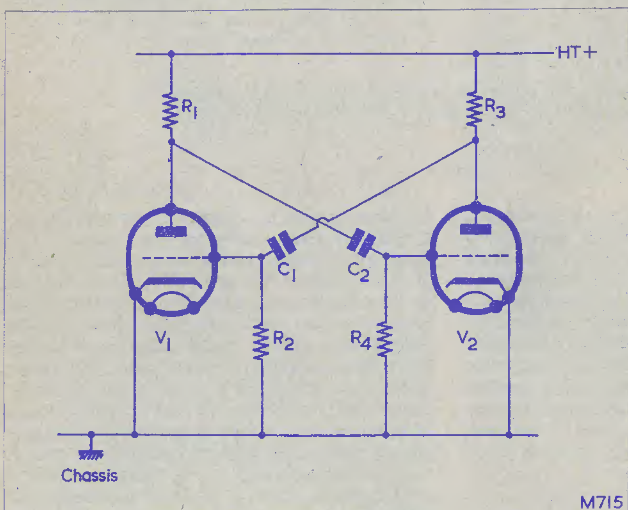


Fig. 130. The symmetric multivibrator. V_1 and V_2 change, alternately, from the conductive to the non-conductive state at a regular frequency.

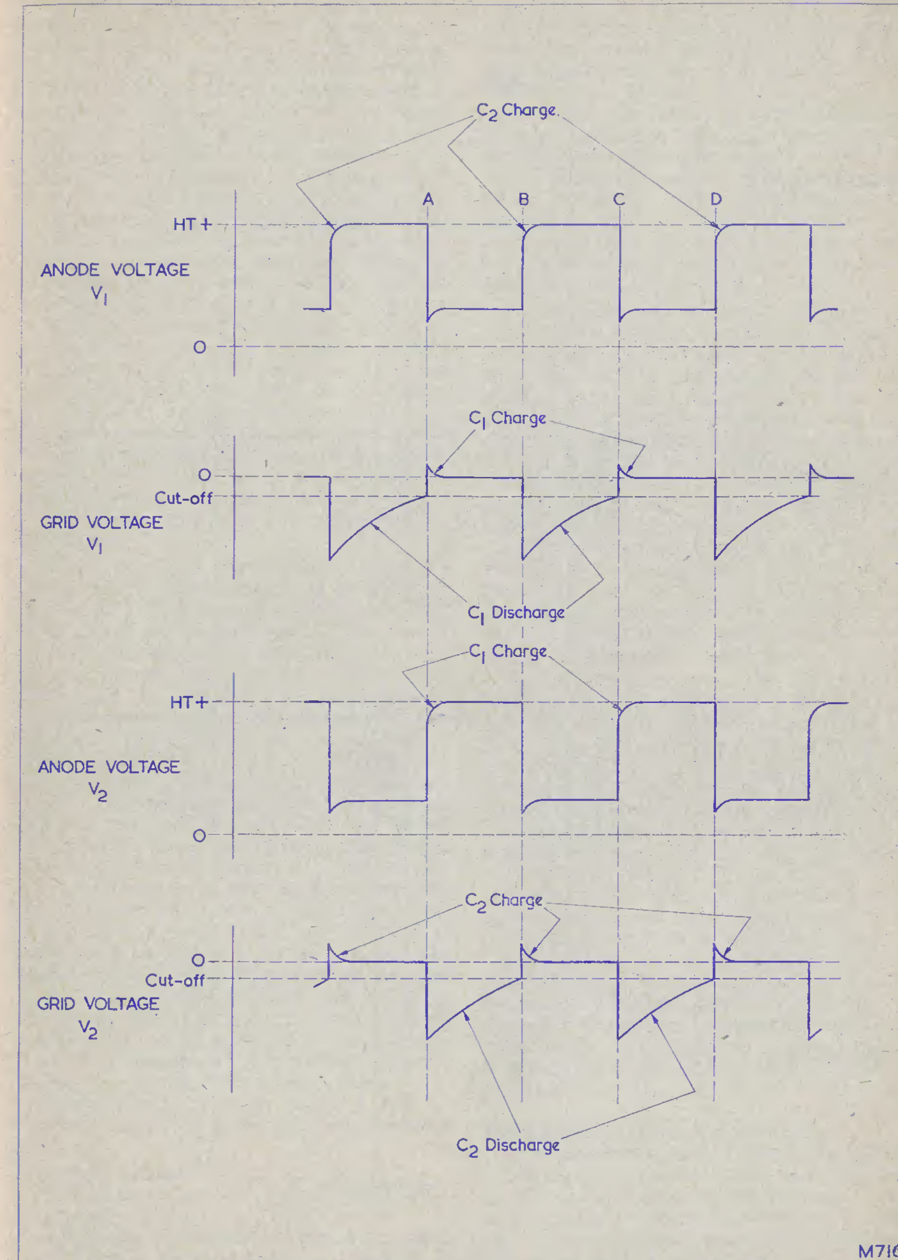


Fig. 131. Anode and grid voltage waveforms for a symmetric multivibrator in which the valves are conductive and non-conductive for approximately equal periods of time. All voltages are with respect to chassis.

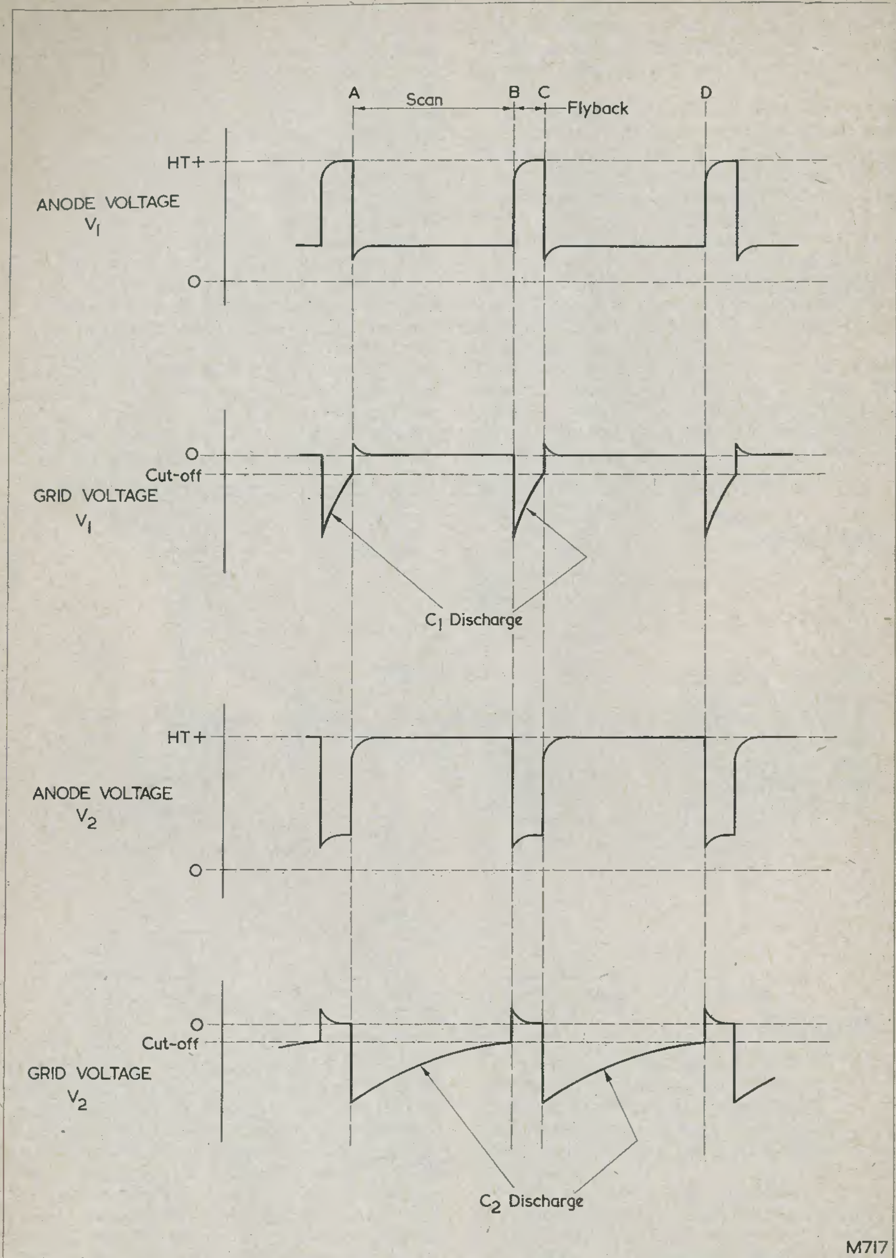


Fig. 132. For television purposes it is desirable to have one valve of the multivibrator conductive for a short period, and non-conductive for a long period. The appropriate waveforms are illustrated here.

At point A we have the case where V_1 becomes conductive. Its grid voltage at this instant is slightly positive of its cathode and the valve draws full anode current in consequence. Because of the full anode current, the anode voltage of V_1 drops to a low value. This drop in anode voltage is passed to the grid of V_2, causing it to go negative by a similar amount. Since V_2 is beyond cut-off its anode voltage rises to the full h.t. potential.

Condenser C_2, previously charged to full h.t. potential, now commences to discharge, and we can see the resultant effect by examining the grid voltage of V_2 between points A and B. At point B, C_2 discharges sufficiently far for the voltage on the grid of V_2 to rise above cut-off. V_2 now commences to draw anode current and we have the changeover from one valve to the other. After point B the circuit remains in a state of equilibrium during the time that C_1 discharges into R_2 and R_3. At point C the grid voltage of V_1 is just within cut-off, and the next half-cycle is initiated. Between points C and D we return to the case where C_2 discharges.

It will be noted that neither V_1 nor V_2 anode rises to full h.t. potential immediately after cut-off, there being a slight rounding-off at the waveform at these points. The reason for this rounding-off is that it is necessary for the appropriate coupling condenser to charge up to the full h.t. potential. A typical example occurs at point B. At this instant V_1 becomes cut off and C_2 has to charge up to full h.t. potential via R_1 and the effective diode given by the grid and cathode of V_2. The rounding-off of V_1 anode waveform at point B is caused by the initial charging current drawn through R_1 by C_2. The initial charging current of C_2 also causes a small voltage to be developed between grid and cathode of V_2, and explains the small positive-going peak in V_2 grid voltage at point B. The fact that the grid of V_2 goes slightly positive has a further effect, because it causes V_2 anode to draw slightly more current at this point than it does when its grid has the same potential as its cathode. This slight increase in anode current is shown, in Fig. 131, as a drop in anode voltage.

Similar effects occur at points A and C, and are caused by initial charging currents in C_1.

Component Values

Several things may be deduced from what we have just seen.

The first of these is that the time occupied in the cycle between points A and B is governed entirely by the time taken for C_2 to discharge into R_1 and R_4 by the requisite amount. Similarly, the time occupied in the cycle between points B and C is governed by the time taken for C_1 to discharge into R_2 and R_3.

Secondly, it is desirable for the anode load resistors to have values which are markedly lower than are those of the grid leaks. If this were not the case the appropriate coupling condenser would take too long a time to reach full h.t. potential at each changeover from one valve to the other, and the rounding-off effect on the anode voltage waveforms would become excessive. If it is necessary for the two halves of the multivibrator to be asymmetric so far as component values are concerned, then R_1 should have a much lower value than R_4, and R_3 a much lower value than R_2.

Finally, there are the points which follow from the fact that the amplitude of the waveform appearing on either anode depends upon the value of the anode load resistor. If the anode load resistor has a very low value, the voltage dropped across it when the associated valve conducts will be similarly low. It is desirable to have relatively high voltage excursions on the anodes in order to ensure that adequate negative voltages are applied to the opposing grids during the changeover from one valve to the other. In practice it is usually quite easy to obtain values for the anode load resistors which provide an adequate negative excursion and which are still markedly lower than the values of the complementary grid leaks.

The waveforms shown in Fig. 131 are those for a multivibrator in which each half-cycle occupies approximately the same period of time, achieved by making both halves of the multibribrator symmetrical in component value and valve type.[1] For television purposes we require an oscillator which provides a waveform capable of being translated to a sawtooth. The circuit of Fig. 130 would meet this requirement if one of the two valves could be made conductive for a short period and cut off for a long period. This may be achieved by making the values of C_2, R_1 and R_4 such that discharge of C_2 is relatively long, and the values of C_1, R_2 and R_3 such that discharge of C_1 is relatively short. The resultant waveforms are illustrated in Fig. 132. The lettered points in this diagram correspond to the similarly lettered points in Fig. 131.

The Cathode-coupled Multivibrator

An alternative type of multivibrator which is frequently employed in television receivers is the cathode-coupled multivibrator, the basic circuit of which is illustrated in Fig. 133. Due to its asymmetry the operation of this multivibrator differs from that of the symmetric circuit shown in Fig. 130.

Before commencing an explanation of its

[1] The waveform given by a multivibrator of this type is known as a "square wave".

operation it should be noted that the cathode-coupled multivibrator has a mutual amplification effect largely similar to that of the symmetric arrangement. If, with neither valve cut off, there is a small negative excursion on the grid of V_2, there is a similar negative excursion on its cathode (the valve functioning as a cathode-follower). This small negative excursion is passed to the cathode of V_1 due to the common connection between the two cathodes. The small negative excursion of cathode voltage has the same effect, in V_1, as has a small positive grid excursion, and an amplified negative excursion appears on its anode. This is passed back to the grid of V_2 via C_1. The same amplifying effect would occur if there were a small positive-going voltage on V_2 grid.

When power supplies are connected to the two valves of Fig. 133 both commence to draw anode current, and both anode potentials commence to drop. Due to the presence of C_1, however, the drop in anode potential of V_1 is immediately passed, in the form of a negative-going voltage, to the grid of V_2. The amplifying effect just referred to now takes place, and it results in a very large negative voltage being applied to V_2 grid. V_2 becomes cut off, whilst V_1 remains conductive.

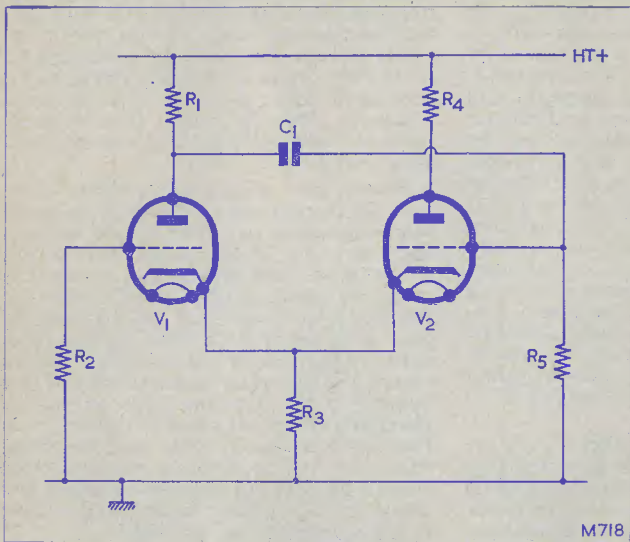


Fig. 133. *The cathode-coupled multivibrator. In this circuit V_2 is cut off whilst C_1 discharges, and is conductive whilst C_1 charges.*

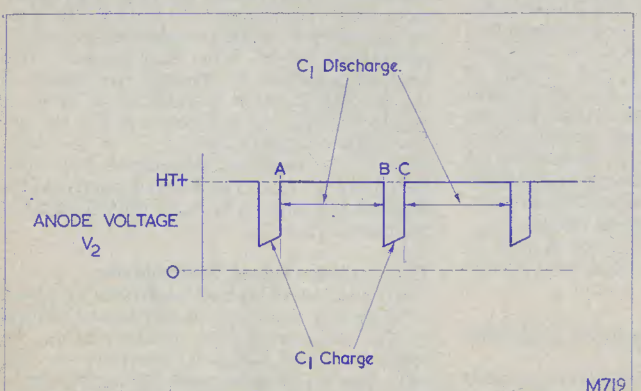


Fig. 134. *The anode waveform of V_2 in Fig*. 133.

We now have the situation where the anode of V_1 is markedly below h.t. positive potential, its grid is at chassis potential, and its cathode is at a potential equal to the voltage dropped across R_3. Since V_2 is cut off, this voltage is that resulting from cathode current in V_1. At the same time the anode of V_2 is at full h.t. potential (because no current flows through R_4), its grid is beyond cut-off, and its cathode shares the same potential as the cathode of V_1. Further, condenser C_1 holds a charge such that its left-hand plate is positive, and its right-hand plate is negative.

C_1 now commences to lose this charge, it discharging via R_1 and R_5. After a period, the voltage across its plates is such that the potential on V_2 grid rises above cut-off level. V_2 commences to draw anode current, thereby causing the voltage dropped across R_3 to increase. This causes the cathode of V_1 to go more positive, with the result that its grid becomes less negative with respect to its cathode, and V_1 draws less anode current. V_1 anode, thereby, causes a positive-going voltage to be passed to the grid of V_2, and the mutual amplifying action of the circuit takes over. The final result is that V_1 becomes non-conductive and a high positive voltage is passed to the grid of V_2.

The reason why V_1 becomes non-conductive is that the voltage dropped across R_3 is greater than its cut-off potential. This voltage is the result of cathode-follower action in V_2, whose grid is held considerably positive of chassis by C_1. C_1 now commences to *charge*, its left-hand plate connecting to the h.t. positive rail via R_1, and its right-hand plate to chassis via the effective diode given between grid and cathode of V_2 and, thence, via R_3. As C_1 charges, the voltage across its plates increases, and the grid of V_2 becomes less positive. So also does the voltage on its cathode. When C_1 has charged sufficiently, the voltage on V_2 cathode will have dropped to an extent which allows the cathode of V_1 to come within cut-off potential. V_1 commences to draw anode current once again, causing a negative voltage to be passed to the grid of V_2, and another cycle commences.

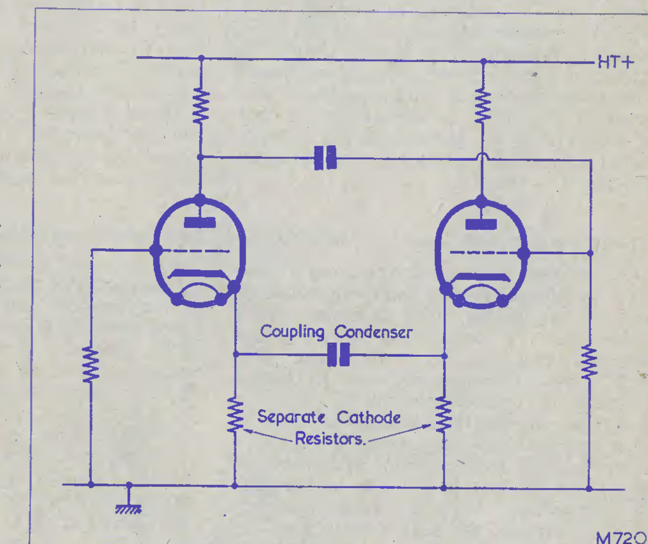


Fig. 135. *An alternative to Fig*. 133 *in which each valve has its own cathode resistor.*

The anode waveform of V_2 is shown in Fig. 134. At point A V_1 becomes conductive and V_2 is cut off. After point A condenser C_1 discharges. V_2 commences to draw anode current at point B, becoming conductive because the potential on its grid is markedly positive of chassis. V_2 grid voltage drops as C_1 charges, and this is reflected by the fact that, between points B and C, its anode potential slopes upwards, indicating a drop in anode current. At point C the next cycle commences.

In the cathode-coupled multivibrator, V_2 is non-conductive during the time that C_1 discharges and is conductive during the time that this condenser charges. Since the discharge circuit for C_1 is via R_1 and R_5, and R_5 does not appear in the charge circuit, it is a very simple matter to make the value of this resistor sufficiently high for the discharge period to be much longer than the charge period. The multivibrator then becomes especially suited for television purposes, the short charge period representing the flyback part of the cycle, and the long discharge period the scan part of the cycle.

A variation on the cathode-coupled multivibrator of Fig. 133 is illustrated in Fig. 135. In Fig. 135 the two valves are given separate cathode resistors, the two cathodes being joined by a coupling condenser. The value of this coupling condenser is such that the time constant it possesses in combination with the two cathode resistors is much longer than that occupied by a single cycle. This arrangement works in exactly the same manner as does that of Fig. 133, changes in cathode voltage in either valve being passed to the other via the coupling condenser. The circuit of Fig. 135 has the advantage that the valves may be given different cathode resistor values if this is necessary for optimum efficiency.

Obtaining a Sawtooth from the Multivibrator

The simplest method of obtaining a sawtooth waveform from a multivibrator consists of employing the cathode-coupled version and of connecting a condenser between chassis and the anode of the valve which is cut off during the scan section of the cycle. A typical example is shown in Fig. 136 (*a*), wherein the additional condenser, C_2, is appended to the circuit of Fig. 133. Referring back to the anode waveform of Fig. 134 we see that, at point B, V_2 becomes fully conductive. With the additional condenser in circuit, the anode voltage of V_2 will still fall in the manner illustrated in Fig. 134 but it will now, also, discharge the condenser. After point C, V_2 becomes cut off. Its anode voltage will now rise slowly, as C_2 charges up via R_4. A sawtooth across C_2 results.

Adding C_2 to the cathode-coupled multivibrator does not upset its functioning provided that the anode of V_2 is allowed to rise to an adequate potential before its next conduction period. This requirement may be readily satisfied by giving an appropriate value to C_2.

