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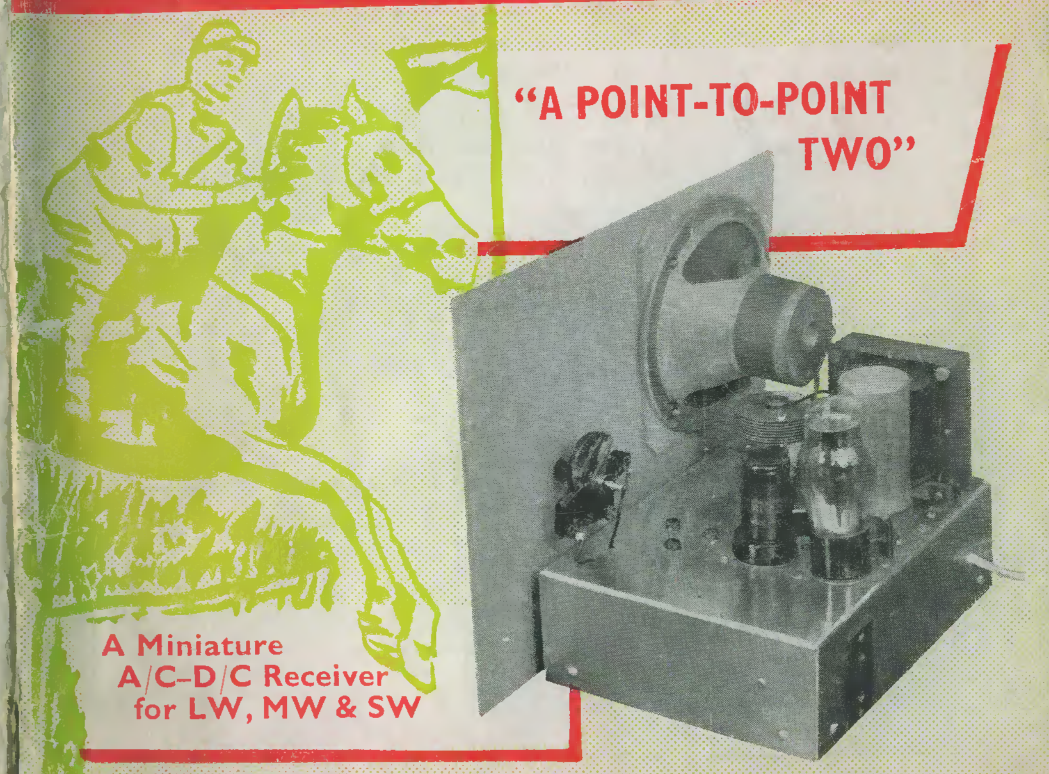
COOPER-SMITH HI-FI STEREO MAIN AMPLIFIER

VOLUME 13
NUMBER 10
MAY
1960

The RADIO Constructor

RADIO · TELEVISION · AUDIO · ELECTRONICS



"A POINT-TO-POINT TWO"

A Miniature A/C–D/C Receiver for LW, MW & SW

Included in this issue

"LITON" TRANSISTOR PARKING LIGHT SWITCH, Pt. 2
RTTY—IN THEORY AND PRACTICE
IS THAT TUBE REALLY FINISHED?
A TEST LOUDSPEAKER
IN YOUR WORKSHOP

DATA Publications 1/9

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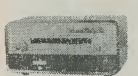
DAYSTROM

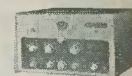
For the Discerning who require the Best Performance at Minimum Price

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.**

AMATEUR TRANSMITTER Model DX-100U

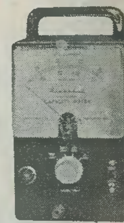


This is the most popular Amateur transmitter in the world and requires no introduction to "Hams" the world over. Covers all bands from 160–10 metres. Self-contained, including power supply, Modulator and V.F.O. **£78.10.0**

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

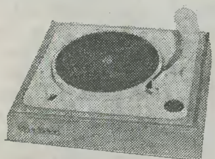
This extremely useful low-priced device will extend the application of your single-beam oscilloscope by enabling it to give simultaneous traces of two separate and independent signals **£9.18.6**

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**

Have you had details of our NEW 2¾" Service 'Scope yet? Model OS.1, 5" x 8" x 14". Weight 10½ lb. £18.19.6.