The symmetric multivibrator of Fig. 130 cannot be modified to provide a sawtooth by connecting a sawtooth-forming condenser between chassis and either of its anodes. The reason for this is that the addition of such a condenser would prevent the anode to which it connects from rising immediately to full h.t. potential when it becomes cut off. In consequence, the mutual amplification effect would be lost and the circuit would not operate reliably. If it were necessary to obtain a sawtooth waveform from the symmetric multivibrator a separate triode, as in Fig. 126 (*a*),[2] would be needed. Alternatively, the triode which is conductive during the flyback period could be replaced by a pentode, as in Fig. 136 (*b*). The screen-grid of the pentode would then function as the anode of a triode, and the pentode anode would allow the condenser connected between it and chassis to discharge when V_2 was conductive and charge when V_2 was non-conductive.

In practice, the symmetric multivibrator is rarely employed to produce sawtooth waveforms directly, because there is little point in using the additional circuitry required when the sawtooth may be so readily obtained from the cathode-coupled arrangement. The cathode-coupled multivibrator is, therefore, the version which is almost invariably used in frame deflection circuits, for which a sawtooth is essential. Modern line deflection circuits do not necessarily require a sawtooth, and may employ either type of multivibrator.

Multivibrator Frequency Control

As occurred with the blocking oscillator, the frequency of the multivibrator is adjusted by varying the time occupied by the long (scan) part of the cycle, that occupied by the short (flyback) part remaining constant. Such a control can be incorporated into the multivibrator by making R_4 in Fig. 130 or R_5 in Fig. 133 a variable component (or, to restrict the range of frequencies controlled, a variable component in series with a fixed resistor). Such a control is then capable of varying the discharge time of C_2 in Fig. 130, and C_1 in Fig. 133.

Synchronising the Multivibrator

Synchronising the multivibrator follows the same principles as are used for synchronising the blocking oscillator. A sync pulse, obtained from the sync separator, is fed to the multivibrator such that it initiates the flyback period.

In Figs. 130 and 133, synchronising may be obtained by feeding positive-going sync pulses to the grid of V_2. (In Fig. 130, this assumes that V_2 is the valve which is conductive for the flyback period of the cycle.) These pulses then cause the grid to rise above cut-off level and initiate the flyback period. Synchronising may also be obtained by feeding negative-going sync pulses to the grid of V_1, since this valve would then offer amplified positive-going sync pulses to the grid of V_2.

[2] Published in last month's issue. The grid of the second triode would connect to the grid of V_2 of Fig. 130, and would discharge a condenser connected between its anode and chassis when V_2 conducted, and allow it to charge up via a series anode resistor when V_2 was cut off. The sawtooth would then appear across the condenser.

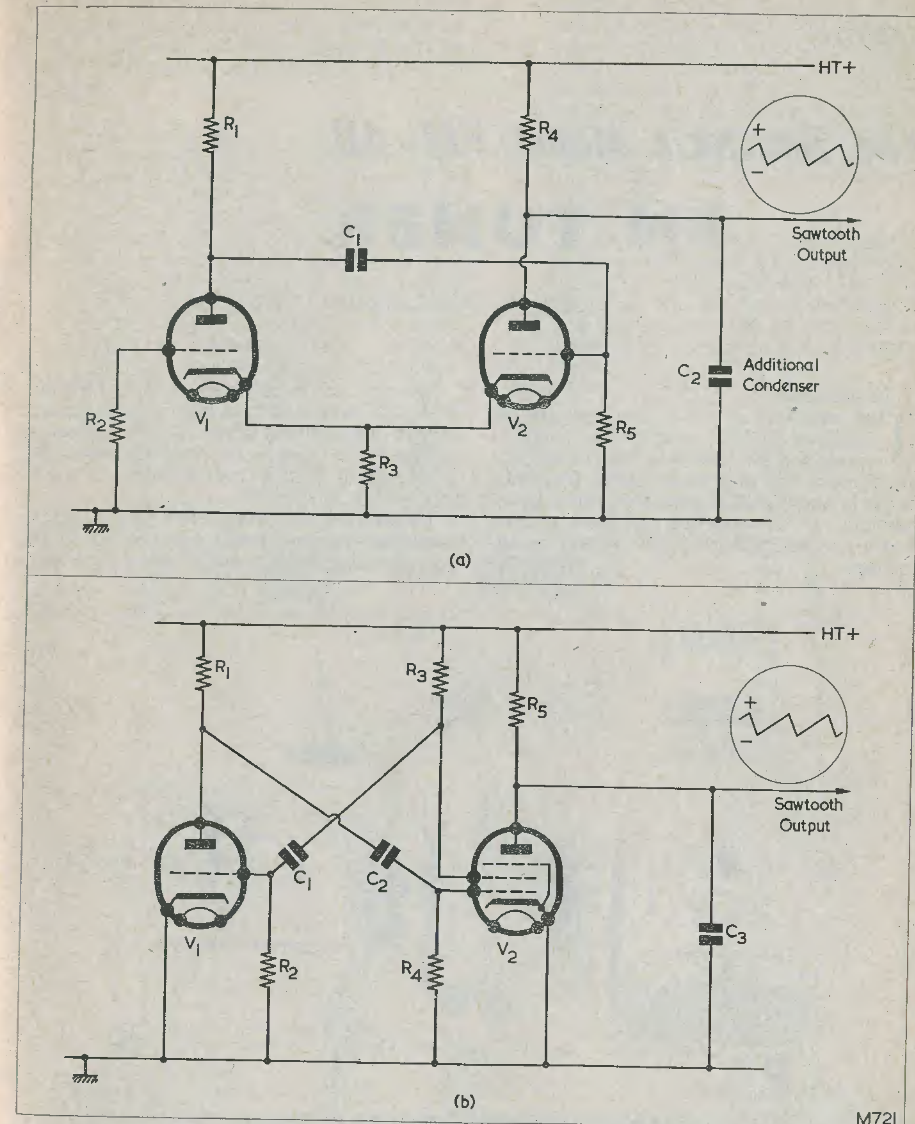


Fig. 136. (a) Adding a condenser to the cathode-coupled multivibrator in order to obtain a sawtooth waveform. (b) By making the valve which is conductive for a short period a pentode, it is possible for the symmetric multivibrator to produce a sawtooth waveform.

Next Month

In next month's issue we shall carry on to deflection output stages.

The Heathkit Model FM-4U FM TUNER

by A. R. Evans

I. Introduction

The advent of v.h.f. f.m. broadcast stations in this country has made it possible for listeners to enjoy the interference-free and wider audio frequency range inherent in this system of radio transmission. In consequence, we have entered into a new era of high quality sound broadcasting.

The advantages of v.h.f. f.m. over LW and MW a.m. reception have been ably explained by Mr. Blundell and others in previous issues of *The Radio Constructor*, and little would be gained from further consideration of v.h.f. f.m. within this article.

To take full advantage of these f.m. transmissions, the f.m. tuner has proved to be very popular, for when connected to a high fidelity amplifier and speaker system the quality of reproduction is outstandingly good. To achieve this high overall standard the f.m. tuner itself must be outstandingly good; its most important requirements being as follows:

(*a*) *High Sensitivity*
High sensitivity with a good signal-to-noise-ratio is most important—particularly for fringe area reception. A test figure of 2.5μV input for 20dB noise quieting has been found acceptable. This means that the tuner's internal noise will be reduced 10 times (20dB) on the input of a 2.5μV signal at the aerial socket. Therefore, actual fringe signals of the order of 10μV will give noise-free reception with this sensitivity.

(*b*) *Wide Bandwidth*
This is required to allow the higher audio frequencies to be passed without attenuation. The audio response must be substantially flat from 20 to 20,000 c/s. An i.f. response of ±300 kc/s at 6dB down will more than provide this requirement.

(*c*) *Freedom from "Drift"*
Superhet receivers working at v.h.f. tend to drift off tune. This is due to poor frequency stability of the local oscillator, which can be corrected by mounting the oscillator in a screened box to avoid rapid temperature changes and by using special temperature-compensated capacitors. A drift within the limits of ±25 kc/s is found to be acceptable.

(*d*) *Detector Distortion*
This part of the circuit if not properly designed will introduce excessive distortion. A figure of slightly less than 1% total harmonic distortion measured at 1 kc/s is about the best that can be achieved with any type of f.m. detector circuit.

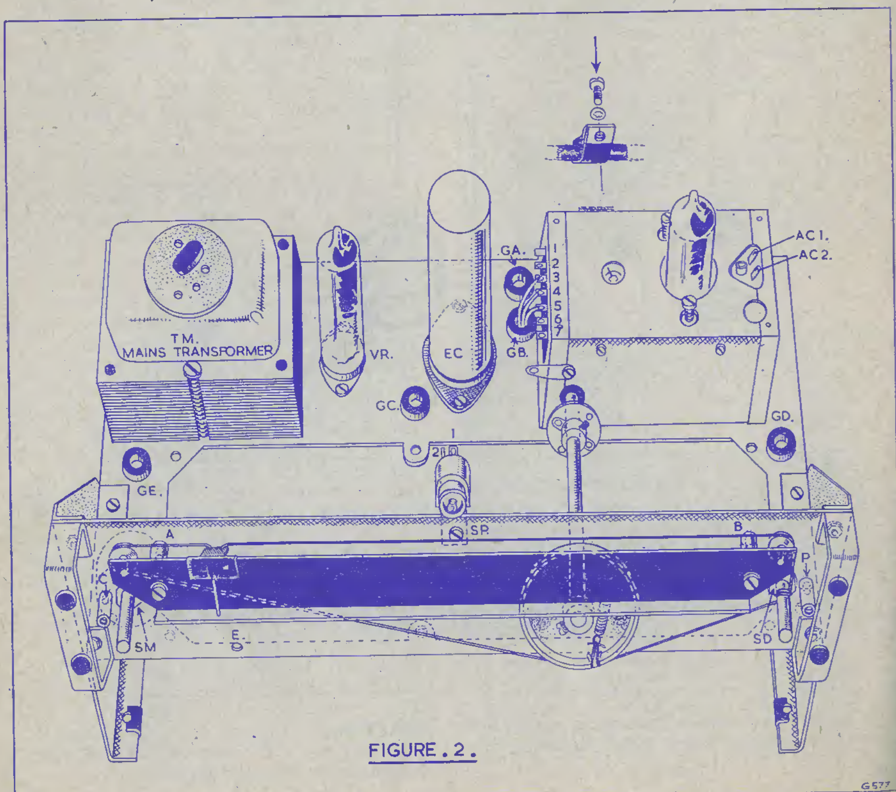


FIGURE . 2 .

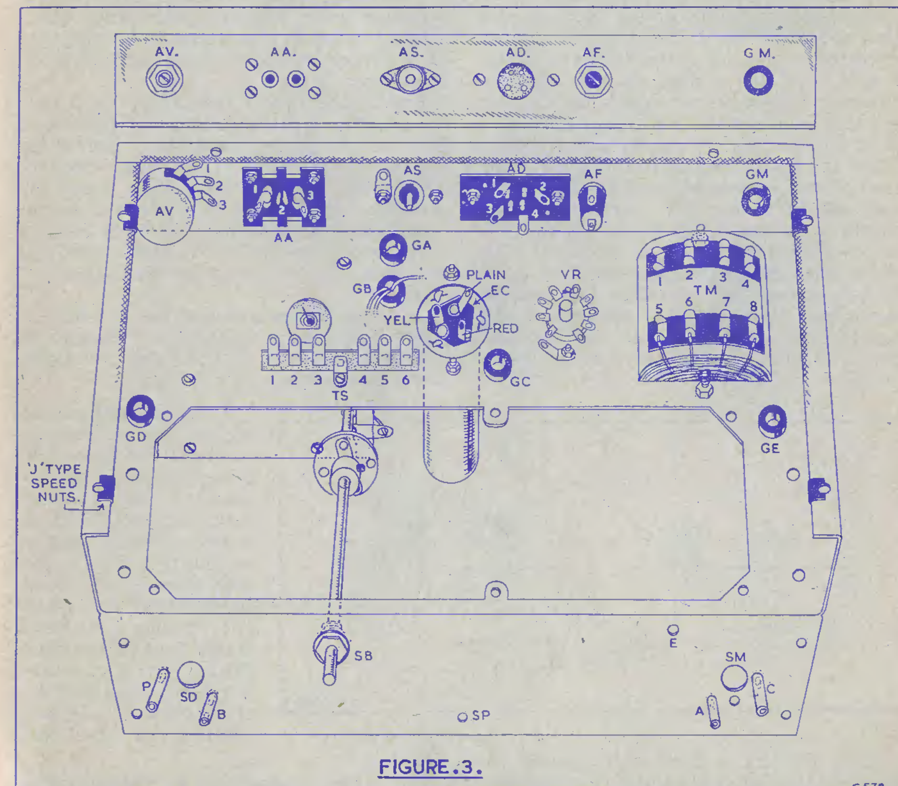


FIGURE . 3 .

II. The Heathkit F.M. Tuner

The Heathkit F.M. Tuner has been designed to meet all the foregoing performance requirements for fringe area high fidelity reception of v.h.f. f.m. over the frequency range 88–108 Mc/s. It is housed in an attractive polychromatic silver grey cabinet with a two-tone grey "Perspex" front panel and golden flanged frame. (See front cover.) The tuner may be used free-standing on a small table or a room-divider. Alternatively, it is equally suitable for equipment cabinet mounting in a horizontal or vertical position. To provide rapid traverse of the tuning scale pointer, flywheel tuning has been used. The stations are accurately tuned-in with the aid of a thermometer-type tuning indicator which shows through the front panel.

Internally, the tuner has three distinct sections. These are power supply, an enclosed r.f. tuning unit and a printed circuit i.f. strip. These sections are mounted on a cadmium-plated steel chassis. The fused power-supply is transformer-operated and electrostatically screened. A special feature is the extremely stable r.f. tuning unit. This is supplied assembled, tested and aligned (designated FMT-4U). The unit is mounted on the right-hand side of the chassis as shown in Fig. 2. The tuning shaft is flexibly coupled to a tuning drum, which has a simple cord driven assembly for the pointer and tuning knob shaft. A printed circuit board is used for the i.f. and detector stages. This assures ease of assembly and freedom from alignment problems, since each component position is printed on the board and the i.f.'s are pre-aligned to individual standards. All components specified in this model have been carefully chosen for reliability and general ruggedness, and are of current British manufacture. A list of parts together with the manufacturers' names of the main items is given.

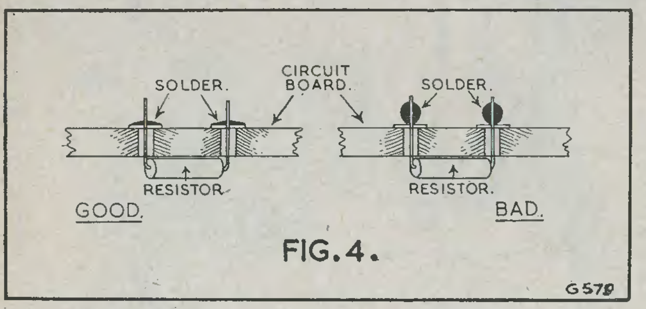


FIG.4.

Many readers will want to know the assembly time of this model. The beginner should have this model working in about 10 to 12 hours—allowing time for component identification, etc. The constructor with some experience should take about 5 to 6 hours to complete the model. In the latter case, some experience of soldering and the memorising of the resistor colour code is assumed. As this tuner has been specially designed to facilitate construction at home, particular attention has been given to the features outlined below.

III. Basic Requirements of Kit Design

Ease of construction is of major importance. Therefore all metalwork has to be produced to accept properly the standard components used. Each component requires to be clearly marked with the correct code value of resistance or capacitance, and in the case of capacitors the actual capacity value should be printed on the component body, since capacitor colour code is rather difficult for the inexperienced to decipher quickly and correctly. In a kit such as the FM-4U, where tuned circuits are used, the problem of correct alignment after assembly is eliminated by pre-aligning each coil to factory standards. Furthermore, printed circuits are used to eliminate stray capacity differences, which would be present if conventional wiring was used. There are other advantages which will be outlined later.

Finally, the finished model must be at least the equal in appearance and performance to that of a factory-assembled instrument costing much more. This being so, the constructor knows that time spent on assembly has been worth while and he has every reason to experience the great pride of achievement, which is a most satisfying sensation when viewing a job well done.

IV. Actual Construction of the FM-4U

A step-by-step Instruction Manual is provided with each kit and below we outline the salient features of construction.

This starts with mounting to the chassis all controls, sockets and power supply components. These components are then wired in a conventional manner as shown in Fig. 3. The next stage is the mounting to the chassis of the R.F. Tuning Unit which is then coupled to a drum drive. The drum drive is readily accessible and therefore facilitates routeing of the cord. (See Fig. 2.)

As stated previously, a printed circuit board has been used for the i.f. and detector stages. Assembly time is thereby greatly reduced and the risk of error minimised. Each component has its own place clearly printed on the board, and its wire ends are merely inserted through the holes on the circuit board, and then soldered to the gold-plated, copper-foil circuit conductors. The method of soldering is very similar to that

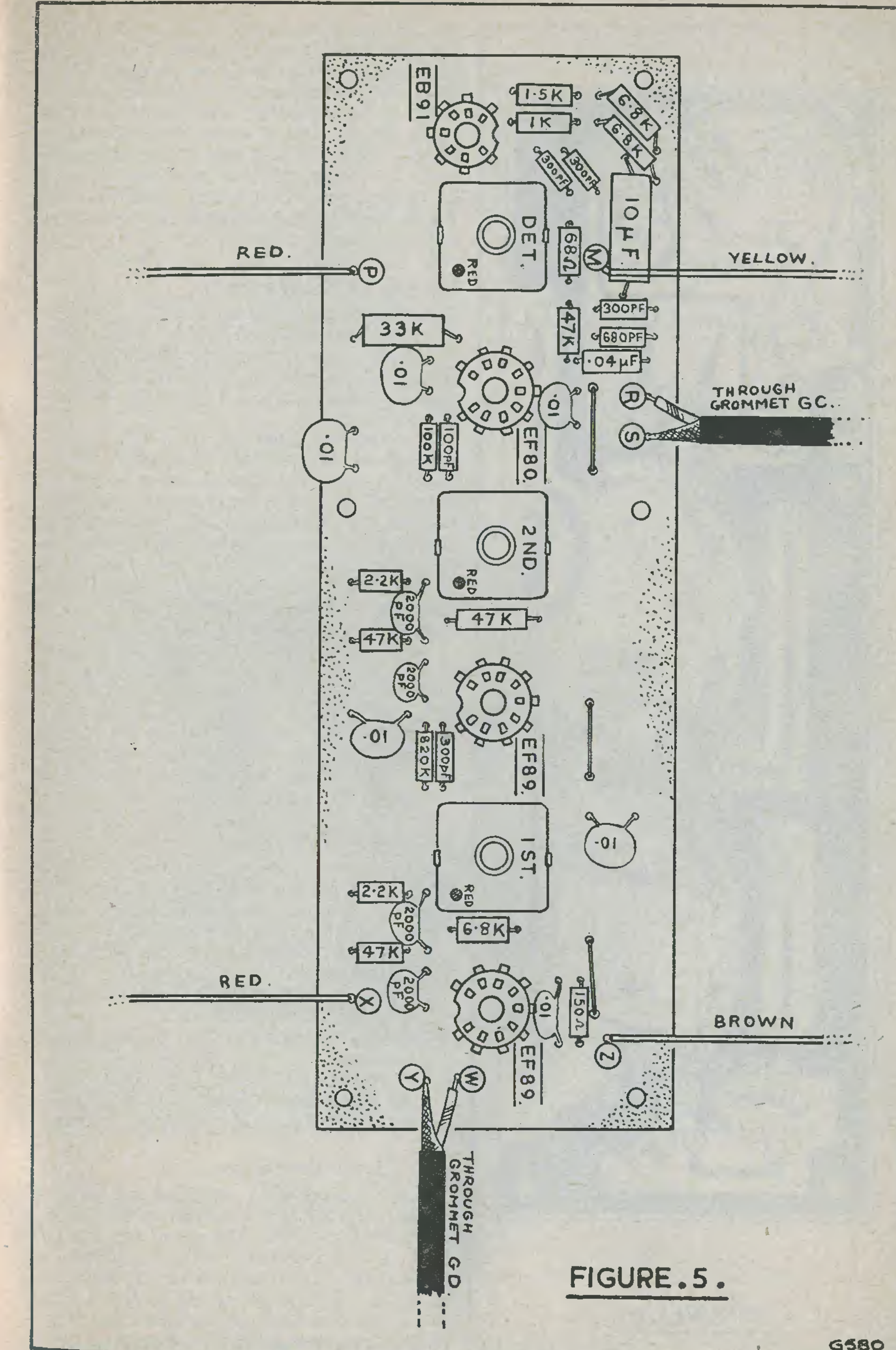


FIGURE.5.

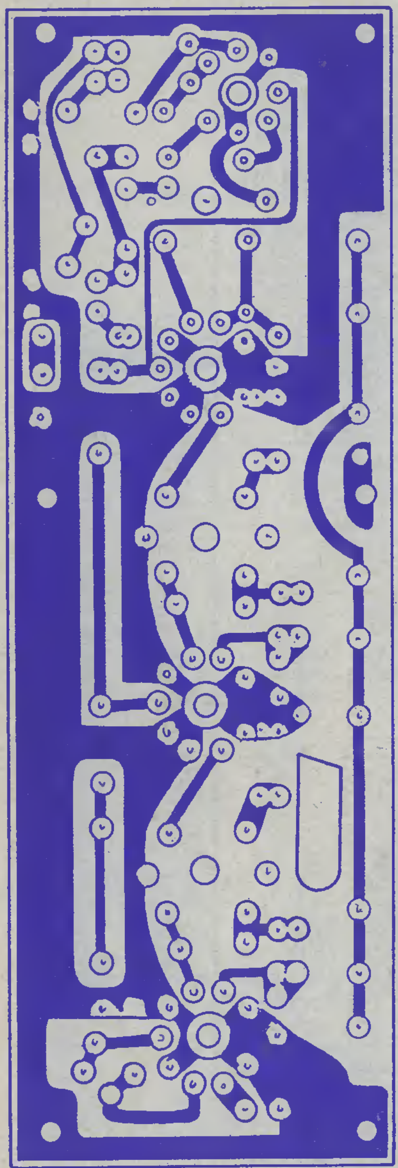


FIGURE . 6 .

used in the conventional wiring of tagstrips, but with printed circuits, there is rather less mass to heat to the correct soldering temperature. In consequence, the soldering iron needs to be in contact with the work for a much shorter time in order to make a satisfactory joint. Fig. 4 shows the difference between a good and a bad joint. Fig. 5 illustrates the component positions and Fig. 6 reveals the routeing of the copper foil conductors.

V. Aids to Construction

All beginners to electronic kit construction are somewhat mystified by the various parts which make up a complete instrument. It is therefore essential for some form of component identification and assembly sequence to be provided.

The method used for Heathkit models consists of "step-by-step" assembly instructions written in a logical order, aided by diagrams and illustrations, showing the component positions at various stages of construction. As a further aid to construction, the constructor is also instructed when to solder each tag, and the number of wires which have to be soldered on each tag. This further check reduces the risk of errors.

It will be noticed that most components shown in the diagrams have a letter and numerical reference; these are referred to in the "step-by-step" assembly instructions, which provide an easy guide to actual location of the types of components. Fig. 7 shows the completed tuner without its cover.

VI. Performance Figures

Listed below are the performance figures taken from a completed FM-4U tuner.

- Audio Output: Nominal 1 volt 30% modulation (into 100kΩ load).
- Frequency Response: ±2dB from 20–20,000 c/s.
- Harmonic Distortion: Less than 1% at 1 kc/s, ±75 kc/s deviation.
- Quieting Sensitivity: 2.5μV for 20 dB quieting.
- I.F. Rejection: Greater than 50dB.
- A.M. Suppression: Better than 30dB.
- Local Oscillator Drift: Less than ±25 kc/s.

VII. Circuit Description

The functions of r.f. amplifier and additive mixer-oscillator are combined in an ECC85 double triode valve. The signal input is fed in via a 75Ω co-axial input and transformer-coupled to the cathode of the r.f. amplifier, 1st triode. This input circuit is broad-band and is pre-tuned to the centre of the band. The r.f. amplifier anode circuit and oscillator grid circuit are permeability tuned and ganged to a tuning shaft. These circuits are tracked by C_3 and C_9 shown in the circuit (Fig. 8).

Capacitors C_7 to C_{15} form the functions of coupling and temperature compensation for the oscillator circuit. The frequency drift of the local oscillator is less than ±25 kc/s. Because of this exceptionally low "drift", a.f.c. has not been incorporated.

From here, we now have the incoming signal frequency and the internal oscillator frequency mixing together which produces the standard 10.7 Mc/s intermediate frequency. The function of this particular circuit is known as "additive mixing." As shown in the circuit diagram Fig. 8, the i.f. output from the r.f. tuning unit is fed to the control grid of the 1st i.f. amplifier. The amplifier output is then transformer-coupled to the control grid of the 2nd i.f. amplifier and finally transformer-coupled to the control grid of the 3rd i.f. stage.

Negative feedback is used on the 1st and 2nd i.f. amplifiers (EF89), and is given by capacitors C_{16} and C_{19} on the 1st i.f. amplifier and C_{22} and C_{24} on the 2nd i.f. amplifier.

Anode-saturation and grid-limiting takes place at the 3rd i.f. amplifier (EF80). A further limiting action takes place on high-input signals at the 2nd i.f. amplifier; formed as a result of the time constant of R_{10} and C_{20}. The time constant characteristics in the grids of the 2nd and 3rd i.f. amplifiers also effectively deal with noise and rapid signal fluctuations.

A ratio detector is used, which provides a superior overall performance, especially at low signal levels.

Finally, the detected audio output is fed via the normal 50μ-second de-emphasis network to a pre-set volume control and output socket.

In anticipation of the advent of regular stereophonic transmissions, sockets are provided for a stereophonic adaptor.

The complete kit of parts for this Tuner can be obtained directly from Daystrom Ltd., Gloucester, or from any of their Authorised Dealers.

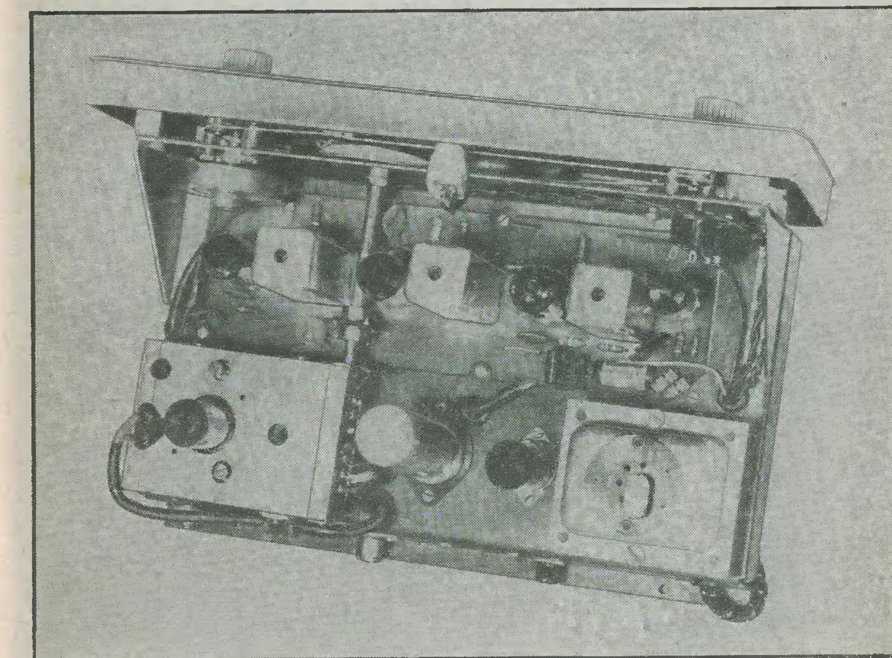


Fig. 7

Above-chassis arrangement of components in the Heathkit Model FM-4U FM Tuner. See also Figure I shown on front cover

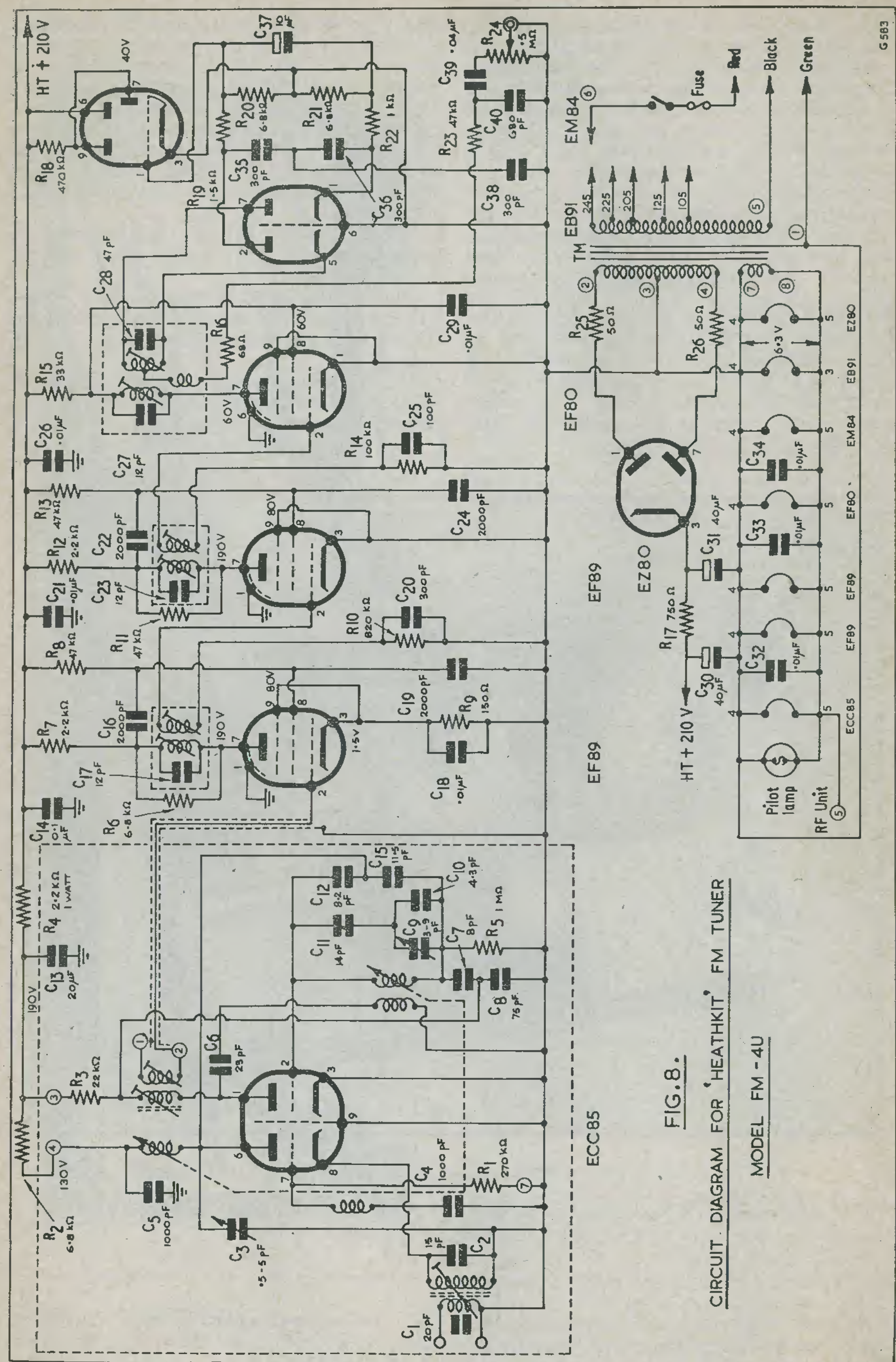


FIG. 8. CIRCUIT DIAGRAM FOR 'HEATHKIT' FM TUNER
MODEL FM-4U

COMPONENTS LIST

No.	Per Kit	Description	
Resistors, Carbon ±10% ½ *watt*			Morganite
H–680C10	1	68Ω (Blue, Grey, Black)	
H–151C10	1	150Ω (Brown, Green, Brown)	
H–102C10	1	1kΩ (Brown, Black, Red)	
H–152C10	1	1.5kΩ (Brown, Green, Red)	
H–222C10	2	2.2kΩ (Red, Red, Red)	
H–682C10	4	6.8kΩ (Blue, Grey, Red)	
H–473C10	4	47kΩ (Yellow, Violet, Orange)	
H–103C10	1	100kΩ (Brown, Black, Yellow)	
H–474C10	1	470kΩ (Yellow, Violet, Yellow)	
H–824C10	1	820kΩ (Grey, Red, Yellow)	
Resistors, Carbon ±10% 1 *watt*			
1–222C10	1	2.2kΩ (Red, Red, Red)	
1–333C10	1	33kΩ (Orange, Orange, Orange)	
Resistors, wire-wound 5%			Plessey
5–500W5	2	50Ω value marked	
7–751W5	1	750Ω value marked	
Capacitors, electrolytic			
25–520	1	10μF 50V d.c.	
25–507	1	40+40+20μF 275V d.c.	
Capacitors, silver mica			L.E.M.
20–502	4	300pF	
20–503	1	680pF	
Capacitors, silver ceramic			F.E.C.
21–503	1	100pF	
Capacitors, moulded paper			Hunts
22–501	1	0.04μF 150V	
Capacitors, ceramic disc			
21–510	4	2,000pF (0.002μF) 500V	
21–511	6	10,000pF (0.01μF) 500V	
Controls			A.B. Metal Products
63–517	1	Rotary On/Off switch	
10–519	1	½MΩ potentiometer (pre-set volume control)	
Transformers			Weymouth Radio
52–504	2	I.F. transformer 1st and 2nd (Yellow Ring)	
52–503	1	Ratio detector transformer (Red Ring)	
54–512	1	Mains transformer	Haddon Transformers
Dial Parts, Knobs, Assemblies			Jackson Bros.
100–505	1	Tuning drum	
349–501	1 length	Dial cord	
453–506	1	Drive shaft assembly	
258–503	1	Spring (expansion)	
613–501	1	Sleeve	
453–507	1	Extension shaft	
456–503	1	Coupling	
455–501	1	Threaded bush	
608–501	1	Flywheel	
100–506	1	Guide plate assembly	
463–503	1	Pointer	
100–504	1	R.F. tuning assembly with valve ECC85	Plessey
462–501	2	Knobs	Elco Plastics

Components List (cont.)

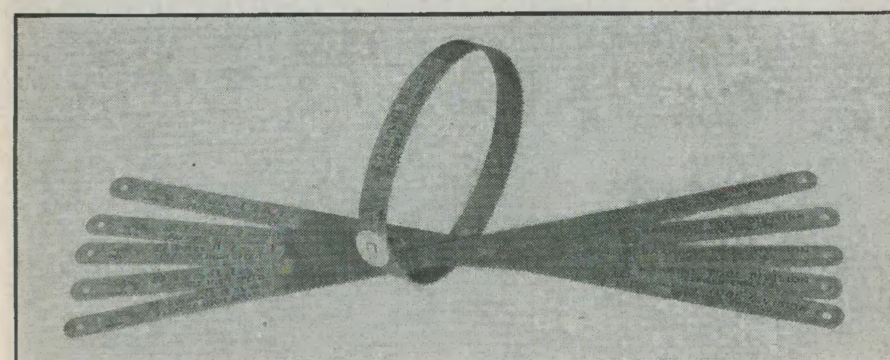
Part No.	Parts Per Kit	Description	
Valves, Pilot Lamp			
411–520	2	EF89	Mullard
411–521	1	EF80	Mullard
411–40	1	EB91 (6AL5)	Mullard
411–523	1	EM84	Mullard
411–522	1	EZ80	Mullard
412–4	1	MES lamp 6.3 volt 110mA	Mullard
Valveholders, Sockets, Plugs, Tagstrips			
434–522	1	Valveholder B7G (printed circuit type)	Plessey
434–521	3	Valveholder B9A (printed circuit type)	Plessey
434–502	2	Valveholder B9A (Chassis mounting type)	Plessey
434–524	1	4-way socket	Carr Fastener, Aerial Pressings
434–505	1	2-way socket (gram)	Carr Fastener, Aerial Pressings
432–506	1	Socket, co-axial (aerial input)	Carr Fastener, Aerial Pressings
438–501	2	Plug (gram)	Carr Fastener, Aerial Pressings
438–504	1	Plug, co-axial	Carr Fastener, Aerial Pressings
431–503	1	6-way tagstrip	Carr Fastener, Aerial Pressings
Wire, Cable, Sleeving			
344–510	1 length	Black covered wire	G.E.C.
344–511	1 length	Brown covered wire	G.E.C.
344–512	1 length	Red covered wire	G.E.C.
344–514	1 length	Yellow covered wire	G.E.C.
343–503	1 length	Co-axial cable	G.E.C.
89–502	1 length	3-core mains cable	G.E.C.
346–501	1 length	$1\frac{1}{2}$mm sleeving	G.E.C.
340–501	1 length	Bare tinned copper wire 22 s.w.g.	G.E.C.
Mechanical Parts			
200–515	1	Chassis	
90–510	1	Cabinet shell	
604–501	1	Escutcheon	
204–517	2	Support bracket	
208–507	1	Tuning indicator clip	
601–103B	1	Base plate	
320–503	1	Front panel (plastic)	
85–505	1	Circuit board	Mills & Rockley
204–520	1	Pilot lamp bracket	
204–521	2	Buffer bracket	
204–518	4	Retaining bracket	
Hardware (screws, nuts, washers)			
250–501	24	6BA x $\frac{1}{4}$in screws, binderhead	G.K.N.
250–502	4	6BA x $\frac{5}{16}$in csk. head	G.K.N.
250–513	4	4BA x $\frac{1}{4}$in screw, binderhead	G.K.N.
250–9U	12	4BA x $\frac{3}{8}$in screw, binderhead	G.K.N.
250–535	2	4BA x $\frac{3}{8}$in screw, csk. head	G.K.N.
250–522	4	2BA x $\frac{3}{4}$in screw, binderhead	G.K.N.
252–501	25	6BA full-hex nut	G.K.N.
252–3U	9	4BA full-hex nut	G.K.N.
252–502	4	2BA full-hex nut	G.K.N.
252–501	28	6BA lockwasher	G.K.N.
254–1U	15	4BA lockwasher	G.K.N.
254–502	6	2BA lockwasher	G.K.N.
253–501	5	$\frac{3}{8}$in flat washer	G.K.N.

Part No.	Parts Per Kit	Description	
252–505	4	Speednut "J" type (with screws)	Spire
252–502	2	Speednut, small	Spire
Miscellaneous			
331–501	1 length	Solder 18 s.w.g. (thick)	
331–502	1 length	Solder 22 s.w.g. (thin)	
259–505	3	6BA locking solder tag	
73–501	6	Grommet $\frac{3}{8}$in (plastic)	
434–520	1	Lampholder M.E.S.	
423–501	1	Fuseholder	
421–501	1	Fuse link 4 amp	
261–501	8	Feet	
255–507	2	4BA tapped pillar $\frac{1}{2}$in long	
255–505	2	4BA tapped pillar $\frac{3}{4}$in long	
481–501	1	Capacitor mounting plate (insulated)	
391–501	1	Heathkit emblem	
261–1	4	Rubber buffer	
595–516	1	Instruction Manual	
346–503	1	Rubber sleeve	
207–504	1	Cable clamp	

TRADE REVIEW

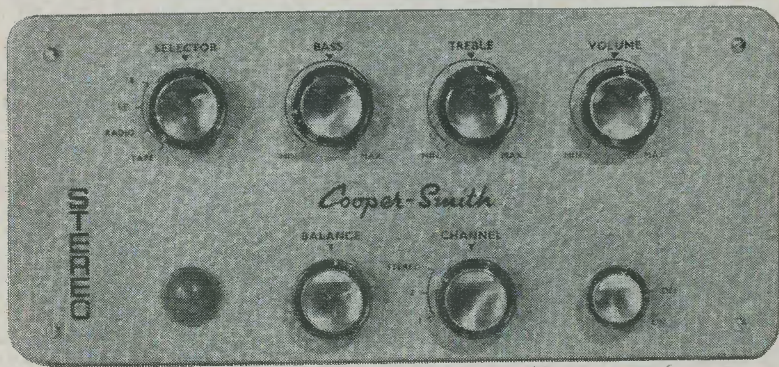
Steadfast Quality Tools (J. Stead & Co. Ltd., Sheffield), in order to simplify administration and achieve better distribution, have arranged that all tools manufactured by the Darwins Group will be concentrated into one section known as the Darwins Tool Division. Additionally, all tools manufactured by the Division will bear the well-known Steadfast brand name. Quality and service of all tools manufactured will be maintained.

The latest new product to be released is the Steadfast Flexible High Speed Hacksaw Blade. These blades are hardened on the teeth only, and give a cutting performance equal to any normal high speed hacksaw blade. By virtue of the fact that it is only hardened on the teeth, a flexibility is introduced into the blade, thereby helping to eliminate the breakage of blades by unskilled labour. This new high speed blade has the flexible properties of low tungsten in conjunction with the ability to give far superior cutting. The new flexible high speed blade will cut any type of steel and withstand misuse. The price is the same as all other high speed hacksaw blades. The illustration herewith shows just how flexible are these new blades. Blade sizes are: 10in x $\frac{1}{2}$in width x 0.025in thickness x 18, 24 or 32 pitch of teeth. 12in x $\frac{1}{2}$in width x 0.025in thickness x 14, 18, 24 or 32 pitch of teeth.



If, for testing purposes, you do bend the ordinary *type of high speed blade be sure to protect your face, for under normal circumstances the blade will shatter and pieces of metal will fly*

The Cooper-Smith



Stereo Control Unit

Part Two

Stage Two

Note: Certain resistors and capacitors are in pairs. These are matched and must be used in the same position in each channel. Keep every component of each channel as far away as possible from its twin.

After fitting S_1 *only*, tags 6 to 11 uppermost, wire up as follows (Fig. 6) using rear wafer of S_1 for the top half (Channel Two) and the front wafer for bottom half (Channel One):

S_1 (11)—VR_1 (3)
S_1 (10)—Tape input
S_1 (9)—Radio input
S_1 (8)—VR_1 (1)
TS (2)—TS (3) (solder tags together)
TS (4)—TS (8)—TS (10) (solder tags together)
Wire from earth point on input panel—TS (10)
TS (13)—R_2 (brown/green/blue) and C_3 (680pF)—S_1 (2)
TS (12)—R_1 (560kΩ) and C_2 (150pF)—S_1 (3)
TS (11)—R_4 (red/red/orange)—S_1 (4)
V_1 (9)—S_1 (6)
V_1 (8)—TS (20)

Note: R_9, R_{12} and R_{19} may be soldered across the 50μF capacitors before fixing to tagstrips.