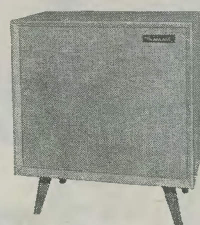


TRANSCRIPTION RECORD PLAYER, Model RP-1U This new RP594 Collaro Transcription Unit has a Ronette Stereo Pick-up, giving excellent results on stereo or mono (33, 45, or 78 r.p.m.) discs. Complete with furniture-grade wooden plinth. **£12.10.0**

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**

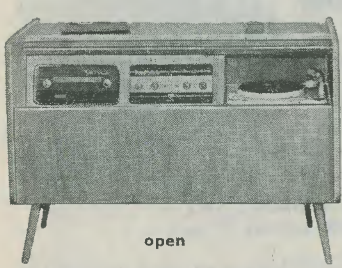
Mk. 2. Tape Deck and Record Player. **£17.8.6**



THE "COTSWOLD"

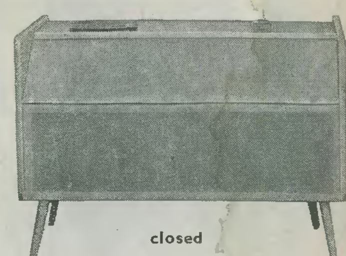
THE "COTSWOLD". This is an acoustically designed enclosure 26" x 23" x 15⅛" housing a 12" bass speaker with 2" speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 32–20,000 c/s. Capable of doing justice to the finest programme source, its polar distribution makes it ideal for really Hi-Fi Stereo. Delivered complete with speakers, crossover 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**

BUY YOUR HI-FI EQUIPMENT ALL TOGETHER AS ONE OF OUR 'PACKAGED DEALS' AND SAVE YOURSELF MORE MONEY!



open

THE "GLOUCESTER"

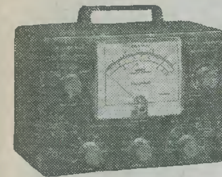


closed

DAYSTROM LTD DEPT. RC5 GLOUCESTER ENGLAND

Heathkit
DAYSTROM

Easily-built equipment of excellent quality at much lower cost



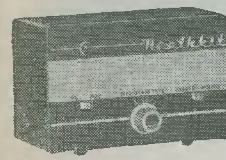
AG-9U

SSU-1

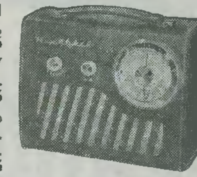
AUDIO GENERATOR: AG-9U. 10 volts, 10 c/s to 100 kc/s pure sine-wave. Switch-selected frequencies/attenuation. **£19.3.0**

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**



USP-1

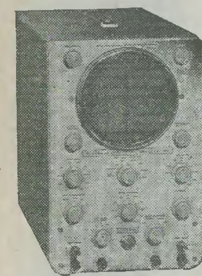


UXR-1

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**



O-12U

V-7A

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 1,500 (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)

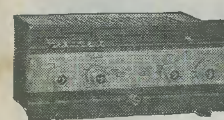
CAPACITANCE/RESISTANCE BRIDGE: C-3U. Measures capacity, 10pF to 1,000μF. Resistance 100Ω to 5MΩ; Pwr. Factor. **£7.19.6**

"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**

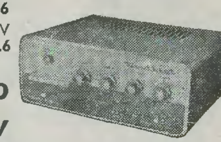
AUDIO WATTMETER: AW-1U. Up to 25 W. continuous, 50 W. intermittent. **£13.18.6**

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



S-33

Two Tape Decks (Collaro and Truvox) and Eight New Models Available this Month.



S-88

Money Saving "Packaged Deals" of Complete Stereo Equipment from £42.10.0

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

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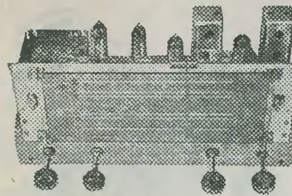
BRITISH HEATHKIT CATALOGUE .... ☐

FULL DETAILS OF MODEL(S) .... ☐

DAYSTROM LTD DEPT. RC5 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/–**.
Dulci, 6 valve AM/FM Hi-Fi model H3. **£19.17.6.**

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

Acos 73 Hi-Fi Pick-up for LP, 78 and Stereo 7", 10" and 12" records. Silent motor, heavy turntable, auto stop. Special offer **£6.19.6** post free

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" elip. 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 465 kc/s 1¾" x ¾" sq. **12/6 pair**
Weyrad 550 Standard 465 kc/s 3½" x 1½" sq. **12/6 pair**

New boxed VALVES 90-day Guarantee

1R5	7/6	6K8G	7/6	EA50	1/6	EZ80	7/6
1S5	7/6	6L6G	10/6	EABC80	8/6	E1148	1/6
1T4	6/–	6N7M	6/6	EB91	6/–	HABC80	12/6
2X2	3/6	6Q7G	8/6	EBC33	8/6	HVR2A	6/6
3S4	7/6	6SA7	6/–	EBC41	8/6	MU14	9/–
3V4	7/6	6SJ7M	6/6	EBF80	10/–	P61	3/6
5U4	7/6	6SN7	6/6	ECC84	9/6	PCC84	9/6
5Y3	7/6	6V6G	6/6	ECF80	9/6	PCF80	9/6
5Z4	9/6	6X4	7/6	ECH42	10/6	PCL82	11/6
6AM6	5/–	6X5	6/6	ECL80	10/6	PEN25	6/6
6B8	5/–	12A6	7/6	ECL82	10/6	PL81	12/6
6BE6	7/6	12AT7	8/–	EF39	5/6	PL82	10/6
6BH6	9/6	12AU7	8/–	EF41	9/6	PY80	7/6
6BW6	9/6	12AX7	8/–	EF50	5/6	PY81	9/6
6D6	6/–	12BE6	8/6	EF80	8/–	PY82	7/6
6F6	7/6	12K7	6/6	EF86	12/6	SP61	3/6
6H6	3/6	12Q7	6/6	EF92	5/6	UBC41	9/6
6J5	5/6	35L6	9/6	EL32	5/6	UCH42	9/6
6J6	5/6	35Z4	7/6	EL41	9/6	UF41	9/6
6J7G	6/6	80	9/6	EL84	8/6	UL41	9/6
6K6GT	6/6	807	5/6	EY51	9/6	UY41	8/–
6K7G	5/–	954	1/6	EZ40	7/6	U22	8/–