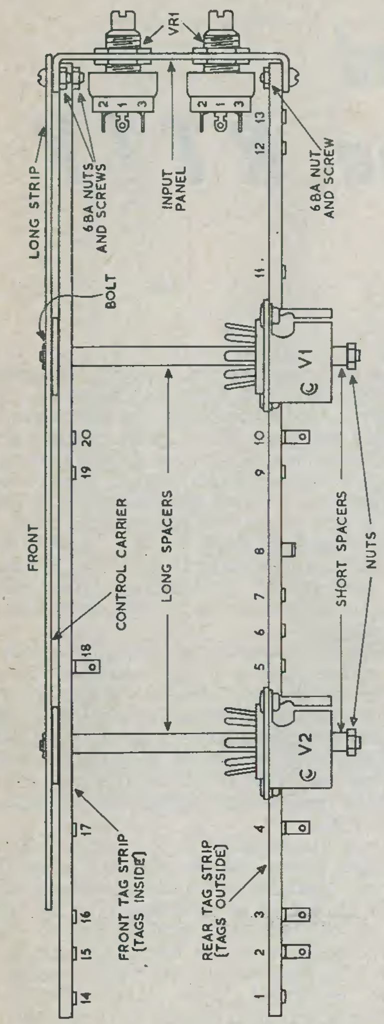
TS (10)—R_9 (red/red/red) and C_8 (50μF) red end—TS (20)
TS (9)—R_8 (220kΩ)—TS (19)
V_1 (1)—R_6 (1MΩ)—TS (19)
V_2 (8)—TS (16)
TS (5)—R_{18} (blue/grey/orange)—TS (18)
V_2 (3)—TS (17)
V_2 (6)—R_{11} (blue/grey/orange)—TS (18)
TS (4)—R_{12} (grey/red/brown) and C_9 (50μF) red end—TS (17)
TS (3)—R_{19} (grey/red/brown) and C_{16} (50μF) red end—TS (16)
TS (2)—C_1 (8μF) red end—TS (15)
TS (11)—C_4 (560pF)—TS (12)
TS (11)—R_5 (68kΩ) and C_5 (82pF)—TS (13)

Stage Three

Join the two centre taps of VR_4 together, and leave 2in of loose wire from the rear end. Fit VR_3 (1MΩ), VR_4 (500kΩ) and VR_5 (250kΩ) dual potentiometers as shown in Fig. 7, connect loose wire mentioned above to TS (8) and join the two VR_5 (2) tags and take to TS (3).

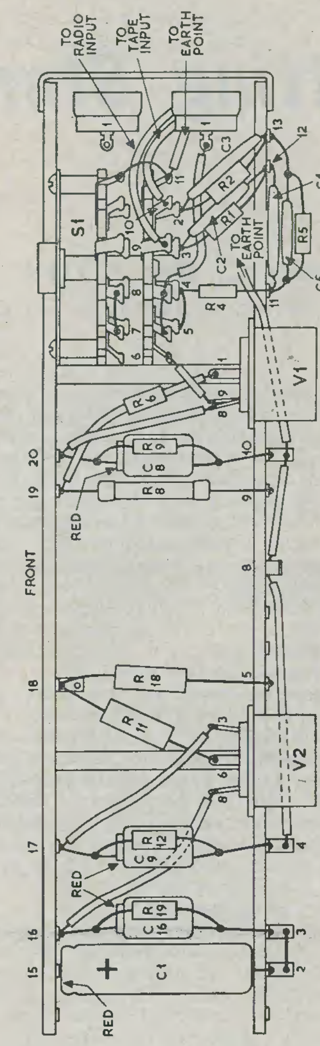
Proceed as follows, using rear section of pots. for top half and front section for bottom half:

VR_4 (2)—C_{14} (50pF)—VR_4 (3) (fit underneath tags)
VR_3 (2)—C_{11} (5,000pF)—VR_3 (1)
VR_3 (1)—C_{12} (5,000pF)—VR3 (3)
VR_4 (2)—R_{16} (orange/orange/yellow)—VR_3 (2)



FRAMEWORK ASSEMBLY (VIEWED FROM ABOVE)

Fig. 5



TOP VIEW OF WIRING (CHAN. 2) BEFORE FITTING POTENTIOMETERS (REPEATED ON OTHER SIDE (CHAN. 1) USING FRONT WAFER OF S1)

Fig. 6

STAGE TWO

VR_4 (3)—R_{13} (brown/black/yellow)—VR_3 (3)
VR_4 (1)—C_{13} (68pF)—TS (7)
VR_3 (1)—R_{14} (red/red/yellow)—TS (7)
VR_3 (2)—R_{15} (brown/green/yellow)—TS (8)
VR_5 (3)—C_{17} (0.1μF)—TS (5)
V_2 (6)—C_{10} (0.1μF)—VR_4 (3)
VR_4 (2)—C_{15} (0.1μF)—TS (5)
TS (6)—C_7 (0.1μF)—TS (9)

(To be concluded next month)

Getting Started on RTTY

by Arthur C. Gee, G2UK
Hon. Sec., British Amateur Radio Teletype Group

Part 3

The teleprinter can be regarded from the practical aspect as consisting of two separate parts, viz., that section which is responsible for transmitting the electrical impulses in accordance with the particular key which is pressed, and that part which prints the information received as letters and numbers, etc., on paper tape or sheet. In many respects these two parts of the machine are quite separate; so much so, that teleprinters are available which receive only, i.e. no keyboard or transmitting mechanism is provided, though this can in some machines be added at any time, if required.

An interesting result of this form of construction is that the T/P can be wired up so that it will "self-print", i.e., when the keys are depressed, the appropriate characters will be typed on to the paper by the receiving mechanism. This is a good way of testing the machine. Furthermore, when operating in this fashion, the speed at which the motor is running is not important; in fact, it can almost be turned over by hand and it will still function in this manner.

To get the machine running in this way, electrical interconnection between the receiving side of the T/P and the transmitting section must be made. The receiving or printing section is actuated by an electromagnet. This consists of two coils of 100 ohms each, with a pivoted magnet between the fields of the two coils. The coils can be connected up in a variety of ways as their leads are brought out to individual terminals, but before dealing with this in detail, let us have a look at the terminal arrangements of the Type 3 T/P generally.

The general wiring circuit is shown in Fig. 1. The terminal strip we are particularly interested in at the moment is that designated Terminal Block 2 in the diagram. It is located right at the back of the T/P towards the right-hand end. Examination of it will show that each terminal position is identified by the series of numbers shown in the diagram. Nos. 1 and 2 are the motor power supply terminals, No. 1 being positive and No. 2 negative. No. 3 is an earthing terminal. No. 4 is not connected. Nos. 5, 6 and 7 are connections to the transmitting contacts; No. 6 goes to the tongue or central contact, Nos. 7 and 5 going to the "mark" and "space" contacts respectively. Nos. 8, 9 and 10 connect to the electro-magnet coils, No. 10 being common to both as shown in the diagram.

Now the easiest way to form a "local loop" for self-printing is to use two low voltage batteries—grid bias batteries seem to do well—and connect them up as shown in the detail in the panel beneath the terminal strip diagram as shown in Fig. 1. Connect up as shown, switch on the motor and type away and the appropriate characters should appear on the tape.

There are available on the surplus market suitable power supplies for providing the current needed to work the electromagnets. They are known as Rectifiers Type 26. The circuit of these is shown in Fig. 2. The resistors shown in the leads to terminals 1 and 3 are limiting resistors resembling small glass enveloped lamps, and these two terminals should be used for supplying the electromagnet when "local loop" working is carried out as indicated above. This power unit can also be used for working the T/P from a radio receiver FSK terminal unit. So it is quite a useful item to acquire.

The connections for wiring up the Type 26 rectifier to the T/P for "local loop" working are shown in Fig. 3. Check that the current through the electromagnet coils does not exceed approximately 40mA. If it does, additional resistors should be put in the "common" lead from terminal 2 to 9.

To use the Type 26 rectifier unit with a

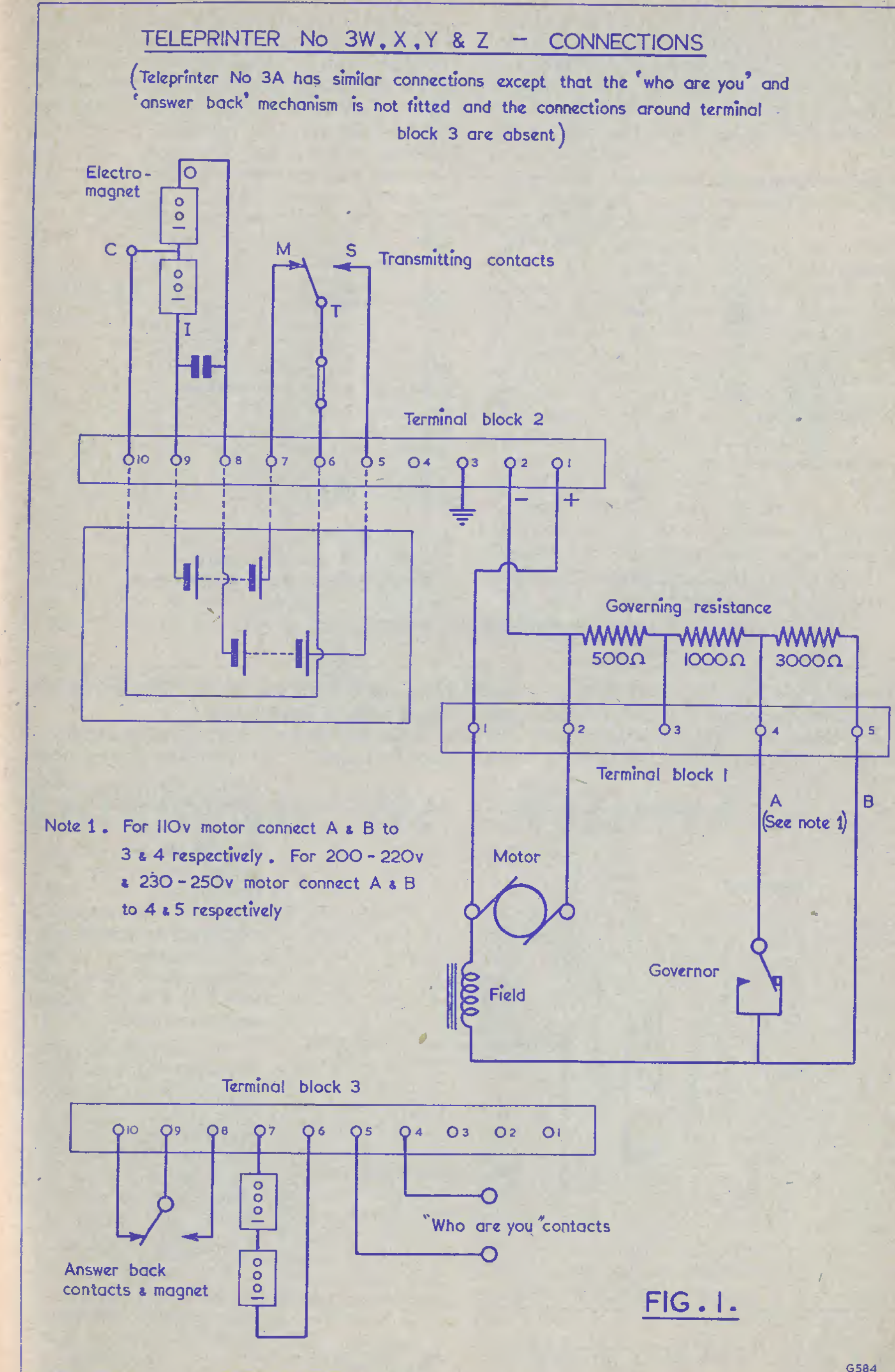


FIG. 1.

polarised relay on an FSK radio receiving terminal unit, the connections are similar to those in Fig. 3 except that T/P terminal 8 is connected to the tongue of the relay and terminals 1 and 3 on the rectifier go to the space and mark terminals respectively on the relay.

Most of the machines obtained so far were pretty dirty and gummed up with old oil. The type heads in particular needed attention in this respect, and the writer is indebted to Clive Pearson, G3IUQ, for the following information on how to clean this component.

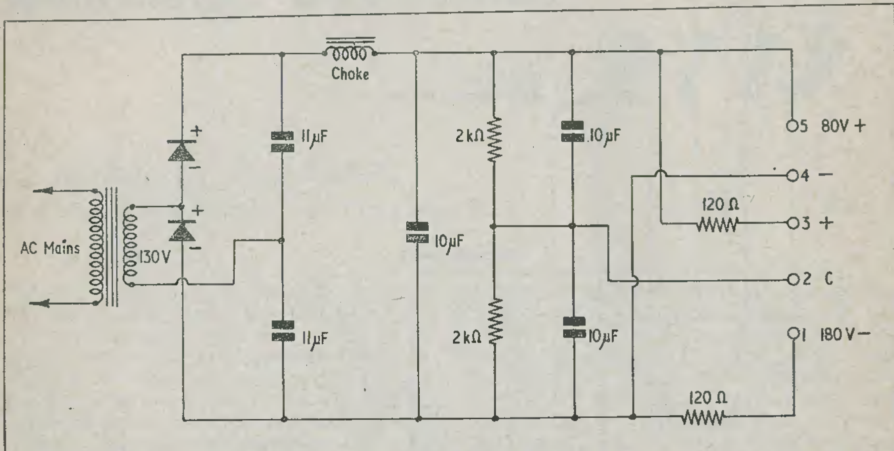


FIG. 2. RECTIFIER TYPE 26

It will be seen that there are quite a variety of ways in which the T/P can be connected up to "self-print" and readers should, with the circuit diagrams given, be able to work out a suitable arrangement for their own requirements.

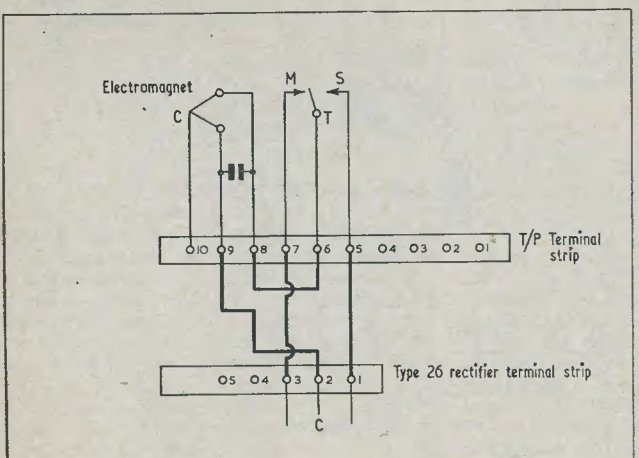


FIG. 3.

Instructions for Cleaning the Typing Head on Creed Type 3 Teleprinters

If the teleprinter is not typing cleanly it may be necessary to clean the typing head. Apart from an accumulation of old ink on the face of the type, a deposit of dirt and congealed oil on the actual mechanism can cause trouble. In order to remove this satisfactorily it is necessary to dismantle the typing head, which is a simple though tedious process.

First unclip the spring retaining the tape puller against the ratchet on the tape roller. Swing the puller and roller assembly back out of the way. Next gently lift the type striker from its pivot just behind the typing head and swing it back.

Next rotate the motor backwards to move the type head backwards from its end stop. Holding the governor at the right-hand side of the motor, undo the small screw holding the type head on to its shaft. The clutch should not slip while doing this, but if it does then hold the final drive to the type selector stationary.

With the securing screw fully undone, the type head may be removed completely. Note the order of assembly to avoid errors when replacing. Now with the head in front of you, take a piece of paper and note down the order of the type. Identification of position is easy as there are 3, 2 and 1 blank positions which may be used as a reference for notes. These blanks are fixed permanently in position and should not be removed.

Three springs hold a circular plate against the type, tensioning it in position. Unhook these at the end remote from the type and remove the tensioning plate. The type can then be removed and the whole assembly should be put into a jar with carbon tetrachloride (or petrol if you are a non-smoker and can keep away from naked lights). Swab gently with a soft brush until all parts and type are clean and rinse in fresh cleaning fluid.

The type may now be re-assembled in correct order, referring to the list already made. When replacing the type apply a little light machine oil with a brush to both sides of the shank of each piece. When all the type is in position, replace the retaining plate and clip back the tensioning springs. Apply a few drops of oil to both clutch pads (these should not have been cleaned in solvent), oil the centre bearing of the head, and replace. Check that the type head is not being forced against the end stop before tightening the retaining screw.

Replace the striker, oiling the pivot lightly, and hook back the spring holding the puller against the tape roller ratchet.

If the machine still does not type cleanly after a few operations, check the clearance between the tape roller and the type. This may be adjusted if necessary. At the front left-hand side, the thumb lever used to swing the roller back is retained in a groove in a knob. Slacken the locking nuts on this knob and screw in or out to adjust clearance. Type while doing this and screw the adjuster in just far enough to give good results.

Having now got your teleprinter working satisfactorily, the next step is to get it copying teletype signals from a radio receiver. A good communications type radio receiver is needed for this, and what is called an FSK Converter or Terminal Unit.

We shall start to deal with this subject in our next article in this series.

Catalogues, etc., Received

Application of R.C.A. Drift Transistors to F.M. Receivers by J. W. Englund and H. Thanos. This reprint from the I.R.E. Transactions on Broadcast and Television Receivers, January 1959, discusses the application considerations involved in the use of drift transistors in the radio-frequency amplifier, oscillator, and intermediate frequency amplifier stages of battery operated F.M. broadcast receivers. Receiver design and performance are discussed in terms of individual stages, and data is presented on gain, bandwidth, signal-to-noise ratio, and frequency stability. The effects of ambient temperature and supply voltage variations are also described. A complete circuit diagram, with component values, of an All-Transistor (9) battery operated F.M. Receiver, together with 9 graphs showing power gain in r.f. amplifier; input resistance, etc., of r.f. amplifier, mixer and oscillator; available power gain of i.f. transistors; tuning characteristics; sensitivity, image rejection and i.f. rejection, etc., etc. Interested readers may obtain further information from R.C.A. Great Britain Ltd., Engineering Products Sales Dept., Lincoln Way, Windmill Road, Sunbury-on-Thames, Middx., quoting Publ/1003/ThH.

A. T. Sallis Radio Control Ltd., 93 North Road, Brighton, Sussex, have forwarded a copy of their latest Mail Order catalogue. Priced at 2s. (post and packing 6d.), this 92-page, well-illustrated booklet lists just about everything that could possibly interest radio control and home hobbyists in general. Relays, ex-Service receivers, electric motors, converters, filters, transformers, meters, r.f. units, switch units, intercoms, telephones, transmitters and power supply units, together with a host of other units and equipment are featured within. A most handy catalogue to have on the shelf.

TRANSISTOR TOP-BAND TRANSMITTER

Designed by D. J. French, Grad. I.E.E.

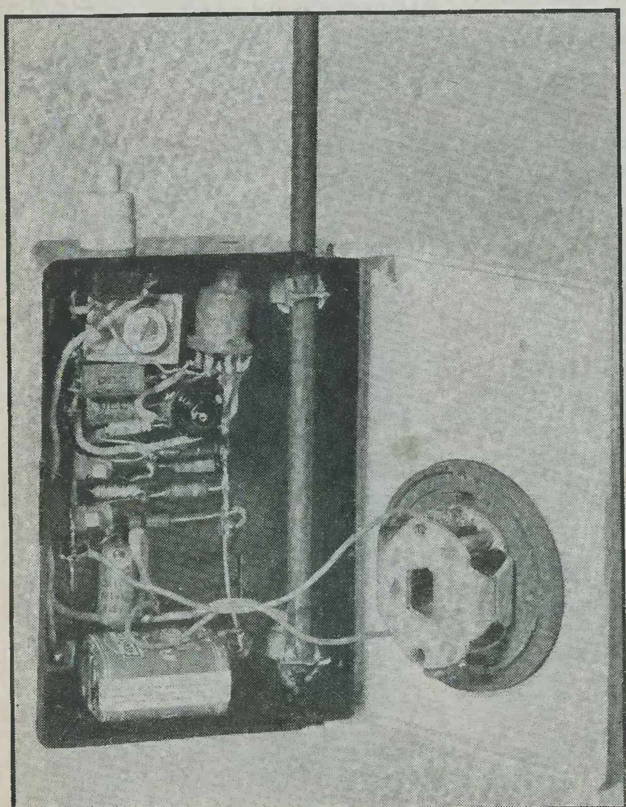
This transistor transmitter has been designed purely for short range local working and would prove ideal for use during field days, between, for instance, the various groups working at differing QTH's and even between teams working in various tented erections, etc. In addition to these uses, it would prove ideal where communication has to be established between officials at a Hamfest or rally, or where the erection of a beam array requires the conveyance of two-way intelligence.

The circuit is shown in Fig. 1. In this, the XA104 transistor is operating in a grounded emitter oscillator circuit, the feedback required to produce the necessary oscillation being obtained via a coupling winding in series with the emitter circuit. The tertiary winding of the coil, with C_6 in parallel, effectively tunes the oscillator over the frequency range of 1 to 2 Mc/s.

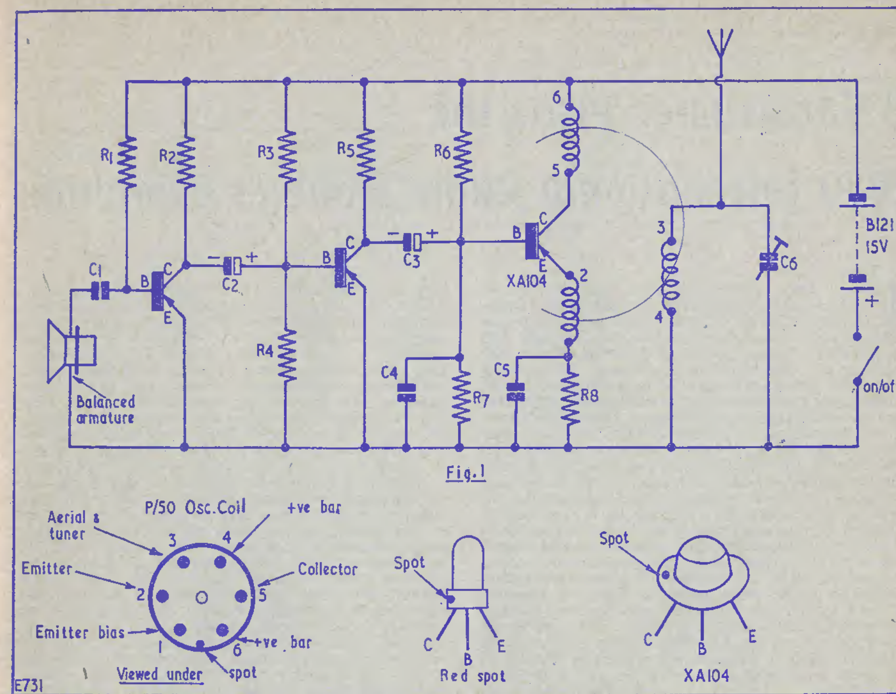
The audio input via the balanced armature microphone is fed into the two-stage amplifier, the output of which is then fed to the base of the oscillator, modulation then taking place. The current consumption of the unit is somewhat less than 3mA, the power requirements being taken from a 15 volt supply.

As will be seen from the photograph (shown here) the radiating aerial used is of the copper rod variety and the range of the transmitter will, therefore, be dependent upon the total length of rods so used. With, for instance, one foot of aerial the effective range will be 15 feet, with 2ft of aerial the range will be 25 feet, a 3ft aerial will radiate some 40 feet, whilst 4ft of aerial will operate over some 60 feet.

The transmitter will be found to be slightly directional in operation, but the frequency stability of the unit is excellent and no drift will be found apparent even after initially switching on. The transmitter should be operated so that the aerial rods are in the vertical plane and it will be found, in practice, that the trimmer condenser C_6 will require some adjustment when the aerial length is either increased or reduced.



Layout of prototype top-band transmitter



Components List

Resistors
- R_1 1MΩ ⅛ watt
- R_2 5.6kΩ ⅛ watt
- R_3 330kΩ ⅛ watt
- R_4 10kΩ ⅛ watt
- R_5 4.7kΩ ⅛ watt
- R_6 47kΩ ⅛ watt
- R_7 10kΩ ⅛ watt
- R_8 1kΩ ⅛ watt

Condensers
- C_1 0.1μF
- C_2 2μF, 9V wkg.
- C_3 2μF, 9V wkg.
- C_4 0.04μF
- C_5 0.04μF
- C_6 100pF trimmer

Transistors
- 2 Red Spot
- 1 XA104

Miscellaneous
- Type P/50 osc. coil (Henry's Radio Ltd.)
- Ever-Ready 15V battery, Type B121
- On/Off switch
- Aerial sections (1ft lengths)
- 3 transistor holders
- Balanced armature unit
- Chassis with clips (Henry's Radio Ltd.)
- Drilled cabinet (Henry's Radio Ltd.)

It should be noted here by the constructor that the radiation of this little transmitter is capable of being picked up on an ordinary medium wave receiver set at the 200 metre end of the band, and in this connection care should be exercised that the unit is, in fact, tuned to the "Top Band" frequency before transmitting commences.

The actual construction of the transmitter is very simple and the illustration herewith shows the physical layout of the various components. The actual layout is not, in itself, critical, although constructors would do well to follow generally that shown adopted here. Care should be taken to ensure that the microphone does not foul the components when the lid of the case is closed. It should also be mentioned here that with the prototype shown, a normal press type switch is included—whereas in the production model kits, a slide switch will be incorporated.

A Constructor visits the

1959 International Radio Hobbies Exhibition

THIS ANNUAL EVENT IN THE AMATEUR RADIO calendar, held under the auspices of the Radio Society of Great Britain, was for the third successive year housed in the Royal Horticultural Old Hall, Vincent Square, London, S.W.1, from Wednesday to Saturday, 25th to 28th November. The opening ceremony was performed by Rear-Admiral K. R. Buckley, M.I.E.E., M.BRIT.I.R.E., Director of Engineering and Electrical Training, Admiralty. During the course of his opening speech, Rear-Admiral Buckley said: "The Radio Society of Great Britain was of great assistance to the Royal Navy as well as to the other Services during the War. In fact, it was from these amateurs that we were able to draw the core for our fighting services during the War; they were quickly placed in positions of great importance. A number of them stayed on after being granted commissions." "Since the War, the Society has played an important part in the formation of the Service reserves where they may be found in every sphere of radio." "Although it has nothing to do with the three Services, I would like particularly to draw your attention to the Radio Amateur Emergency Network. This, as the name implies, is only to be used in emergencies such as air disasters, floods and train crashes, etc." "I imagine many of you are very interested in the signals given out by the space vehicles flying round our earth." Rear-Admiral K. R. Buckley then declared the Exhibition open.

Within the hall, many firms well-known to radio hobbyists, and several amateur groups and societies, occupied the various stands. Of the former, the most striking feature to the writer was the introduction, for the first time, of American communications receiver manufacturers and their products, via the medium of British import companies. Now that import restrictions on dollar purchases are much easier, the amateur can expect more of these excellent goods to appear on the British market.

The great feature of the Exhibition this year was "Communications Receivers of the World," and a whole stand was organised with many famous receivers from various countries of the world—all of them working.

Dealing with the communications receivers first, the point to note here is that most of them are new—at least to us hobbyists in this country. **Collins Radio Company** were showing their 752S-1 receiver and the 32S-1 transmitter. These, together with the KWM-2 transmitter were new to the writer.

The Minimitter Company Ltd. featured their new "M.R.44" communications receiver—the plaque winner. This receiver is designed for high performance on the six main amateur bands. The ranges covered by the 8in slide rule scale are: 1.8 to 2 Mc/s, 3.5 to 3.8 Mc/s, 7.0 to 7.3 Mc/s, 14.0 to 14.45 Mc/s, 21.0 to 21.45 Mc/s, and 28.0 to 30.0 Mc/s. This 11-valve double-superhet is designed for communication under all conditions—AM telephony, CW and Single Sideband (SSB), the three modes being switch selected. The r.f. section is comprised of 15 tuned circuits in a completely screened unit. The tuning dial is flywheel loaded giving a tuning ratio of over 60:1 with complete absence of backlash. The second mixer-oscillator is crystal controlled and both oscillator h.t. voltages are stabilised. A half-lattice crystal filter in the i.f. circuit allows of a 3 kc/s bandwidth, while the incorporated "Q" Multiplier allows complete variable selectivity, either when used alone, or in conjunction with the crystal filter. A calibrated "S" meter is included in the design. The new concentric panel controls provide a compact and efficient panel layout. Aerial input is designed to match a 75Ω co-ax feeder and the output matches to a 3Ω speaker. Weight 19lb, dimensions 17in x 10in x 8½in. The price carriage paid U.K., £55.

Hallicrafters Company [James Scott & Co. Ltd., Glasgow]. Of the well-known receivers featured here, no fewer than four were new designs, these being: SX110, which includes within its tuning range the standard broadcast plus 3 shortwave bands, 540 kc/s to 34 Mc/s. A large slide-rule bandspread dial, calibrated for all bands, an "S" meter of new design and an attractively designed and colour-toned facia are features. A crystal filter and noise limiter are included in this 7-valve receiver. The main frequency dial is circular and capable of being read to fine limits. The S107 receiver has a new styling and some impressive features. The extremely large tuning scale covers virtually the whole width of the cabinet, with separate bandspread and logging scale. The unusually wide coverage of this receiver is 540 kc/s to 34 Mc/s and 48 to 54.5 Mc/s. This is an 8-valve design. The new S108 receiver has a similar coverage to that of the SX110, but is without the "S" meter, aerial trimmer and crystal filter. A built-in speaker is included and this, with the calibrated slide-rule dial and temperature compensated oscillator, makes this 8-valve design ideal for the general coverage enthusiast. The S38E receiver is the very latest version of the most popular (in U.S.A.) short wave receiver. The frequency coverage here is again 540 kc/s to 32 Mc/s. Electrical bandspread, slide-rule dial and built-in speaker are included in this design. A 5-valve receiver, this one—as with most other Hallicrafters receivers—is designed to operate from a mains supply of 105/125V, 50/60 c/s. Matching transformers to operate from the 220/250V 50 c/s mains supply commonly in use here are available from James Scott & Co. Ltd. The S38E is designed for a.c./d.c. operation at 105/125V, the remainder being for a.c. operation only. Other receivers featured on this stand were—the SX62A, the specifications for this being 550 to 1,620 kc/s and three shortwave bands covering 1.62 to 32 Mc/s A.M. and 27 to 109 Mc/s F.M. The band in use is individually illuminated on the slide-rule scale. Some 14 valves, plus rectifier and voltage regulator, are included. The SX100 is a double conversion receiver covering 538 to 1,580 kc/s and three shortwave bands 1,720 to 34 Mc/s, calibrated bandspread, "S" meter, 12 valves plus rectifier and voltage regulator. The SX101 Mk. IIIA receiver features complete coverage of the amateur bands 10, 15, 20, 40, 80 and 160 metres with a special position for the 10 Mc/s WWV calibration transmission. A dual conversion design, this receiver incorporates 13 valves plus rectifier and voltage regulator.

The General Electric Co. Ltd. featured their well-known BRT400D receiver. This series of receivers has resulted from the continuous development of the earlier type BRT400 and BRT400B, first introduced in 1948. This later series retains all the basic design and construction features of the earlier types plus a number of circuit refinements and additional facilities. The BRT400D is a 14-valve superhet having a frequency range of 150 to 385 kc/s and 0.51 to 30.0 Mc/s covered in 6 bands. Six-step variable selectivity and a crystal filter are included, and provision is made for including diversity reception and, in conjunction with suitable terminal equipment, FSK (frequency shift keying) telegraphy operation. Normally operating from an

a.c. mains supply, the receiver can be operated from a 12V d.c. supply via the use of a BRT401 battery power unit. The BRT400D is available in four basic models: BRT400D, standard model in table cabinet; BRT402D, standard model for mounting in 19in racking system; BRT400E, as for the BRT400D but fitted with a 500 kc/s calibration oscillator; BRT402E, as for BRT402D but again fitted with a 500 kc/s calibration oscillator. An audio filter is incorporated in all models, this having a bandwidth of 200 c/s at 6dB, centred on 1,000 c/s.

Home Radio [Mitcham] Ltd. featured, among many other interesting exhibits, the Eddystone range of communications receivers. Among these were to be seen the 680X, a 15-valve design from 480 kc/s to 30 Mc/s in 5 bands; the 888A, a 12-valve receiver covering the ranges 1.8 to 2 Mc/s, 3.5 to 4 Mc/s, 7.0 to 7.3 Mc/s, 14 to 14.35 Mc/s, 21 to 21.5 Mc/s and 28 to 30 Mc/s. This design incorporates a crystal calibrator, audio filter and oscillator trimmer. The a.c./d.c. design 840A was also to be seen as was the new 880 receiver—the only one of its kind in existence at the present time—no details of this being available.

The Heathkit [Daystrom Ltd.] stand featured their well-known range of kits for the home constructor, among these being the DX-100U amateur transmitter, the VF-1U variable frequency oscillator, the DX-40U amateur transmitter, the UXR1 6-transistor portable receiver, the FMT-4U FM tuner and various items of test equipment in kit form.

Mullard Ltd. presented a most attractive display of various valves and semi-conductors currently available to the home constructor and, in addition, produced an apparently inexhaustible supply of circuits and leaflets of great value to the fraternity. Among those the writer noticed were: *Circuit for Self-Contained Tape Amplifier*, a very useful 15 page booklet; *Two-Valve Pre-Amplifier*, this being for use with magnetic and crystal pick-ups, microphone and radio inputs and tape recorder playback heads; *Four Channel Mixing Amplifier*, and various other leaflets giving supplementary information on circuits, cross-over networks for loudspeakers, etc., etc. Several experts were available on the stand at all times to answer queries. A feature that appealed to the writer here was the provision of several Suggestion Boxes—I trust they received plenty!

AVO Ltd. Here the writer noted the famous Model 8 multimeter, an instrument designed primarily for the electronic and radio engineer. The new Multiminor was also to the fore, this compact instrument being both inexpensive and capable of use in the shack, and indeed within industry. The latest addition that was noted were the Prodclips, these being extremely handy in the workshop, capable as they are of being used both as test prods or clips. Other items of note here were the well-known range of signal generators, valve testers, valve voltmeters and other measuring equipment.

Short Wave Magazine Ltd. displayed many American radio textbooks, the well-known DX Zone Map and the various amateur awards such as the Worked All British Counties, VHF Century Club and Four Band Award, etc.

Taylor Electrical Instruments Ltd. were showing their new high sensitivity pocket-size Multimeter Model 127A. This instrument is the first pocket-sized multimeter in this country with a sensitivity of 20,000 ohms per volt. A large, easy to read, two-colour scale with a 3¼in arc is a feature of this compact instrument. Its main advantage, apart from the small size, is the ability to measure resistance up to 20MΩ with self-contained batteries. Another new meter on display was the Model 100A. With a sensitivity of 100,000 ohms per volt d.c. and 5,000 ohms per volt a.c., this instrument has no less than 35 ranges. It is fitted with a three-colour 5in open scale with an anti-parallax mirror. The Model 20B Circuit Analyser, for fault finding by r.f. and a.f. signal tracing through the circuits, and the Model 94A TV Waveform and Alignment Generator, were also of interest.

Lektrokit [All-Power Transformers Ltd.] displayed for the first time their very ingenious and versatile electronic construction system of experimental chassis. This construction system consists of a few simple and inexpensive prefabricated chassis components from which experimental chassis can be constructed simply, quickly and cheaply. The dimensions of the Lektrokit chassis, etc., have been designed to be compatible with a wide range of standard commercial electronic components. Complete chassis can be assembled from a few basic Lektrokit parts and the standard electronic components available on the market today.

Jason Motor & Electronic Co. Here were to be seen the many well-known Jasonkits, including the popular F.M. Tuners FMT1, 2 and 3. In addition, a very wide range of test equipment—currently being offered to the enthusiast in kit form—were to be seen and handled.

Data Publications Ltd. — The Radio Constructor. Here was to be seen a very wide range of books catering for the home constructor. The demand for books with the knowledge and information contained therein grows apace from year to year, this being very apparent from the increase of titles over the last few years. In large demand was the annually published *Radio Amateur Operator's Handbook*, this by now being virtually a necessity on the operating table. The writer was pleased to note that a new publication had been launched to coincide with the exhibition, this being a title that will obviously have a future and, at the same time, fulfil a much-felt want with the younger fraternity. *Short Wave Receivers for the Beginner* is an ideal publication for those making a start in the hobby.

It is impossible in such a short review, of course, to mention each and every individual stand. Many other stands were of interest and obviously a great deal of time and trouble had been spent on them by the exhibitors. What of the Clubs and Societies?

R.T.T.Y. A new aspect of amateur radio was shown on the stand, organised at short notice by the British Amateur Radio Teletype Group. Much interest appeared to be shown by many visitors in RTTY. The stand was equipped with an HRO receiver and teletype gear in working order. The type of equipment shown is that available to the Group and this, together with practical circuits for receiving and transmitting RTTY, and examples of some of the work carried out by the Group to date, made an impressive show. This stand, incidentally, was one of those shown on B.B.C. "telly" during the course of the exhibition.

Amateur Radio Mobile Society. Here one was able to obtain copies of the News Letter No. 1 and the very finely produced *Mobile News* produced by Fred (G2BCX) and Freda Judd. The item of equipment that interested the writer here was the mobile power pack, completely transistorised, 95% efficient, that gave an output of 500V at 115W. This new departure using power transistors is being currently marketed as a kit of parts after negotiations between the manufacturers, Transipack Ltd., 29 Burnt Ash Hill, London, S.E.12, and the Society. At the stand the writer was very pleased to have a personal QSO with G3KVF and his XYL Sylvia—two very keen members of the A.R.M.S.

Radio Society of Great Britain. Many units of home-constructed equipment were to be seen here from the near professional to the first efforts of the youngsters. Of the latter, those that impressed the writer were the grip dip oscillator, the 1-valve EF50 receiver and the morse practice oscillator made by the boys of the Science and Radio Club organised by science master J. F. Turner, G3AYZ, of Aldersbrook County Secondary School, Wanstead, E.12. It is encouraging to see youthful enthusiasm displayed in such a practical manner, and G3AYZ is to be congratulated on his interest and work with the boys of the Club.

The society amateur radio station, GB3RS, equipped with the "Vanguard" transmitter, was to be seen working other stations and, by all accounts, many interesting QSOs were carried out.

Other items of home-built equipment that caught the writer's eye were the 1,300 Mc/s transmitter constructed by A. L. Mynett, G3HBW, the portable 144 Mc/s Tx/Rx operating from a 6V vibrator pack, constructed by G3MEV, and the 144 Mc/s Tx built by G. C. Fox, G3AEX. All these items were displayed on the UHF Group stand. Two other items of equipment that were of interest were the fully transistorised communications receiver, covering 1.8 to 30 Mc/s, by W. J. Colclough, G3XC, and the very fine, almost-professional home-built receiver covering the 10, 15 and 20 metre bands constructed by J. D. Hays, G3BDQ.

Altogether, this year's show was one of great enjoyment to the writer and, one hopes, to the majority of those who were lucky enough to attend.

BUILDING AN A.C. MAINS Miniature Receiver

by S. E. ADDIS

It is felt by the writer that there still exists a demand by home constructors for the smaller type of receiver of the mains operated type for use in the workshop or at the bedside. This type of set has certain advantages over others in that it takes up little space and is constantly ready for use. In addition, it provides a great interest for those who wish to try their hand at the construction of the miniature receiver.

The set described in this article is the outcome of a great deal of experiment and construction. It provides what the author considers to be the best from designs published in the past and for its size the performance is extremely good, with quality and volume being more than adequate for the purposes mentioned.

Circuit and Component Considerations

Working from the input stage, it was decided that for full coverage medium and long wavebands should be included; but for those constructors who can obtain full coverage on the medium waveband, the long waveband coil can be quite conveniently omitted. This, of course, has the added advantage that no wavechange switching is required.

For the aerial circuit a ferrite rod aerial was tried and will work quite well with this receiver. The disadvantage is that with this little set the ferrite rod aerial has to be mounted quite close to other metal parts and this tends to bring up background noise, particularly on distant stations. It was decided, therefore, to use aerial coils in a superhet circuit with a small throw-out aerial, and this type of set gave maximum performance. In order to maintain the miniature characteristics of this receiver, the smallest components consistent with good performance are used, and in this respect the Osmor range of iron cored coils are specified. The bottom end coupling type are most suitable because, although they require extra condensers and a resistor on the input circuit, they greatly simplify the wavechange switching, thus allowing a smaller switch to be used. For this reason a single bottom end oscillator coil is used for medium waveband reception and this is shunted by a fixed condenser for use on the long waveband.

The tuning condenser is a component which can take up a large amount of space on a small chassis, and as a guide the constructor should endeavour to obtain the smallest possible unit consistent with the highest capacity. Smaller capacities will, of course, give a loss of coverage at the l.f. end of the wavebands.

The valve used as frequency changer is the Osram type X78, and this was chosen because it offers a triode hexode on a B7G base. It should be noted that the cathode of this valve is connected to one pin of the heater, and care should be taken to see that this pin is earthed to chassis. Valve 2 is a Brimar 6BJ6 variable mu r.f. pentode, which was chosen because of its B7G base and low current requirements. The valve is connected as an i.f. amplifier, and a reflex arrangement also allows it to carry out a second function as an l.f. amplifier. This arrangement does not give quite as much gain as two separate valves, but the economy in space makes the reflex circuit well worth while. Due to the low screen voltage on the valve and the damping due to the reflex arrangement, the secondary of the second i.f. transformer tends to tune rather flatly, and in this connection transformers having the highest "Q" consistent with small size should be used. The Osmor miniature i.f. transformers were used in the prototype.

As no signal diode is available in the 6BJ6 valve, a Brimar type GD3 germanium diode is used for signal rectification and a.v.c. bias, and was found to give a very clear signal, particularly on distant stations where the lack of grid hum, so noticeable with diode triodes, was very pleasing.

The final valve in the circuit is a Brimar 6AK6, again chosen for its B7G base and low current consumption. A miniature electrolytic condenser is used in the cathode of this valve, and no feedback arrangements are connected in order to preserve maximum gain from this stage. The anode of the valve is fed with h.t. direct from the rectifier in order to obtain the highest voltage; no noticeable hum was caused by this method of connection. Should hum be troublesome, the connection may be made direct to the smoothed h.t. line. If the first method of connection is made a smoothing resistor of 2 watts rating will suffice. For the second method a rating of 5 watts should be used, and the resistor should be mounted in such a way that any heat will not damage other components.

For the sound output stage it now remained to select a suitable speaker and output transformer. Dealing with the speaker first, it was finally decided to use one of 3½in diameter. A larger size, while improving reproduction, tends to make the layout too bulky. With the smaller sizes there is a serious loss in quality and a tendency to overload. The speaker should be chosen with care, the ideal being one with the smallest back to front measurement. Regarding the output transformer, a type as used in personal portable radios and made by "Radiospares" was used in this design. Although designed for a small battery valve, this transformer, despite its small size, gave a very good performance and after many months of use seems quite able to stand up to the heavier demands made on it in a mains-operated circuit. Regarding the tone correction condenser, one or two values from 0.001μF to 0.01μF can be tried, but it should be remembered that reproduction on a receiver of this size is greatly improved when the set is fitted in a cabinet.

Power Supply

The power requirements of the set are very small, the h.t. being under 25mA and the l.t. 0.6 amp, and therefore it is possible to use a miniature mains transformer of the converter type. The rectifier is of the small half-wave contact-cooled type, and should be bolted flat to a part of the chassis to assist cooling. For smoothing a double electrolytic condenser in a 1in dia. can is used, and the value of 16+24μF 250VW is quite satisfactory. This together with the smoothing resistor completes the power pack, which should be switched by a single-pole switch on the volume control.

Construction

The prototype receiver was constructed on an aluminium chassis size 6in x 3in x 1½in, but final measurements depend upon the component sizes. The receiver should follow the usual "side by side" layout with the h.f. components at one end and the loudspeaker and power components at the other. In the interests of stability a "follow my leader" layout should be adopted from the frequency changer through the i.f. stages to the detector so as to keep all leads as short as possible. The aerial coils may be mounted on the chassis deck, with the oscillator coil below-chassis. Before the final size of the chassis is decided, the components may be laid out to best effect on a sheet of paper and a drawing made of their positions. In this way it is possible to form a very compact layout. When positioning components on the top of the chassis, due care must be taken with regard to what will be mounted underneath so as to avoid complications when fixing the components.