B.B.C. Pocket Transistor. M.W. and L.W. Radio Kit **32/6**. Phones **7/6**, or 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, 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 30k to 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. 220V 45mA, 6.3V 2A	**15/6**
SMALL. 220-0-220V 50mA, 6.3V 2A	**17/6**
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**. Goodmans 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 $\frac{3}{16}$"
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. ⅜" sq. x 2½" or ⅜" sq. x 1¼", **2/–** with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6-1, **2/3.**
REMPLOY INSTRUMENT IRON, 230V 25W, **17/6.**
MAINS DROPPERS. 3" x 1½". With adj. sliders, 0.3A, 1,000 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.
RADIO & TV SERVICE SHEETS 2/6 plus S.A.E.

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

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.** (PCC84 valves if preferred.)
BAND III I.T.A.—Same prices
Tuneable channels 8 to 13. Gain 17dB. 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, 3mm, **3d.**, 6mm, **5d.** yd.
NEON MAINS TESTER SCREWDRIVERS, 5/–.
SOLDER RADIOGRADE, 4d. yd, 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/–**; 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.**; 0.5/350V, **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/–	50/350V	5/6	8/500V	3/–
2/350V	2/3	100/25V	3/–	16/500V	4/–
4/450V	2/3	250/25V	3/–	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/–
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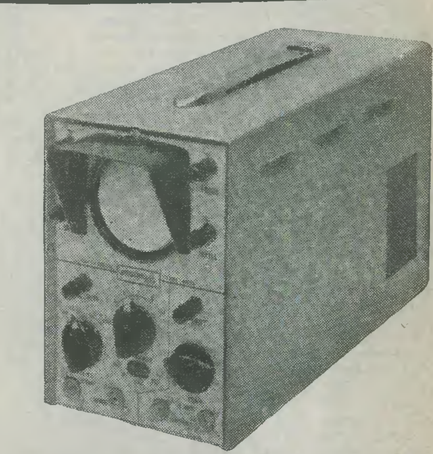

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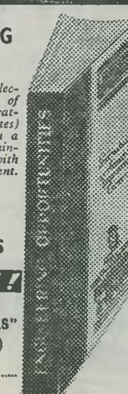

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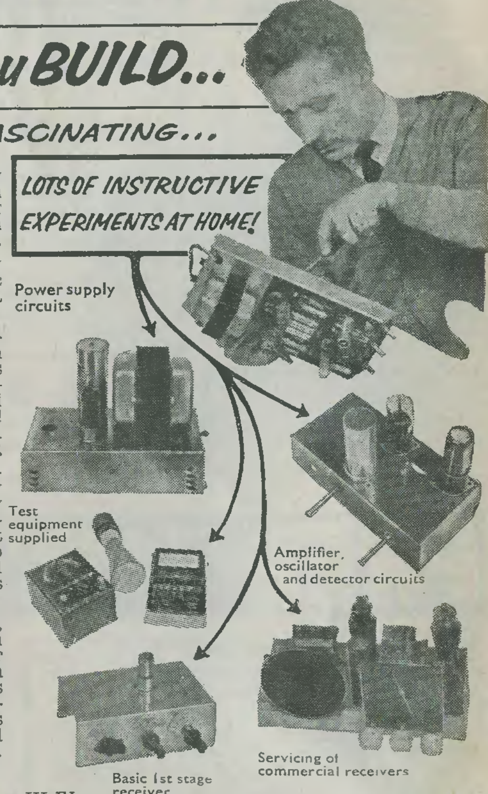

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MAY 1960

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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.

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suggested circuits

No. 114 A Visual Bell Indicator

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

The writer has recently received several requests from readers for the circuit of a device which will give visual warning, by causing a lamp to be illuminated, whenever a bell is rung. A device of this nature may then be used for such purposes as advising television viewers or those who are hard of hearing that a front door bell has been rung. An important feature asked for by the writer's correspondents was that the warning light should remain illuminated for about a minute or so after the appropriate bell-push had been released. This would ensure that the visual warning was not missed, and it would also enable lighting circuits to be operated at the bell-push itself. Another requirement was that the warning lamp circuit should be capable of being easily connected into existing bell wiring.