The writer found that the most difficult component to mount is the loudspeaker. If mounted on the chassis an overall height of more than 5in made the receiver too high in proportion. In order to keep the measurement down and at the same time use a chassis of the required depth, a cut-out was made to allow the speaker to sink into it and so reduce the overall height. This results in some loss of space on the underside of the chassis, but is well worth while. Constructors should make a cut-out in stiff cardboard and then transfer the outline to the chassis material for cutting.

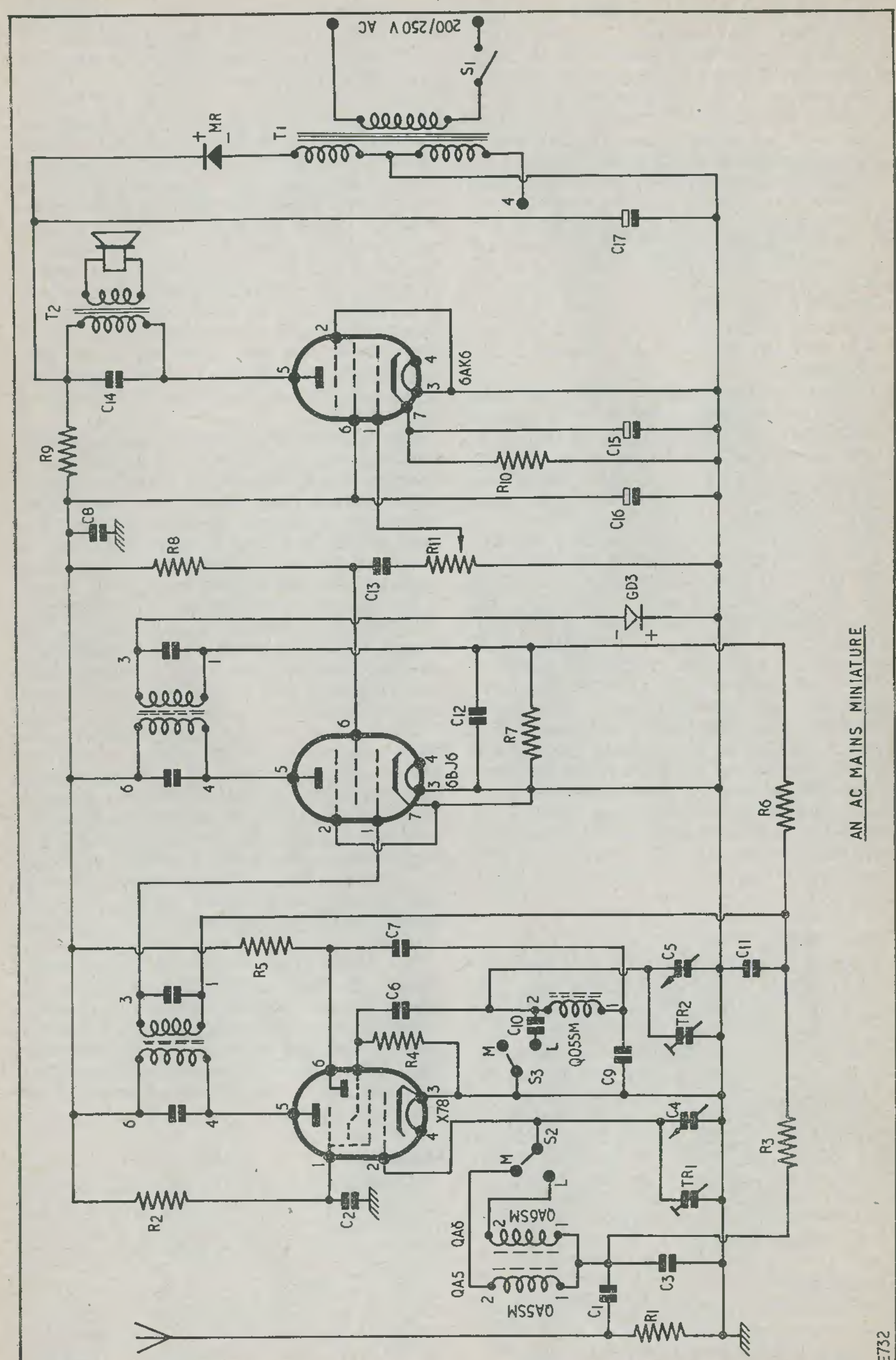
Other ideas will no doubt occur to the home constructor. For instance, a receiver was constructed entirely on a flat panel, the loudspeaker being mounted in the centre and the other components arrayed around it. This very considerably reduces the back-to-front measurement and makes the set useful for standing on a narrow mantelpiece or shelf. In all cases, however, the layout design should enable the leads to be as short as possible.

For safety, the aerial and mains leads should be made detachable by means of small plugs and sockets. This can very often avoid disaster, as if one gets caught up in the leads the set will remain in position rather than suffer damage, the plugs being pulled out. This point is worth considering with all small light receivers.

Alignment

No problems should be encountered with the alignment of the set. The miniature i.f. transformers can be obtained pre-tuned to 465 kc/s, which greatly assists the alignment procedure.

On completion the receiver should be switched on and allowed to warm up. Switch to the medium waveband and turn the volume control to maximum. With the



aerial connected slowly rotate the tuning condenser, searching for the local B.B.C. station which should now be heard. If no signal is available, touch the grid of each valve with a screwdriver. A loud click should be heard in the loudspeaker at each stage if it is working properly. Should no sound be heard each stage should be tested for fault. Having picked up an outside Broadcast signal, the cores of the i.f. transformers should be carefully adjusted for maximum volume. Only a small movement of the cores should be required. As mentioned previously, the cores on the second i.f. transformer will tune with a slight spread due to damping. They should be positioned for maximum volume. The next step is to locate a station as near to 200 metres as possible and adjust the medium waveband trimmer for maximum volume. Tune to a station near to 450 metres and adjust core of medium waveband coil for maximum volume. Return to the 200 metre signal and again adjust trimmer for best performance. Repeat until no further improvement is obtained. Switch to the long waveband, locate B.B.C. Light Programme on 1500 metres, and adjust core of long waveband coil for maximum signal. It will be noted that no trimming adjustments are given for the oscillator stage. These adjustments mainly affect the position in which a given station can be tuned and will depend upon the tuning condenser and dial in use. Unfortunately there are no matched coils, tuning condenser and dial available for such a small receiver. The constructor should study advertisements in *The Radio Constructor*, when it will very often be found that suitable components are being offered. Trimming adjustments are most conveniently carried out at night when a great number of stations can be heard on the medium waveband.

Cabinet

The author has had considerable experience in the construction of the smaller type of receiver, and it has been found that the best type of cabinet is constructed from plywood, covered with leather cloth. An easy way to make a cabinet is to construct it as a complete box, first drilling the front for controls and speaker, and the back for ventilation. After assembly the back may be sawn off. The whole is now cleaned off, covered with leather cloth and assembled with hinges and a small clasp.

It is urged that in any case a cabinet be provided for the receiver, as with this type of set the improvement in quality when in a cabinet is outstanding.

Components List

Resistors

R_1 10kΩ $\frac{1}{2}$ watt
R_2 27kΩ $\frac{1}{2}$ watt
R_3 1MΩ $\frac{1}{2}$ watt
R_4 27kΩ $\frac{1}{2}$ watt
R_5 47kΩ $\frac{1}{2}$ watt
R_6 27kΩ $\frac{1}{2}$ watt
R_7 470kΩ $\frac{1}{2}$ watt
R_8 100kΩ $\frac{1}{2}$ watt
R_9 2kΩ 2 watts (see text)
R_{10} 470Ω $\frac{1}{2}$ watt
R_{11} 1MΩ volume control

Valves

V_1 Osram X78
V_2 Brimar 6BJ6
V_3 Brimar 6AK6
D_1 Brimar GD3

Condensers

C_1 0.01μF T.C.C.
C_2 0.01μF T.C.C.
C_3 0.0025μF T.C.C.
C_4 Half twin gang (see text)
C_5 Half twin gang (see text)
C_6 100pF T.C.C.
C_7 100pF T.C.C.
C_8 0.01μF T.C.C.
C_9 470pF T.C.C.
C_{10} 300pF T.C.C.
C_{11} 470pF T.C.C.
C_{12} 470pF T.C.C.
C_{13} 0.01μF T.C.C.
C_{14} 0.01μF T.C.C.
C_{15} 25μF 25VW electrolytic
C_{16} } 16+24μF electrolytic T.C.C.
C_{17} } 1in can electrolytic T.C.C.

Miscellaneous

TR_1, TR_2, 50pF trimmers
Tuning condenser Jackson type O (type OO for smaller size (reduced coverage))
R_{11} 1-MΩ volume control, with switch S_1
3½in moving coil loudspeaker
Personal portable output transformer, T_2
3 B7G valveholders
Mains transformer 200V, 25mA; 6V, 1 Amp, T_1
2 miniature i.f. transformers type QIFF (Osmor)
3 coils type QA5SM, QA6SM, QO5SM (Osmor)
Contact cooled rectifier
Knobs, dial, plugs and sockets
Mains lead

A Variable Attenuator

by **M. A. HAMMOND**

A TELEVISION RECEIVER SITUATED IN AN area of high signal strength will often display excessive contrast which cannot be reduced to a satisfactory level. This state of affairs can be remedied by fitting an attenuator between the aerial feeder and the input socket of the receiver. The attenuator to be described here, being variable, gives the refinement of selecting the degree of attenuation best suited to the particular case, and one can then leave the unit *in situ* or substitute the more usual fixed attenuator that can be bought from most dealers, which, of course, should correspond to the best "value" selected by the variable unit.

Referring to the circuit diagram Fig. 1, it will be seen that it consists of a switched "T" network of resistors between two co-axial sockets, or, to prevent the use of a further connector between attenuator and set input, a short co-axial lead with plug could be substituted for one of the sockets. It therefore follows that this network is obviously for "unbalanced" feeders, i.e. co-axial cable (usually 70–80 ohms).

The resistor values shown are theoretical but, in practice, the nearest preferred values as indicated in the "remarks" column of the components list will suffice. These are, of course, 5% preferred values (see table on page 851 of *The Radio Constructor*, June 1959), but a satisfactory result could also be obtained by using the nearest 10% preferred range of resistors.

A small diecast box (Eddystone) was found to be a suitable housing with the lid forming the panel on which all components were mounted. It is not proposed to give structural details for making a suitable box, as most constructors prefer to fabricate their own design (which is always better) or use something or other already to hand. Likewise, the tagstrips could even be dispensed with and the wiring suspended around the switch —a matter of personal preference. In the writer's case the layout shown in Figs. 2 and 3 was adopted, and is illustrated for guidance only.

Finally, if it is found necessary to alter the contrast on changing from Band I to Band III (or vice versa), quite obviously the attenuator should be placed in the feeder with the stronger signal, assuming there are two aerial sockets on the receiver and no other method of reducing sensitivity is available. An admirable feature of the writer's television receiver (Spencer-West 172) is the facility for reducing sensitivity of Band I only, which allows the picture signals to be equalised in areas where Band I is greater than Band III. The overall sensitivity of the equalised signals is then adjusted by a separate control.

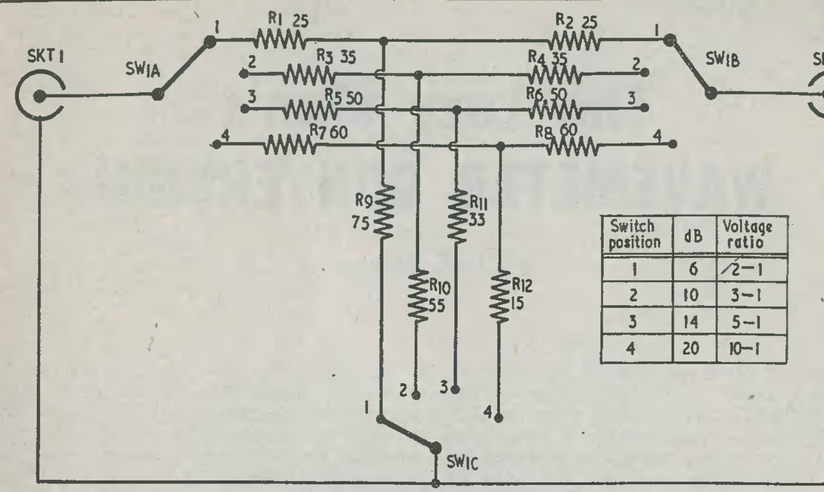
Components List

Resistors

R_1, R_2	25Ω ¼W 5% (theory) Use 24Ω pref. value
R_3, R_4	35Ω ¼W 5% Use 36Ω pref. value
R_5, R_6	50Ω ¼W 5% Use 51Ω pref. value
R_7, R_8	60Ω ¼W 5% Use 62Ω pref. value
R_9	75Ω ¼W 5%
R_{10}	55Ω ¼W 5% Use 56Ω Pref. value
R_{11}	33Ω ¼W 5%
R_{12}	15Ω ¼W 5%

Miscellaneous

SW_1 Switch 3-pole 4-position rotary
SKT_1, SKT_2 Standard co-axial socket
Tagstrip 10-way
or any other suitable arrangement
Tagstrip 4-way (2 reqd)
or any other suitable arrangement
Knob, skirted or pointer type
Box 4½in x 2½in x 1¼in approx.
See text



Switch position	dB	Voltage ratio
1	6	√2–1
2	10	3–1
3	14	5–1
4	20	10–1

Fig. 1
Circuit diagram of variable attenuator

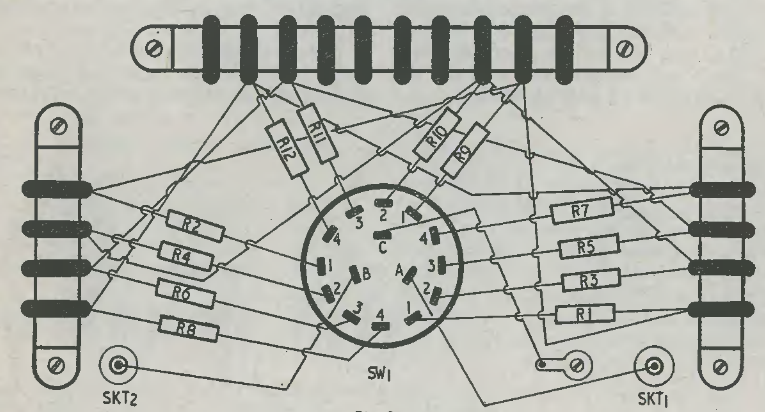
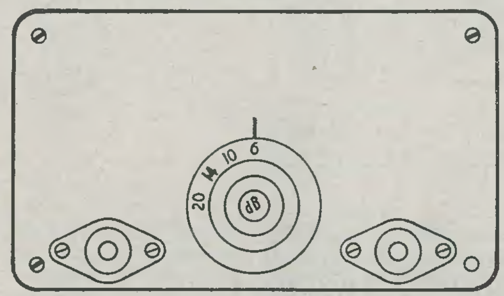


Fig. 2
Wiring



E698

Fig. 3
Front view

The Lazy Man's WAVEMETER CONVERSION

By J. F. Bishop

A FINE WAVEMETER NOW ON THE SURPLUS market at a very low figure is the BC.906D. The tuning range of 145 to 235 Mc/s is useful for the 2 metre and I.T.A. bands. Also, this can be extended by minor modifications which we will come to later. As it stands, this wavemeter is operated by loop input to a tuned cavity and the output is rectified by the diode section of a 1S5 valve, with the resulting d.c. biasing on grid to give a dip on the anode current meter. The power supplies required are 45 volt h.t. battery and 1½ volt l.t. battery.

To replace the valve and convert without a lot of dismantling, the transistor diode assembly was built on to a B7G plug to form a direct replacement for the valve. This plug of rather unusual type may be obtained from Z & I Aero Services Ltd., 14 South Wharf Road, London, W.2, together with the BC906D. "Any" transistor of medium gain and diode may be obtained from a number of sources.

The first step is to remove the l.t. connections to the toggle switch as these are not now required. Then connect a two-pin plug

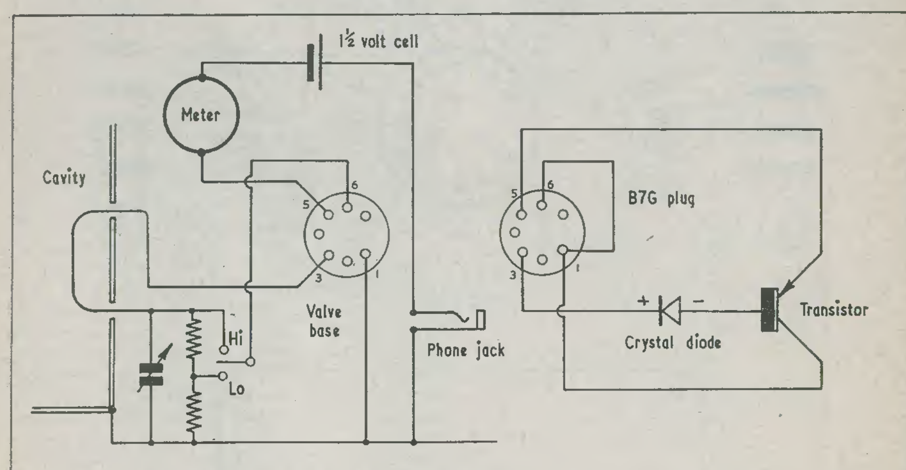


FIG. 1.

If the 1S5 valve is replaced by one of the surplus transistors the battery requirement and the sensitivity is increased by approximately 20dB on the "Hi" range when used on low powers, and sensitivity on "Lo" for high powers is reduced.

to suit AD.35 1½ volt battery to h.t. leads, making the h.t.+ connection go to the negative on battery (transistor live side negative). Change over the leads to the microammeter so that readings will be in correct sense and remove the leads to the meter shunt, which is no longer required. Remove meter shunt and 'phones shunt.

To make up plug-in transistor unit, the crystal diode and transistor are soldered into the B7G plug, taking care to use a heat shunt on leads so as to avoid damage. The transistor collector is taken to pin 5, the emitter to pin 1 and the base connection is joined to negative (black end) of the crystal diode. The red end, or positive, of the crystal diode is taken to pin 3 of the B7G plug, and pin 6 is earthed down to pin 1. This makes the plug-in unit complete for use. (Fig. 1.)

All that remains now is to plug in the transistor and 1½ volt (AD35) supply to unit and test. With "Hi-Lo" switch set to "Hi," a small signal will give a good reading on the microammeter, or phones. But in the "Lo" position quite a large signal will be required to give a reading, which is useful for close field strength checking of transmitter.

To increase the coverage of the unit, the tuning condenser of 18pF can be changed to a 75pF long spindle (ex TR.1196) type. This will increase the range to 75–235 Mc/s, but will entail re-calibration with a signal generator.

The best way to change the tuning condenser is: Firstly, remove the dial by the three holding screws and spindle grub screws (2). Release condenser nut and then withdraw centre line and rear end of cavity (4 screws) complete. Replace in reverse order after changing condenser and unit is ready for re-calibration. To improve performance on the low frequency end of the band, the input loop should be made larger by reshaping.

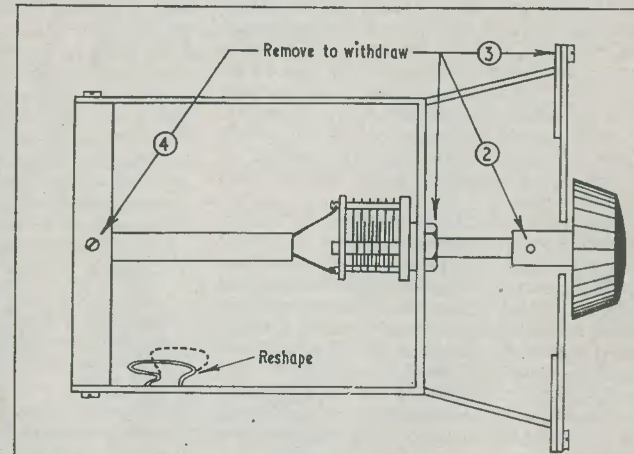


FIG. 2.

Can Anyone Help?

Requests for data are inserted free of charge. Enquirers undertake to answer all correspondence and defray all expenses

Champion Electric A.C./D.C. Radio and Sobell 610 Radio.—R. Low, 45 Millar Road, Saltcoats, Ayrshire, would like to obtain the circuit of the former and any coil details that are available on the latter receiver. All replies dealt with and expenses refunded.

* * *

National HRO Senior.—R. R. Lann, 3 Bath Street, Nairn, Scotland, would like to buy or borrow a manual and, if possible, calibration charts and any "mod" details of this communication receiver.

* * *

Ex-R.A.F. Contactor Master Type 1, No. 10A/10984.—J. Lawson, 76 Victoria Road, London, N.9, would like to obtain information on this unit.

* * *

Triumph Multimeter Model 351.—P. Denny, 73 Stone Street, Tunbridge Wells, Kent, requires a service sheet or manual of this equipment.

* * *

Cossor Portable All-Dry Receiver, AD41.—K. E. Le Masurier, "Aqir", Feugre Cobo, Guernsey, Channel Islands, would like to obtain the servicing sheet or data on the above; purchase if possible, the receiver is a 1945/46 model.

* * *

PCR2 Receiver.—Can anyone help with circuit diagram and alignment data for this receiver, please?—E. Sedman, 4 Galtres Ave., Stockton Lane, York.