Bell Transformers

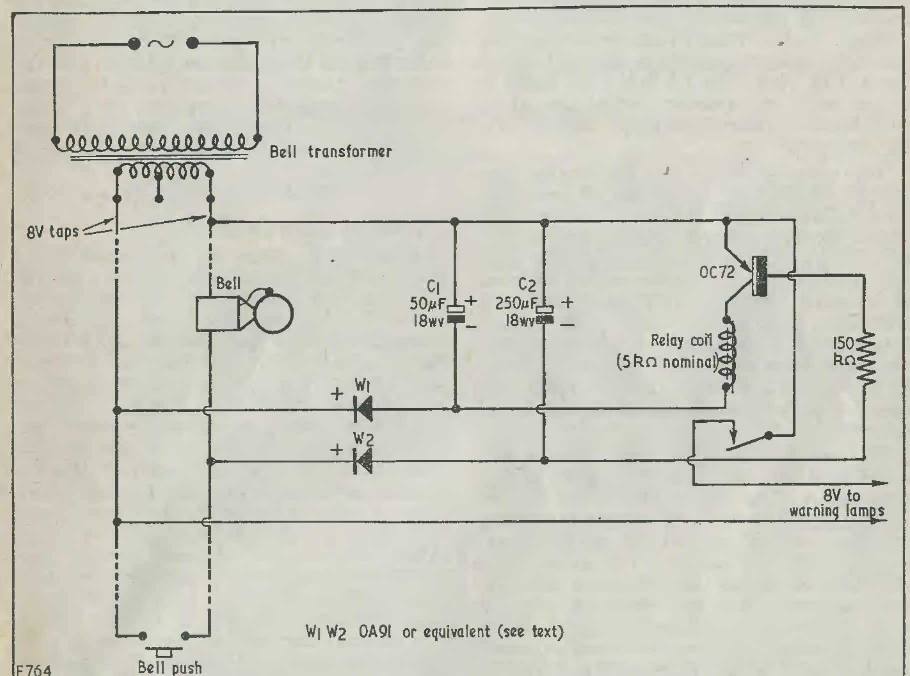
A device of this nature must inevitably employ some form of switching device, the obvious choice here being a simple relay. The necessity of having the switching circuit remain completed for a period as long as a minute after the bell-push has been released raises another complication. This period is far longer than could be accommodated by capacity in direct combination with a relay coil without the introduction of high operating potentials, and so the use of a valve or transistor becomes almost inevitable.

In consequence of these factors, some form of power supply for the lamp switching circuit becomes necessary. A further point is that this power supply will have to be available continually, even if the switching circuit is called upon to operate as infrequently as once a day.

The writer decided that the best solution to the power supply problem would consist of employing a bell transformer, this transformer serving also to provide operating current for the bell itself. In many cases such a transformer would already be in use, with the result that the switching device would merely need to be added to it. If the existing bell circuit was powered by batteries, the introduction of a bell transformer would not upset bell operation or wiring and would offer an inexpensive method of obtaining the power required from the mains.

A bell transformer is intended to operate with its primary connected permanently to the mains supply, the bell circuit being fed from its secondary. The current drawn from the mains by the continually-connected primary is negligible. It is usual for the secondaries of bell transformers to offer 8 volts, with a tap at 3 or 4 volts. As the transformers are called upon to give low secondary currents at occasional times only, secondary voltage regulation is markedly inferior to that given by mains transformers of the type encountered in electronic work.

In order to ascertain whether a bell transformer, with its attendant poor regulation, would be suitable for the proposed switching circuit the writer decided to check the performance of a typical component of this type. An inexpensive transformer was purchased at a popular chain store, this claiming a total secondary output of 8 volts at 0.5A. The transformer was very small in physical size, measuring in its plastic case 2½in x 1½in x1½in. When tested it was found that the total secondary voltage was 8.3 off load, this dropping to 6.9 volts at a current of 0.3A. It was felt that the source resistance of the transformer secondary calculated from these figures—approximately 5Ω—was sufficiently low for the requirements of the switching circuit, and would be representative of typical bell transformer performance. Indeed, the 5Ω figure might well be higher than that offered by larger and more expensive components.



The Circuit

The warning light switching circuit employing the bell transformer as a source of power accompanies this article. The secondary of the transformer connects, via the bell, to the bell-push in conventional fashion. Connected permanently across the transformer secondary are rectifier W_1 and condenser C_1. In consequence, a steady potential close to the peak value of the secondary voltage is continously available across C_1, and this is applied to the relay coil in series with the emitter-collector terminals of the transistor. Normally, the base of the transistor is at the same potential as its emitter, and negligible collector current is passed.

When the bell-push is pressed, the transformer secondary is connected across the bell, which then rings. The secondary voltage is also applied to rectifier W_2 and condenser C_2, causing the condenser to charge and a negative voltage to be applied to the 150kΩ resistor connecting to the base of the transistor. The transistor at once conducts and energises the relay, whereupon the relay contacts connect the transformer secondary to the warning lamp circuit.

Whilst the bell-push is depressed C_2 remains fully charged. As soon as the bell-push is released this condenser commences to discharge, discharge currents flowing through the 150kΩ resistor and the base-emitter circuit of the transistor, and through the back resistance of W_2 and the bell. After a period, C_2 discharges such that the transistor collector current is sufficiently low to allow the relay to de-energise. The warning lamps become extinguished, and the circuit is ready for the next operating cycle.

Practical Points

There are a number of practical points in the circuit which need to be discussed.

The first of these concerns the warning lamps. Paying regard to the 0.5A secondary rating of the transformer employed in the prototype, it was considered advisable for the warning lamps to consume a current of 0.3A maximum. Such a current is sufficiently high to enable conventional flash lamp bulbs to be employed. One or more 0.3A bulbs may then be employed in series in the warning lamp circuit, a series resistor being inserted, if felt necessary, to drop excess voltage. In the writer's case it was felt that, since the secondary voltage dropped to 6.9 for a 0.3A load, two 3.5 volt 0.3A bulbs in series with no resistor would be quite satisfactory. This combination was used in the prototype.

The relay employed is a lightweight type which energises at a current of less than 2mA.* For operation in this circuit the relay should be set up to energise at a coil current of 1.75mA. Under this condition the relay will de-energise at approximately 0.5mA. It is usual, when a relay is energised via a transistor, to connect a diode across the coil to prevent the formation of high voltages if the relay energising current suddenly drops. In this circuit the energising current falls gradually, and a diode across the coil is not necessary.

The rectifiers W_1 and W_2, actually germanium diodes, are specified as OA91's or equivalents. The requirements here are not critical, apart from the fact that the diodes employed should have a maximum inverse voltage rating in excess of 20 volts. It is desirable to ensure that W_2 does not have an excessively low back resistance, or C_2 will discharge too rapidly. The writer checked several diodes of different type and manufacture in the W_2 position, however, and encountered no undue trouble on this count.

Similarly, in order to prevent too rapid a discharge in C_2, it is advisable to ensure that this component has a high leakage resistance. A new component of reliable manufacture should be fitted here. The length of time over which the relay remains energised may, of course, be increased or decreased by modifying the value of this condenser.

It will be noted that the rectifier circuit W_1, C_1, and the transistor and relay coil, are connected across the bell transformer secondary permanently. This method of operation is quite permissible, as the standing current drawn by these components is negligible.

Operation

It was found that, after completion, the circuit worked with complete reliability. The relay energised immediately the bell-push was pressed, and it remained energised for 55 to 75 seconds after the bell-push had been released. The reason for this variation in times was that relay energising current decayed very gradually after the first 40 seconds or so of discharge in C_2 had taken place. In consequence, slight variations in relay de-energising current had an exaggerated effect on timing periods.

The voltage across C_1 was 11.5 before the bell-push was pressed. With the bell operating, it dropped to approximately 7, rising to 9.5 when the bell-push was released and the warning lamps were drawing current. Despite continual repetition of circuit operation the transformer remained completely cool, and there was no evidence of over-running.

Alternative Lamp Circuits

Apart from giving an indication that a door bell has rung, the circuit may be employed for other uses. A particularly attractive idea consists of having the relay energise a heavier relay capable of switching mains voltages. Pressing the door bell may then cause a porch light to be switched on and remain illuminated during the time needed to allow a visitor to enter. An alternative idea, for use when the device is used by those who are hard of hearing, consists of having a warning lamp illuminate a panel near the bell-push. This panel could then bear a legend such as: "Visual Door Alarm—Please Be Patient". Only one additional lead from the switching circuit to the bell-push is needed for this facility, as one of the leads to the bell-push is already common to one side of the warning lamp circuit. A suitable printed panel, which may be cut out if desired, appears with this article.

DEAF

VISUAL DOOR ALARM
PLEASE BE PATIENT

* A suitable relay is available from Home Radio (Mitcham) Ltd., under Catalogue No. Z.70.

OBITUARY

It is with deep regret that the Directors of Data Publications Limited have to announce the sudden and unexpected death, on Wednesday 23rd March, of their friend and colleague, Mr. C. W. C. Overland.

Mr. Overland was, of course, Editor of *The Radio Constructor*, and his untimely passing is a sad and personal loss to all connected with this magazine.

Mr. Overland, who was only 48 years of age, was educated at Haberdashers' Aske's Hampstead School, and before becoming a technical journalist was a radio engineer. He was a founder member of Short Wave Press, as Data Publications Limited was then called, and an original Director. In 1949 he became Editor of *The Radio Constructor*. In addition to his other activities he took a leading part in the formation of the International Short Wave League and was a prominent radio amateur with the call sign G2ATV.

Cremation took place at the West London Crematorium on Tuesday 29th March, the service being conducted by the Revd. George E. Easter. Many friends and business acquaintances attended.

To his widow and two sisters we extend our deep sympathy and sincere condolences.

BOOK REVIEWS

W. E. Thompson

EXPERIMENTAL RADIO ENGINEERING (4th Edition). By E. T. A. Rapson, M.SC. (ENG.) LONDON, A.C.G.I., D.I.C., M.I.E.E., M.BRIT.I.R.E. 201 pages, 207 diagrams. Published by Sir Isaac Pitman & Sons Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 12s. 6d.