* * *

Unit SSR-I-E (CWF 2070).—E. V. S. Samuel, Editor, *The Young Observer*, P.O. Box 116, Colombo, Ceylon, wishes to obtain circuit diagram for this ex-W.D. 5-valve receiver marked externally as above. Willing to pay or send Ceylon stamps.

The Superspeed Soldering Iron

Most readers will be well aware of the sense of irritation which occurs when a small soldering job needs to be done and one has to wait five or ten minutes for the iron to get hot. Again, if it were not for having to wait for the soldering iron to heat up, many odd moments could be snatched to do a little more wiring-up on the new rig, instead of having to wait until one has twenty minutes or so to spare.

Your reviewer, having to renew his soldering iron recently, as the bit was badly burnt away through long periods of overheating, decided to try one of the new Superspeed Soldering Irons. The makers claim that these reach soldering temperature in six seconds, that the thumb controlled switch saves overheating—thus economising in electricity and prolonging the life of the bit—and that the weight and size of the complete instrument make it ideal for intricate radio and electronic work.

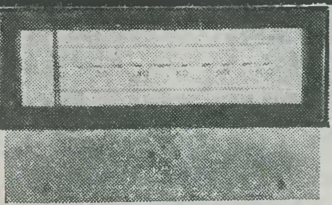
The iron works from a supply of from 2.5 to 6 volts a.c. or d.c. It can be run from a car battery, or used on the work bench from a mains transformer specially supplied for the job.

In use, the instrument came up to all the claims made for it. Its almost instantaneous heating is certainly an outstanding feature, and once one has experienced this freedom from the usual heating-up period it is difficult to imagine going back to the conventional type of iron. The iron is well made, well balanced and of handy size. The transformer supplied for heating it is of adequate size and quality, and a metal strip on top provides a convenient rest for the iron when not in use.

This is an instrument which can be thoroughly recommended and the saving in time, patience, current and expense of replacements makes the higher initial cost very worth while.

Manufacturers: **Enthoven Solders Ltd.**, Upper Ordnance Wharf, Rotherhithe Street, London, S.E.16. *Tel.:* BERmondsey 2014. Retail prices of the soldering iron and transformer are 39s. 6d. and 35s. 6d. respectively. Postage and packing extra.

Fully Guaranteed Components



S. L. 16 DRIVE

A general purpose slide rule drive for FM/VHF units, short-wave converters, etc. Printed in two colours on aluminium, with a 0–100 scale, and provision is made for individual calibrations. Complete with bronze escutcheon and glass.

PRICE 13/9

It's reliable if it's made by Jacksons

JACKSON BROS
(LONDON) LTD.
Kingsway · Waddon · Surrey
Telephone CROydon 2754/5

BUILD YOUR OWN

MAYKIT
TRANSISTORISED CAR RADIO

★ HYBRID DESIGN—5 VALVE SUPERHET, TRANSISTOR AND PRINTED CIRCUIT
★ STANDARD SIZE 7" x 2"—12V BATTERY
★ ALL NEW COMPONENTS—AVAILABLE SEPARATELY OR IN COMPLETE PACK

First and best DO-IT-YOURSELF Car Radio. Uses new Brimar low volt valves, no vibrator. Printed circuit and power transistor. Also MAYKLITE automatic Car Light Switch, single units switches car lights on when dark. £4 complete. Send for free booklet or 3/6 for Car Radio booklet.

Service facilities available

Can be built for £13·10·0 *plus 5/– p. & p.*
Cash with order, C.O.D.,
or write for BUY-AS-YOU-BUILD details

Dept. D MAYRA ELECTRONICS LTD
118 BRIGHTON ROAD . PURLEY
Telephone Bywood 1263

For Safety's Sake use AVO Prodclips

Safety first every time with these patented spring-loaded AVO Prodclips.

Cleverly designed for use as insulated prods, they are invaluable for reaching and holding test points which are difficult of access.

Post Free
15/-
per pair

AVO LTD AVOCET HOUSE
92-96 VAUXHALL BRIDGE RD LONDON SW1
VICtoria 3404 (12 lines)

A member of the Metal Industries Group of Companies

C2

REPANCO
HIGH GAIN COILS

Dual Range Crystal Set Coil, Type DRX1		2/6
Dual Range Coil with Reaction, Type DRR2		4/–
Matched Pair Dual Range T.R.F. Coils, Type DRM3	pair	8/–
Pair Dual Range Superhet Coils, Type SH4	pair	8/–
Miniature Iron Dust Cored Coils, Type "R"	each	3/3

Range	Aerial	H.F.	Osc.
800 2,000 m.	RA1	RHF1	RO1
190 550 m.	RA2	RHF2	RO2
70 230 m.	RA3	RHF3	RO3
15 50 m.	RA4	RHF4	RO4

Ferrite Road Aerial, Dual Range Type FR1		12/6
Miniature I.F. Transformers, Type MSE (465 kc/s)	pair	12/6
Standard I.F. Transformers, Type TCG (465 kc/s)	pair	13/6

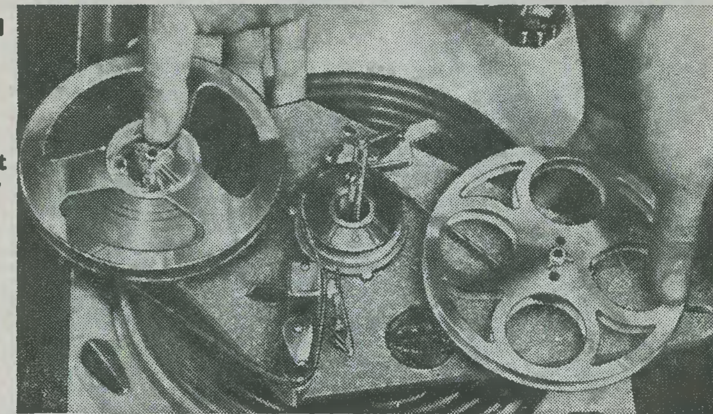
Send S.A.E. for latest Repanco Component Catalogue

Radio Experimental Products Ltd.
33 Much Park Street, COVENTRY
Telephone 62572

A REVOLUTIONARY NEW BRITISH INVENTION!

★ **Uses standard tapes**
★ **Plays at $7\frac{1}{2}$" per. sec. or 3 other speeds**
★ **Records direct from radio or microphone**

Results equal to a £50 recorder — yet costs only £13 12s. (or £17. 11s. complete with special moving-coil microphone and 600 ft. reel of tape).
EASY TERMS



Instantly turns any gramophone into a first-class Tape-Recorder
and back into a record-player in a moment!

Gramdeck is completely *new* . . . a revolutionary and ingenious invention that instantly turns your gramophone into a tape-recorder and back into a gramophone at will! Slip the Gramdeck on to your turntable and you have the finest tape-recorder you've ever heard! Lift it off . . . your gramophone is ready to play records again. There are no motors or valves to go wrong—and *you get reproduction that has to be heard to be believed.*

"Ingenious—simple . . . why on earth did no one think of it before!"—THE TAPE RECORDER.

"Ingenious and robust."—BRITISH SOUND RECORDING ASSOCIATION JOURNAL.

"Quality of reproduction excellent . . . real hi-fi results . . . potential is tremendous . . . both designer and manufacturer should be congratulated."—BRITISH RADIO & TV RETAILERS' REVIEW.

"Better than many so-called hi-fi recorders . . . robust . . . carefully designed . . . excellent value."—AMATEUR CINE WORLD.

Everyone is praising the Gramdeck. "*The quality is at least equal to that obtained from a good microgroove disc,*" says a leading professional journal.

WORKS FROM ANY RECORD PLAYER OR RADIOGRAM

Gramdeck records and reproduces with a wonderful depth and breadth of tone. Because it uses equipment that is already in your gramophone it only costs a fraction of the high-quality tape-recorder you would normally require. Full details, specifications, photographs, easy terms, etc., are given in the Gramdeck Book. Send for your FREE copy today.

MADE BY THE FIRM THAT MAKES MICROWAVE WAVE-GUIDES FOR VISCOUNTS AND BRITANNIAS

FREE BOOK—POST NOW!

I would like to know how to turn my gramophone into a first-class tape-recorder . . . please send me the Gramdeck Book—FREE and without obligation.
(Write if you prefer not to cut coupon.)

NAME ....

ADDRESS ....

....

GRAMDECK (Dept. RC/806)
29 Wright's Lane Kensington London W8

Gramdeck
GRAMOPHONE TAPE RECORDER

GRAMDECK TURNS A TURNTABLE INTO A TAPE-RECORDER

12V D.C. Magnetic Switch. Cuts out on 2 amp. overload or dead short. **13/6.** Prevents burn-outs.
New and Boxed Collaro Conquest 4-speed Record Auto Changers. 200/250V A.C. **£7.19.6.** P.P. 3/6 or B.S.R. ditto, **£6.19.6.** P.P. 3/6.
Mains Transformers. Input 200/250V. Output tapped 3 to 30V 2A or 5, 11, 17V 5A. Each **24/6.**
F.W. Metal Rectifiers. 12/6 volt 1A, **7/6**; 3A, **13/–**; 4A, **17/6**; 6A, **27/6.**
New Base Reflex 12" Speaker, separate 4" tweeter, in floorstand cabinet 22¾" x 8" x 13½", by prominent manufacturer. **£6.15.0.** List Price £15.15.0.
Mains Transformer and Rectifier, giving 12V 1A d.c. output. **19/6.** Ideal for model supply.
Relays. We hold large stocks. Any contact combination and operating coil voltage supplied from **3/–.**
Special Offer. 6V relays with 4-make contacts, **6/–**, 2 for **11/6**, 3 for **16/–.**
Key Switches from **3/–.**
Cossor 3 watt Audio Amplifier Kit with two speakers. **£6.2.6.** List Price £9.15.0.
Toggle Switches d.p.d.t. **3/–.**
Micro Switches, make and break. **5/6.**
Nickel Nife Batteries. 1.2V 2.5A. Size 3" x 2¾" x 1". Practically everlasting. **6/–** or 3 for **16/–**, 4, **21/–.**
Army Morse Keys. 3/–.
Lightweight H.R. Phones. 17/6.
H.S. Twist Drills. Set 7, $\frac{1}{16}$"–¼". **4/–.**

All items post paid, new and guaranteed

LISTS SENT ON REQUEST

Post orders only to

THE RADIO & ELECTRICAL MART

29 STATION APPROACH SUDBURY TOWN WEMBLEY MIDDX

PROTECT YOUR CAR AT NIGHT

PHOTOELECTRIC PARKING LIGHT SWITCH

will switch your lights on at dusk—off at dawn, automatically, while you are at work, in bed, or away from home. Controlled by light. Transistorised. Negligible consumption (.008 amp.). Avoid accidents, fines. Save your battery.

Kit of parts	**52/6**
Built and tested	**57/6**
Instructions only	**1/–**

Pat. applied for *Money back guarantee*

ST. JOHN'S RADIO

156 ST. JOHN'S HILL SW11 BATtersea 9838

L. F. HANNEY

77 LOWER BRISTOL ROAD BATH

TRANSISTORS

Red Spot, 5/–; White Spot, 6/6; Brimar TS1 6/– (Audio). **Ediswan** XA104, 18/–; XA103, 15/–; XB102, 10/–; XB104, 10/–; Genuine **Mullard** OC44, 26/–; OC45, 23/–; OC71, 14/–; OC72, 17/–; 2 x OC72 (matched), 34/–. (All post free.)

All Repanco, Teletron, Ardente components in stock, and miniature resistors, condensers, speakers, etc.

Shopping List available for **Mullard Amplifiers** described in "Circuits for Audio Amplifiers."

S.A E. for LIST please.

Get these

CIRCUITS & WIRING DIAGRAMS

T.R.F. Circuits	Mains Circuits	Send
Battery Circuits	Filter Circuits	1/–
Portable Circuits	TV Converter Circuits	(stamps)
S'het Circuits	etc., etc.	

OSMOR COILS are regularly used and recommended by designers writing in "Practical Wireless," "Wireless World" and "Radio Constructor." Why not follow the experts?

"Q COILS" All ranges • POTTED COILS • FM COILS
SPEAKER CROSS-OVER COILS
TAPE COILS • ROD AERIALS
SUB MINIATURE COILS
COILS and I.F.s for Transistor Circuits • MIDGET I.F. TRANS With ferrite cores

OSMOR **418 Brighton Road South Croydon**

Telephone CRO 5148/9

REPANCO MINI-3

A new local station pocket transistor Radio.

- Size 5in. x 3⅛in. x 1⅜in.
- Long and Medium Wave.
- Dual Ferrite Aerials.
- Loudspeaker reception.
- Regenerative RF Reflex Circuit.

Send Now! 1/6 (post free) for easy wiring plans, instructions and price list.

Mail Order and Trade:

RADIO EXPERIMENTAL PRODUCTS LTD

33 Much Park Street COVENTRY

Telephone 62572

Wholesale Enquiries and Export:

REPANCO LTD

O'Brien's Buildings 203-269 Foleshill Road COVENTRY

Telephone 40594

Premier RADIO

23 TOTTENHAM COURT ROAD LONDON W1 *Telephone* MUSeum 3451/2

The "Petite" PORTABLE

MAY BE BUILT FOR £7.7.0 plus 3/– P. & P.

Batteries extra.
HT 10/– (Type B126) or equivalent.
LT 1/6 (Type AD35) or equivalent.
★ Size only 8" x 8" x 4½".
★ Instruction book 1/6.
Battery Eliminator, available in component form price **37/6** plus 2/– P. & P.

Why not convert your battery portable to mains operation with the **COSSOR MU2 BATTERY ELIMINATOR?**

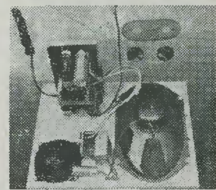
This Eliminator is completely assembled and supplied with 4ft of Mains Lead and Torpedo Type of On/Off Switch. It is housed in 2 Metal Containers approximately the same size as the AD35 and B126 Batteries, and suitable for such receivers as the Cossor 543, 551 and 552 or receivers operating on 1.4V L.T. and 90V H.T. for use on 200–250V A.C. mains. Size: L.T. Unit 3" x 2¼" x 1⅝", H.T. Unit 4" x 2¾" x 2". Original price 3 gns. OUR PRICE for a limited period only, **37/6** plus 2/– P. & P.

VISIT OUR NEW BRANCH AT
309 EDGWARE ROAD · LONDON W2
Telephone PADdington 6963

THE BEREC

Battery Receiver for only **£4.19.6** plus 5/– p. & p., or **£1** deposit and 5 monthly payments of **19/–.** This receiver is ideally suitable for use in the home or where normal electricity supply is not available, remarkable reception on both medium and short wavebands, incorporating the following latest type miniature battery valves: DK92, DF96, DAF96, DL96, and operates on an external B103 battery or equivalent. It is housed in an attractive two-tone metal case. Size 11½" x 7½" x 5¼" Battery EXTRA, **18/6.**

THE FAMOUS COSSOR
3 watt Audio Amplifier Kit 562K



Original Price £9.15
Our Price £5·19·6
P. & P. 2/6

This Kit when assembled will provide a compact versatile amplifier which incorporates the most up-to-date printed circuit and is suitable for operation from radio, microphone and gramophone. The circuit design includes negative feedback and two high performance loudspeakers are used which ensures high quality output. All items are supplied including 10" x 6" loudspeaker, a 4" treble speaker and even solder

---

FREE TO AMBITIOUS ENGINEERS

— THE LATEST EDITION OF ENGINEERING OPPORTUNITIES

Have you sent for your copy?

ENGINEERING OPPORTUNITIES is a highly informative 156-page guide to the best paid engineering posts. It tells you how you can quickly prepare at home for a recognised engineering qualification and outlines a wonderful range of modern Home Study Courses in all branches of Engineering. This unique book also gives full details of the Practical Radio & Electronics Courses, administered by our Specialist Electronics Training Division—the *B.I.E.T. School of Electronics,* explains the benefits of our Employment Dept. and shows you how to qualify for five years promotion in one year.

We definitely Guarantee
"NO PASS—NO FEE"

Whatever your age or experience, you cannot afford to miss reading this famous book. If you are earning less than £20 a week, send for your copy of "ENGINEERING OPPORTUNITIES" today—FREE.

WHICH IS YOUR PET SUBJECT?

Mechanical Eng., Electrical Eng., Civil Engineering, Radio Engineering, Automobile Eng., Aeronautical Eng., Production Eng., Building, Plastics, Draughtsmanship, Television, etc.

GET SOME LETTERS AFTER YOUR NAME!

A.M.I.Mech.E.
A.M.I.C.E.
A.M.I.Prod.E.
A.M.I.M.I.
L.I.O.B.
A.F.R.Ae.S.
B.Sc.
A.M.Brit.I.R.E.
City & Guilds
Gen. Cert. of Education
Etc., etc.

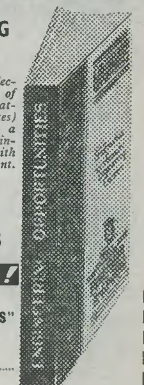
PRACTICAL EQUIPMENT

Basic Practical and Theoretic Courses for beginners in Radio, T.V., Electronics, Etc., A.M.Brit.I.R.E. City & Guilds Radio Amateurs' Exam. R.T.E.B. Certificate P.M.G. Certificate Practical Radio Radio & Television Servicing Practical Electronics Electronics Engineering Automation

INCLUDING TOOLS!

The specialist Electronics Division of B.I.E.T. (incorporating E.M.I. Institutes) NOW offers you a real laboratory training at home with practical equipment. Ask for details.

B.I.E.T. SCHOOL OF ELECTRONICS



POST COUPON NOW!

Please send me your FREE 156-page "ENGINEERING OPPORTUNITIES"
(Write if you prefer not to cut page)

NAME ....

ADDRESS ....

....

....

SUBJECT OR EXAM THAT INTERESTS ME ....

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY *(Incorporating E.M.I. Institutes)*
(Dept. SE/23), 29 Wright's Lane, London, W.8

THE B.I.E.T. IS THE LEADING ORGANISATION OF ITS KIND IN THE WORLD

Record Changers

BRAND NEW. GUARANTEED

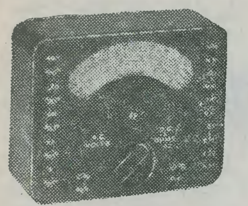
GARRARD 4-SPEED SINGLE PLAYER
★ GC2 head ... ... **£6.19.6,** P.P. 3/6

B.S.R. UA8 4-SPEED AUTO-CHANGER
★ Brand new ... ... **£6.19.6,** P.P. 3/6

B.S.R. UA8 4-SPEED AUTO-CHANGER
★ Wired for stereo ... **£8.19.6,** P.P. 3/6

COLLARO CONQUEST 4-SPEED AUTO-CHANGER **£7.19.6,** P.P. 3/6

Avo-Minor Multimeter



0–500V a.c./d.c. in 5 ranges.
0–500mA d.c. in 5 ranges
Resistance 0–20kΩ
Complete with leads and leather case
79/6 P.P. 2/–
(In new condition)
Fully Guaranteed
A bargain buy for the home constructor.

Microphone Inserts (P.P. 6d. Any Type)

CRYSTAL:

ACOS ...	23–4 ...	1½" square ...	7/6
ACOS ...	19–4 ...	1¾" round ...	14/–
ACOS ...	14 ...	1½" round ...	7/6
ACOS ...	6–9 ...	2" round ...	12/6

MAGNETIC:
Hearing aid type miniature magnetic "full-tone" insert (List 30/–) ... ... each. **15/–**

Crystal Microphones

ACOS 39–1 Stick Microphone with Stand (List 5 gns.) **39/6.** P.P. 1/6

ACOS 40 Desk Microphone with built-in stand. (List 50/–). **25/–**, P.P. 1/6.

FREE LISTS By return of post

1. Meters: Vibrators: Surplus Units: Test Equipment
2. Quartz crystals over 600 for all purposes–2 pages
3. Transformers Mains and Audio: Electrolytic Condensers: Potentiometers: Switches and Controls–4 pages
4. Transistors, Transistor and Miniature Components
5. Valves, T.V. and 'Scope Tubes and Equivalents

UNBEATABLE VALVE PRICES!

ALL GUARANTEED: SEND FOR FREE COMPLETE LIST OF OVER 600 TYPES. INCLUDES TX, TUBES AND INDUSTRIAL UNITS.