Since this book was first published in 1940, students of radio technology have regarded this book as a standard textbook on experiments and measurements. From time to time the author has revised his text, deleting out-of-date experiments and introducing modern methods, and taking each opportunity to keep abreast of the times.

The original pattern has not changed; indeed, it does not need to. The text consists of 95 experiments. The subject is stated, and the procedure to be adopted is described. The results of the experiment are then set down, and the conclusions to be drawn are briefly stated. The procedure and results contain diagrams of the circuit or function to be investigated, and curves, tables, or other parameters illustrate the results. At the end of the book, the conclusions for each experiment are described in detail.

The student is thereby enabled to take any experiment he chooses and learn by making his own tests and measurements far more than he would by merely reading about it. The book has thirteen sections, dealing with series and parallel tuned circuits, coupled circuits, static characteristics of thermionic valves and transistors, dynamic constants of thermionic valves, characteristics of amplifiers, rectifiers and demodulators, valve oscillators, audio-frequency measurements, radio-frequency measurements, attenuators and filters, radio receiver tests, electro-acoustic tests, cathode-ray tubes, timebases and applications.

AUTO RADIOS. By Jack Darr. 154 pages, 100 diagrams and illustrations. Published by John F. Rider Publisher Inc., 116 West 14th Street, New York. Available in England from Messrs. Chapman & Hall Ltd., 37 Essex Street, London, W.C.2. Price 26s.

The business of fitting and maintaining car radio installations is more prolific in America than in this country. It is inevitable, therefore, that a book which originates in the U.S.A. should deal exclusively with car radios made there, but much of the material and information available in this book can apply to a great extent to similar installations over here. One needs to have a fair acquaintance with terminology used for American cars, in order to follow correctly some of the statements made, otherwise it might be easy to mount a whip aerial in some inaccessible and ridiculous position!

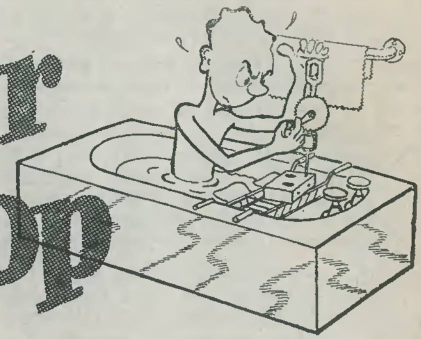
There is a lot of good advice, practical experience, and sensible diagnosis to be found in Jack Darr's book. He deals very well with the problems of interference sources and the methods of suppression, and the servicing of the car radio receiver and power supplies. Transistorised and hybrid receivers are very well described, and a useful chapter on the service workshop provides plenty of valuable know-how for the service engineer. A short chapter discusses ways of converting from 6V to 12V supplies.

FUNDAMENTALS OF RADIO AND ELECTRONICS (2nd Edition). Edited by W. L. Everitt. 805 pages, 592 diagrams and illustrations. Published by Constable & Co. Ltd., 10 Orange Street, London, W.C.2. Price 57s. 6d.

As is to be expected with a book of this size, the field covered is fairly wide. It delves far deeper into fundamentals than many other smaller books can hope to do, mainly because these latter are primers rather than textbooks. The first three chapters introduce the reader to the mathematics applicable to radio, and take a brief look into d.c. and a.c. theory. From this point onwards, progress becomes more rapid and advanced, taking into consideration en route many aspects of radio technique which less pretentious books would have no room for.

Although some matters are not dealt with as fully as the title suggests, there are other textbooks from which more could be learned. If this statement seems to counter what has been said in the previous paragraph, it should be explained that to deal fully with, say, all the aspects of low-frequency amplification, rectifier circuits, and transmitter techniques, the book would extend somewhat beyond the concepts of fundamentals; it therefore seeks to give a good insight into many subjects, and frequently touches upon high-power equipment. It follows that those seeking specialised knowledge on a particular subject will find in this book enough to take them well on the road of understanding, and lead them to the wider fields to which other works can steer them.

In your Workshop



This month Smithy the Serviceman and his able assistant, Dick, discuss a number of diverse subjects, these ranging from television tuner drift to film projection cues

RUSH, RUSH, RUSH", COMPLAINED DICK, "rush, rush, rush!" Smithy the Serviceman glanced round at his assistant.

"Last month", he pointed out, "you were grumbling because things were too quiet."

"That may be", said Dick, "but the present situation is ridiculous!"

Smithy's assistant glanced round at the chock-full "awaiting-repair" rack.

"Dash it all", he remarked, "the sets are overflowing from the rack on to the floor!"

Hum on F.M.

"All the more reason", said Smithy, "for you to apply some really speedy trouble-shooting tactics on them."

"That's all very well," replied Dick hotly, "but some of the faults I'm getting aren't too easy. For instance, I've got an a.m./f.m. job on the bench now which hums on f.m. only. And you should just *see* the wiring around the wave-change switch!"

"A.M./F.M. switching circuits do get a little complicated in some receivers," conceded Smithy. "But the fault needn't necessarily be in the switch wiring. Does your set hum all the time, or just on stations?"

"It hums a bit between stations, and a lot when a signal is tuned in."

"Sounds like modulation hum."

"That's what I thought," said Dick. "So my first reaction was to change the double-triode r.f. and oscillator bottle."

"A very obvious step," approved Smithy. "A little leakage between heater and, say, oscillator grid (Fig. 1 (*a*)) can cause enough 50 c/s a.c. to appear on the latter to give you quite heavy modulation hum. What happens, of course, is that the oscillator frequency then becomes frequency modulated at 50 c/s, and frequency modulates any incoming signal in consequence."

"With the result", chimed in Dick, "that the 50 c/s frequency modulation is detected by the discriminator. Whose job it is to do just that! Anyway, I'd have thought that cathode-heater leakage would have been a more probable snag than grid-heater leakage."

"Not these days," said Smithy, "because almost all modern v.h.f. oscillators have their cathodes anchored very securely down to deck. In earlier times, manufacturers used to use e.c.o.s (Fig. 1 (*b*)), with the result that cathode-heater leakage could cause quite a lot of trouble."

"Is that why e.c.o.s aren't used now in v.h.f. receivers?"

"Partly," said Smithy, "and partly because the heater used to jump around in the cathode occasionally, causing a very disconcerting change in frequency because of the alteration in stray capacities. Anyway, to return to your set, do I presume that swapping the double-triode didn't clear your trouble?"

"You do," replied Dick. "The next things I thought of were such terrible subjects as leaks in its valveholder, but as the one in this set was pot I decided it should be safe enough."

"Pot?"

"Ceramic."

"Ah, yes," said Smithy. "A ceramic valveholder should be safe enough. Besides, one doesn't go around changing valveholders just like that. Especially valveholders in v.h.f. circuits. There are plenty of other things to suspect before that stage is reached."

"So I proceeded", continued Dick, "to take a perfunctory at the h.t. supply to the oscillator. A bit of ripple on that could easily give modulation hum." Smithy nodded approvingly. "So I temporarily popped an extra 200μF which was lying around across the oscillator h.t. supply." Smithy winced. "But the hum remained."

"I've been wondering where the sparks were coming from," commented Smithy. "I don't disagree with popping extra capacity across a suspect smoothing condenser, but there's no need to go mad. 16μF is quite big enough for sound receiver servicing.

"I think, anyway," continued the Serviceman, "that you're following the classic approach to this particular problem. But I would, myself, have tried one or two more valves before delving into the works and checking smoothing. If the hum only appears on f.m. you should say to yourself: what valve performs a different function on f.m. to that which it performs on a.m.? The very first valve that comes to my mind in answer to this question is the triple-diode-triode. (Fig. 2.) This has two diodes and the triode around one cathode, and a completely separate diode around a second cathode. In conventional circuits, the separate diode is only used for f.m. Another valve which changes functions when you switch from a.m. to f.m. is the triode-heptode or -hexode frequency-changer. The heptode, or hexode, section normally becomes a straightforward 10.7 Mc/s i.f. amplifier on f.m. In most sets the triode section is killed on f.m., but in some it is switched into circuit as an extra a.f. voltage amplifier. So I should certainly check the triple-diode-triode and frequency-changer in your set before looking anywhere else, the triple-diode-triode being the more likely suspect so far as modulation hum is concerned."

As Smithy spoke, Dick was already rummaging around in the valve cupboard. He soon found a new triple-diode-triode and plugged this into the faulty receiver.

"Ah," he remarked in a pleased tone, as the receiver came to life, "that's cleared the hum!"

"Good," said Smithy. "It turned out to be easy enough after all, didn't it? I should guess that there's a bit of heater-cathode leakage in the separate diode of the bottle which caused the hum."

"It seems a pity to throw it away, though," said Dick, "especially when you consider that only a quarter of it has gone up the wall! The receiver I've been fixing is a universal one, so couldn't I try it in a set with a mains tranny, where the heaters wouldn't have so high a potential above chassis?"

"I think you'd be wasting your time," remarked Smithy. "Because you'll very probably find that the triple-diode-triode is at the earthy end of the heater string in your set anyway. However, if you feel all that hard-up I suppose you *could* use it in a

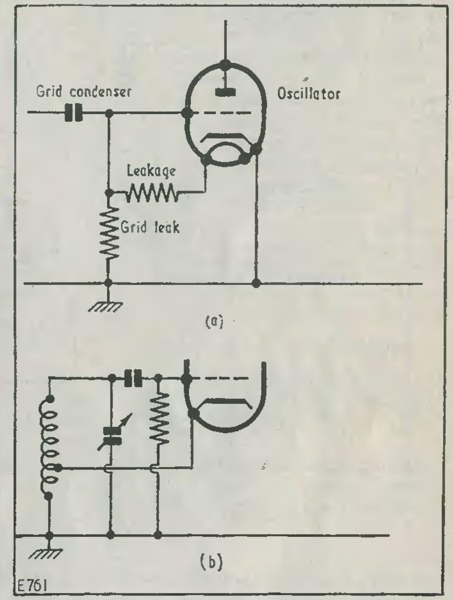


Fig. 1 (a) Leakage between grid and heater of the oscillator in an f.m. receiver may cause modulation hum. (b) A type of oscillator (actually a modified Hartley) which is commonly referred to as an electron coupled oscillator (e.c.o.). For true electron coupled operation the valve would be a screen-grid or pentode type, an output at oscillator frequency being obtained from its anode

conventional a.m. circuit, ignoring the separate diode."