0A2	10/–	3V4	7/6	6C4	5/–	6SL7	6/–	12K8	10/–	83V	10/–	DK91	7/–	KT33C	8/6
0B2	10/–	5R4G	8/6	6C5	5/–	6SQ7	6/–	12SC7	6/–	83	10/–	DL91	7/–	KT66	12/6
0Z4	5/–	5V4	10/–	6F6	7/6	6SR7	6/–	12SG7	6/–	807	5/–	DK92	7/6	KTW61	6/6
1A5	5/–	5X4G	10/–	6F8	7/6	6SS7	6/–	12SH7	6/–	807USA	7/6	DL94	7/6	KTW63	5/–
1A7	12/6	5Y3GT	6/–	6F12	5/–	6U4	12/6	12SJ7	6/–	AC/SG	10/–	DM70	8/6	MVS PEN	
1C5	10/–	5Y4G	10/–	6F32	7/6	6U7	5/–	12SK7	6/–	AC2PENDD		EB91	5/–		10/–
1H5	10/–	5Z3	10/–	6F33	5/–	6V6G	6/–	12SQ7	8/6		12/6	EBC33	6/6	MS PEN	10/–
1L4	5/–	5Z4G	8/6	6J5M	5/–	6V6GT	7/6	14S7	14/–	AC/PEN	10/–	EF50	4/–	MU14	7/6
1LD5	5/–	5Z4M	10/–	6J7M	7/6	6V6M	10/–	25A6	10/–	AC/VP1	10/–	EL32	5/–	MX40	10/–
1LN5	5/–	6A7	9/–	6K7G	5/–	6X4	6/–	25L6	10/–	AC/VP2	10/–	EL33	12/6	N14	10/–
1N5	10/–	6A7	9/–	6K7M	7/6	6X5GT	5/–	25Z4	9/–	AR8	5/–	EM34	7/6	PEN4VA	
1R5	7/–	6AB8	10/–	6K8M	10/–	7A7	9/–	25Z5	9/–	AZ31	10/–	EM80	10/–		10/–
1S4	7/–	6AC7	5/–	6L6M	10/–	7D5	10/–	25Z6GT	10/–	CL33	12/6	EM81	10/–	PEN25	5/–
1S5	6/6	6AG5	5/–	6Q7G	7/6	7D6	10/–	28D7	4/–	CY1C	10/–	EM85	11/–	PEN46	5/–
1T4	6/–	6AK5	6/–	6R7	6/–	7S7	9/–	3Z55	8/6	DAC32	10/–	FC4	10/–	PP36	10/–
3A4	7/–	6AL5	5/–	6SA7	6/–	7Y4	7/–	42	7/6	DAF91	7/–	FW4/800		PX25	12/6
3A5	9/–	6AM5	5/–	6SC7GT	7/6	9D6	5/–	43	10/–	DCC90	9/–		10/–	QP21	5/–
3D6	4/6	6AM6	5/–	6SG7	6/6	12AH7	6/–	50B5	10/–	DF91	7/–	GZ32	11/–	QP25	6/6
3Q4	7/6	6B8G	4/6	6SH7	5/–	12AU6	9/–	50C5	10/–	DH63	7/6	GZ34	11/–	SP4	10/–
3Q5	9/–	6BR7	12/6	6SJ7	6/–	12BE6	10/–	75	10/–	DK32	12/6	HL23/DD		TDD4	10/–
3S4	7/–	6BW6	8/6	6SK7	6/–	12J7	10/–	80	8/6	DK40	10/–		6/6	U50	6/–

P.P. 6d. per valve. Orders above £3 post free.

"PRACTICAL TRANSISTOR CIRCUITS"

A booklet produced for the home constructor containing transistor circuit diagrams, practical layouts, data and information. All components used are readily obtainable from us.

(1ST EDITION) **2/–** POST FREE

TO **HENRY'S RADIO LTD**
Enclosed please find remittance value 2/– for "Practical Transistor Circuits," Radio Receiver Leaflets and Components Lists.
RC4
NAME ....
(BLOCK CAPITALS, PLEASE)
ADDRESS ....
....

	ALL TRANSISTOR UNITS DESCRIBED	Total Cost	P.P.
1	Radio Control Receiver (27 Mc/s) ...	50/–	1/–
2	R.F. I.F. Generator (450 kc/s to 3 Mc/s)	25/–	1/–
3	Light Operated Switch	27/6	1/–
4	Square Wave Generator (Audio) ...	20/–	1/–
5	Signal Tracer (Audio I.F. R.F.)	37/6	1/6
6	Hearing Aid Amplifier	95/–	1/–
7	3-Channel Audio Mixer	42/6	1/–
8	Audio Generator	25/–	1/–
9	Addon Amplifier (250mW powerstage)	59/6	1/6
10	2 Watt Power Stage (for Continental, etc.)	52/6	2/–
11	Baby Alarm—100% safe	92/6	2/–
12	Top Band Transmitter (1.8 to 2 Mc/s) ...	57/6	1/6
13	3 to 12 Mc/s Xtal Osc.	22/6	1/–
14	35 Metre C.W. Transmitter	27/6	1/–

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

Opposite Edgware Road Tube Station. *PADdington* 1008/9 OPEN MONDAY to SAT. 9–6, THURS. 1 o'clock.

ANNOUNCING: Entirely New Design in Transistor Portable Radios!

"CONTINENTAL–6" Combined Portable/Car Radio

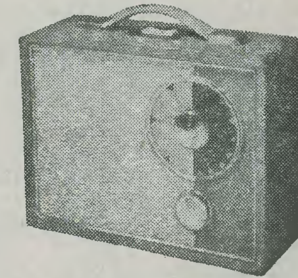
"Medium and Long Wave Full Tuning". *For Style, Quality Performance and Value for Money.*

★ Plessey Printed Circuit
★ 6 Ediswan Transistors
★ 5" High Fidelity Speaker
★ 400mW Push-Pull Output
★ Internal Ferrite Aerial
★ Slow Motion Tuning
★ Full Instructions
★ Printed Circuit marked with Component Numbers
★ Trimming Tool Supplied
★ Double Tuned I.F.s

All components available separately. Send for descriptive leaflet and prices.

Total Cost of all Components
£11.10.0
including Cabinet, Car Radio, AVC and all Components (P.P. 3/6)

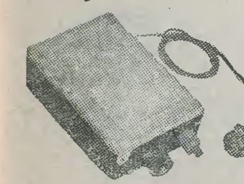
A highly sensitive and selective portable fully tuneable on medium and long waves. Performs equally well as a car radio. Low running costs, good looks and care of construction combine to produce a radio equal to any commercial receiver in the 20 gns. class.



Size 9½" x 7" x 3¼" Weight 4lb

All Components for the Popular **"TRANSISTOR-8" £10.19.6** P.P. 2/6 *FREE BOOKLET*

MAJOR–3 (*3-Transistor Radio*)

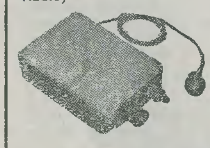


★ 5-stage Reflex Circuit
★ No Aerial or Earth
★ Min. Volume Control
★ 3 Ediswan Transistors
★ Medium Wave Tuning
★ Size 4½" x 3" x 1¼"
★ Personal phone

(As described in R.C., Sept. '59

Complete **87/6** P.P. 1/6
NEW EASY-TO-FOLLOW BOOKLET
RECEPTION GUARANTEED ANYWHERE

MAJOR–2 (*Two-Transistor Pocket Radio*)



★ 4-stage reflex
★ Medium wave; tuneable!
★ Very sensitive
★ No aerial or earth
★ Complete layout
★ Over 6 months on one battery
★ 4½" x 3" x 1½"
★ Weight only 4 ozs
★ Personal phone

Complete **69/6** P.P. 1/6
EASY-TO-FOLLOW BOOKLET
All components sold separately
GOOD RECEPTION ANYWHERE
(NOTE: PLEASE BEWARE OF IMITATIONS)

MINOR–1 (*Transistor Pocket Radio*)

★ 3" x 2" x ¾"
★ Medium Wave
★ 3-Stage Reflex
★ Internal Aerial
★ Smallest yet
★ Personal phone

All components with case and phone **49/6.** P.P. 1/6
THE SMALLEST WORKING RECEIVER WITH BUILT-IN FERRITE AERIAL EVER OFFERED
All parts sold separately *Diagram and List Free*

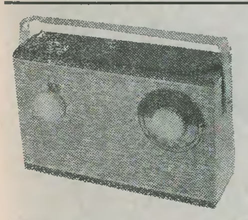
TRANSISTORS From 5/- ea.

Fully Guaranteed

SBO78 10 Mc/s, **10/–**; SB305 25 Mc/s, **15/–**; SB231 30 Mc/s, **22/6**; SB231R 50 Mc/s, **30/–**; OC170 70 Mc/s, **35/–**; XC121 250mW, **17/–**; (*Matched pairs* 500mW) XC131 500mW, pairs, **34/–**; V15/10P 10 watt, **17/6**; Red Spot, **5/–**; White Spot, **7/6**; XB104, **10/–**; OC44, **26/–**; OC71, **14/–**; OC45, **23/–**; XC101, **16/–**; XA104, **18/–**; XA103, **15/–**.

Free complete list and data on request.

"SUPER-SIX" Transistor Portable Superhet



★ Medium and Long Waves
★ 6 Mullard Transistors
★ Printed Circuit
★ Sensitive and Selective
★ Ferrite Rod Aerial
★ 3" 150Ω Speaker
★ Full Assembly Instructions
★ Size 7" x 2" x 1¾"
★ Trimming Tool supplied

Complete set of parts including attractive cabinet
£9.10.0.
P.P. 2/6
All parts sold separately

High sensitivity and selectivity combine to give excellent reception on both medium and long waves, this set is recommended by us as being one of the easiest-to-build printed circuit transistor sets ever offered.

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

At junction of Edgware Road and Harrow Road *Telephone* **PADdington 1008/9**

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 12th of the month for insertion in the following month's issue. The Publishers cannot be held liable in any way for printing errors or omissions, nor can they accept responsibility for the bona fides of advertisers.

PRIVATE

WANTED. Soundmaster Tape Recorder, faulty or unfinished kit acceptable.—Box No. F100.

OSMOR "MINIMAGIC" VHF-FM TUNER. Ready assembled but requires simple alignment, full instructions supplied. Page 156, October '57 *The Radio Constructor* for similar circuit, £3 10s. complete. Components alone normally £4 10s.—Box No. F101.

BARGAIN PARCEL. Useful resistors, capacitors trimmers, valves, 5s. to clear stock.—59 Featherstone Road, Stevenage, Herts.

VIEWMASTER. Chassis complete with valves, aluminised tube, E.E.H.T., £3.—21 Manor Way, North Middx. Harrow,

FOR SALE. New assembled Jason Crystal Calibrator CC10, £20. Valve Voltmeter EM10, £22. Audio Generator AG10, £16. C.W.O.—Mines, 41 Sandringham Road, Bitterne Park, Southampton.

FOR SALE. Radiogram, 4 speed Hi-G pick-up, Medium and Long Wave, £12. 10s. Also mains motor, 3,600 r p.m., 12s. 6d.—L. Harrison, Fritwell, Bicester, Oxon.

FOR SALE. PCR3 Receiver, as new, with internal power pack, £10 o.n.o.—26 Tavistock Road, Launceston, Cornwall.

AMATEUR DISCONTINUING HOBBY. Valves, speaker, components, etc., £2, bargain.—Woodward, 42 Grosvenor Road, Southport, Lancs.

TO CLEAR. Box capacitors, approx. 30, high values, 12s. 6d. Box assorted audio transformers, approx. 20, 17s. 6d. Box assorted meters, amp. and mA, 30s. Box assorted switches, plugs, sockets, 10s. Labgear coils DSL/14 and 21, 5s. 6d. each. G.E.C. Bell Transformers, 200–250V in 4–8–12V out, 10s. Mains transformer, 350–0–350: 5V 2A; 5V 2A; 6.3V 2A; 2V 2A; £1. Rotary, 12V in 285V 60mA out; 12s. 6d. Rotary, 12V in 480V 40mA out, 12s. 6d. Ext. speaker, wood cabinet, 14 x 14 x 7in, 12s. 6d. VHF Wavemeter Type W. 1549, 10s. Valves: 6V6, 6K6, 12AT7, DL92, 807, 6BW6, 6BR7, 6AG7, 6SA7, 6SK7, VT136, 6AG5, 6AT7, at 5s. 6d. each. 36 assorted *QSTs*, mostly pre-1952, 10s. Ditto, mixed *QST*, *CQ* and *R.S.G.B. Bulletin*, 10s. 50 assorted *Bulletins*, pre-1953, 10s. Bound vols. *Bulletin*, 15–19 and 21, 5s. each. Gyro demonstration model with rotary, 12V input, £1. UG9 High Speed Marconi Morse Recorder, new, £10. Model 9W Morse Code Perforator, keyboard, 230V a.c. £10. Fractional H.P., a.c. motor, £1. Postage and packing included in above prices—"East Keal" Romany Road, Oulton Broad, Lowestoft, Suffolk.

TRADE

MATHEMATICS. Key for Radio/TV, 12s. 6d., or conversion course, 42s.—Write Tutorial Mathematics, 200 Buchanan Street, Glasgow.

SERVICE SHEETS. From 1s. 100 TV sheets, 18s. 6d. Radio and TV electronic books. Valves from 1s. 6d. 50 new resistors, 5s. 6d.; 25 condensers, 5s. 6d.; 12 electrolytics, 5s. 6d. Crystal Set kit, 8s. 6d. Transistor kit, 28s. 6d. Loudspeakers (used), 9s. Lists, 3d.—Hamilton Radio, 237 Sedlescombe Road North, Hastings.

continued on page 479

CLYNE RADIO LTD.

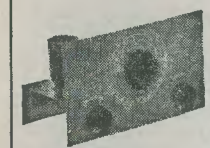
Specialists in Equipment for Home Construction (Send stamp for complete list)

ALL POST ORDERS AND CORRESPONDENCE TO
162 HOLLOWAY ROAD · LONDON N7
NOR 6295/6/7

18 TOTTENHAM COURT RD. LONDON W1
MUS 5929/0095
Callers welcome at both branches

NEW! FOR THE CONSTRUCTOR

Super One Valve Short Wave Radio



World Wide Coverage at most reasonable cost. Covers 40–100 metres with the coil supplied. Can be extended to cover 10–100 metres. Provision is also made for the addition of two extra valve stages. Employs the famous Acorn type 954 valve. All necessary components can be supplied complete with full assembly instructions at ONLY 35/– plus 2/– P. & P. Send 2/– for point-to-point wiring diagram and price list.

Super Personal Portable

A wonderful little set that you can take anywhere. Ideal for camping, picnics, etc. Detachable aerial rod supplied. Covers Medium Waveband 200–500 metres. Can be built in approx. 1 hour. All necessary components available at the following SPECIAL INCLUSIVE PRICES: 1-Valve Version ONLY 35/–. Super 2-Valve Version ONLY 41/–, plus 2/– P. & P. Send for point-to-point wiring diagram and parts price list, 2/– post free. Extra for use with the above DLR5 balanced armature headphones 7/6 pair.

Two-Transistor Personal Portable

This is an amazing little receiver with built-in aerial, and small enough to be held in the palm of the hand. Medium Wave reception at wonderful volume. Supplied with drilled chassis and colour coded components. Easily assembled with the aid of the easy-to-follow assembly instructions provided. Total cost of all necessary components, including transistors, deaf aid type earpiece, wiring wire and even solder. ONLY 69/6, P. & P. 1/6. Parts price list and Easy Lay-out Plans 2/– post free.

WONDERFUL BARGAINS

PLESSEY CHASSIS FOR SPARES. All this for only 9/6
56 resist, 7 variable. Controls. Condens., incl. electrolytics. Coils. 7 I.F. and R.F. transf.; 14 v/holders. 9 B7G—5 B5G—3 octal. 4 transf. mains—O.P.—line—frame. Chokes. Metal rec., 300 volt 250 mA, fuse panel, scanning coil, focus magnet, plugs, sockets, switch, and chassis screws. Tagstrips, etc., I.F. strip in separate power pack can be used without dismantling. Chassis have been used, but were working when stored. 7 pages of circuits and instructions showing position of each component. Carr. 10/6.

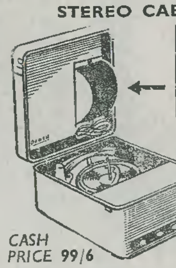
EXTENSION SPEAKER 19/6, in polished cabinet. Fitted with 8″ P.M. speaker 2—ohms, switch and flex. P. & P. 3/6.

8″ P.M. SPEAKER, 5/9. Have a slight cone repair not affecting the quality. Tested and guaranteed. P. & P. 2/9.

ELLIPTICAL SPEAKER, 19/6. 9½″ x 4½″. Ideal for record players, etc. P. & P. 2/6.

STEREO CABINET

"PERTH" PLAYER CABINET



As shown at the Radio Show. In two tone colour. Extension speaker to match, which is secured in lid (arrow indicates position when fixed). Size: 18″ x 14″ x 8½″ high. P. & P. 5/6.

AMPLIFIER—ELLIPTICAL SPEAKER can be obtained from us to make this a player to be envied by your friends. Complete player normally retails at 35 gns.; 6/1 deposit. Balance at 4/11 for 19 weeks.

★ ★ TRANSFORMERS ★ ★

MAINS AUTO TRANS., 8/9. 0–205–225–245V at 300mA. Isolated windings of 6.3V at 3.5A–6.3V at 2.5A–2V at 1.4A. P. & P. 3/9.

MAINS TRANS., 5/9. Prim. 200/250V Sec. 0–100–250V at 150mA. Suitable for small amplifiers. Size 2¾″ x 1½″. P. & P. 1/9.

MAINS TRANS, 7/9. Prim. 200/250V. Sec. 300–0–300V. 6V at 3.3A. P. & P. 2/9.

MAINS TRANS., 6/9. Prim. 200/250V Sec. 300–0–300V. 6.3V at 3A, 5V at 2A. P. & P. 2/9.

FRAME O.P. TRANS., 1/9. 500 ohms Prim., 18 ohms Sec. P. & P. 1/6.

EY51 ISOLATION TRANS., 5/9. 7V. 1–1 ratio. P. & P. 1/9.

O.P. TRANS., 1/3. Std. size 2–5 ohms. P. & P. 1/–. 20 for £1. Carr. 5/6.

Stamp for FREE catalogue UK only

Dept. C1
PP COMPONENTS LTD.
219 ILFORD LANE ILFORD ESSEX
Telephone: ILF 0295

TRADE—*continued*

continued from page 477

CATALOGUE No. 14. Government surplus and model radio control, over 500 illustrated items, 2s. (refunded on purchase) p.p. 6d.—Arthur Sallis Radio Control Ltd., 93 (E), North Road, Brighton.

"MEDIUM WAVE NEWS" monthly during DX season.—Details from B. J. C. Brown, 196 Abbey Street. Derby.

JOIN THE INTERNATIONAL S.W. LEAGUE. Free Services to members including Q.S.L. Bureau. Amateur and Broadcast 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 SWLs, Transmitter Section 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., 21s. per annum. —Secretary, ISWL, 12 Gladwell Road, London, N.8. *Telephone* FITzroy 1019.

AT LAST—at a reasonable cost—quality Hi-Fi in your home by building it yourself under our new system. FREE Brochure from: Dept. RC21, Radiostructor 40 Russell Street, Reading, Berks.

LEARN RADIO AND ELECTRONICS the NEW Practical way Very latest system of experimenting with and building radio apparatus—"as you learn". FREE Brochure from: Dept. RC10 Radiostructor, 40 Russell Street, Reading, Berks.

MORSE CODE TRAINING. Special courses for Beginners. Full details from (Dept. R.C.) Candler System Company, 52 Abingdon Road, London, W.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 3s. 9d. from G. A. Miller, 225 Nether Street, London, N.3.

"WORLD RADIO HANDBOOK". Copies available, 1960 Edition, 16s. 6d., inc. post and packing from ISWL, 12 Gladwell Road, London, N.8. *Telephone* FITzroy 1019.

1,000 INTERESTING ITEMS. List 3d.—Rogers, 31/33 Nelson Street, Southport, Lancs.

TECHNICAL WRITING IN ELECTRONICS, Radio and TV Instruction Books, Service Manuals, Brochures, Technical Drawings, etc.—F. C. Judd, A.Inst.E., Rotech, 152 Maybank Road, London, E.18. *Telephone* BUCkhurst 9315.

HIGH CLASS DUPLICATING, Electronic Stencil Illustrations, circuits, etc. Sheets or booklets. —Rotech, 152 Maybank Road, London, E.18. *Telephone* BUCkhurst 9315.

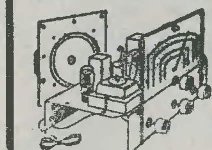
INCORPORATED Practical Radio Engineers home study courses of radio and TV engineering are recognised by the trade as outstanding and authoritative. Moderate fees to a limited number of students only. Syllabus of Instructional Text is free. *The Practical Radio Engineer*. journal, sample copy 2s. 6,000 Alignment Peaks for Superhets, 5s. 9d. Membership and Entry Conditions booklet, 1s., all post free from the Secretary, I.P.R.E., 20 Fairfield Road, London, N.8.

THE INTERNATIONAL HAM HOP CLUB is a non-profit-making organisation open to RADIO AMATEURS AND SHORT WAVE LISTENERS. OBJECT: To improve international relationships through an organised system of hospitality. MEMBERS offer over-night hospitality to visiting members, entrance fee 2s. 6d. ASSOCIATE MEMBERS invite radio amateurs to visit their stations. S.A.E. for FREE Associate membership. FAMILY EXCHANGE holidays arranged, also FRIENDSHIP LINKS between radio clubs. H.H.C.'s official journal, *Ham Hop News*, 5s. per annum. Hon. Gen. Secretary: G. A. Partridge, G3CED, 17 Ethel Road, Broadstairs, Kent.

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 12th of the month for insertion in the following month's issue. The Publishers cannot be held liable in any way for printing errors or omissions, nor can they accept responsibility for the bona fides *of advertisers.*

SUPER CHASSIS 79/6 5-valve superhet chassis, including 8″ p.m. speaker and valves. Four control knobs (tone, volume, tuning and w/change). Four wavebands with position for gram, p.u. and ext. speaker. A.C. Ins. carr. 5/6.



IDEAL RADIO CHASSIS 39/6
5-valve s/het a.c. radio or radiogram chassis. 3 w/band and gram switched. 8″ p.m. speaker included. Valve line-up: 6K8, 6K7, 6Q7, 6V6, 5Z4 (not included). Chassis size 19½″ x 7½″ x 9″. Knobs 2/– extra. Ins. carr. 5/6.

EXTENSION SPEAKERS 19/6
Polished oak cabinet. Fitted with 8″ p.m. speaker of the highest quality, std. matching to any receiver 2–5 ohms. Switch and flex included. P. & P. 3/9.

8″ P.M. SPEAKERS 8/9
A good quality speaker suitable for extensions or stereophonic. Std. 2–5 ohms. Fit one in the kitchen for the wife! P. & P. 2/9. Fitted with o.p. trans 10/– plus post.

CHASSIS CABINETS COMPONENTS
Stamp for FREE catalogue
TERMS—INTEREST FREE

DUKE & CO (Dept. K1) ILF 6001–3 621 ROMFORD ROAD MANOR PARK E12