Drifting Tuner

By now Dick had replaced the cabinet on his receiver and was carrying it to the "repaired" rack. He next selected a very new-looking television receiver for repair, and Smithy returned to his own work.

But not for long.

"Hey, Smithy."

The Serviceman grunted a non-committal reply which Dick decided was an invitation for further conversation.

"This t.v.'s slipped a channel!"

"What?"

"That's right," said Dick. "Our local Band III transmitter's on Channel 9 but I can only get it on Channel 8 on this tuner! Also, it's rather weak."

"Try Band I," suggested Smithy.

A quick succession of loud clicks from receiver.

"Hmm," he said. "The fine tuner has to go right over to the full capacity end to get a correct signal. It seems as though the oscillator tuned circuit section in the innards of the tuner has lost a bit of capacity, or, perhaps, inductance somehow; that would explain why I have to put the fine tuner over to maximum capacity on Band I to make up for the loss. The loss in capacity probably has much more effect at Band III, and you have to put extra inductance in as well to make up for it. That's why you get Channel 9

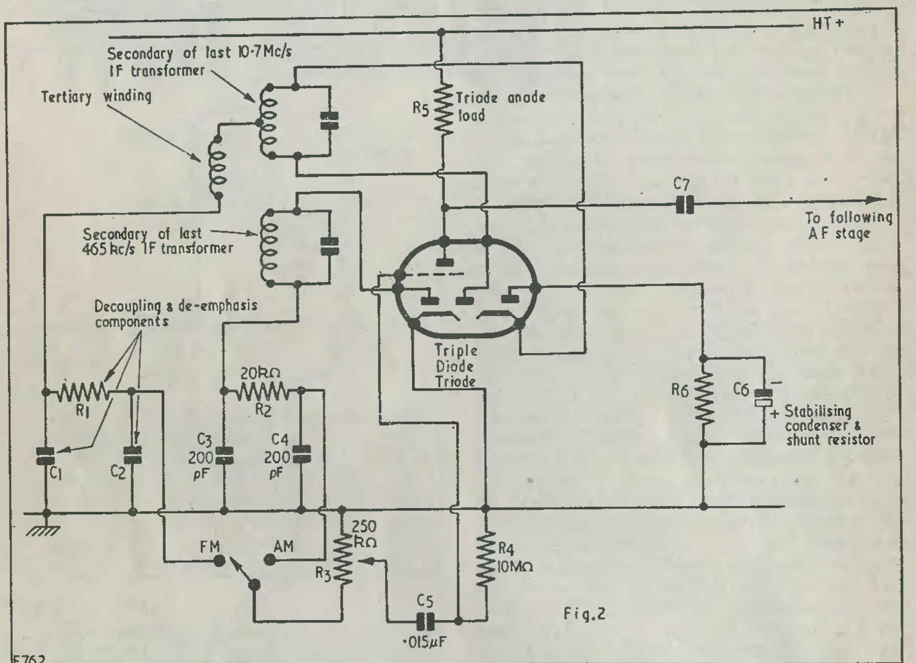


Fig. 2. Illustrating, in simplified form and with representative component values where generally applicable, the type of circuit likely to be encountered at the triple-diode-triode stage of an a.m./f.m. receiver. The 465 *kc/s secondary has one end connected to the left-hand diode, and the other end to the decoupling filter* C_3, R_2, C_4. *When the switch is in the "a.m." position, the detected* 465 *kc/s signal appears across the volume control* R_3. *The* 10.7 *Mc/s secondary connects via the centre and right-hand diodes to the stabilising condenser and shunt resistor, following normal ratio discriminator practice. A.F., available from the tertiary winding, passes through the filter and de-emphasis components,* C_1, R_1, C_2, *and the switch (when in the "f.m." position), to the volume control* R_3. *Leaky-grid bias for the triode voltage amplifier is provided by* C_5 *and* R_4

Dick's bench announced that he was energetically obeying Smithy's instructions.

"It's O.K. on Band I," he announced. "At least it's coming up on the right channel, and at proper strength. The fine tuner isn't half 'endey', though."

Smithy left his bench to look at Dick's by going down a channel. Switch back to Channel 8."

The turret indexing mechanism, subjected to Dick's muscular handling, clattered briskly as he wrenched the knob to its new position.

"I do wish you wouldn't be so *vigorous*,"

complained Smithy.

"The turret's meant to be turned," said Dick in an injured tone, "and the insides of all t.v. tuners I've seen are definitely of the heavy engineering variety."

"But the *knob* isn't," said Smithy. "There may be as much as two inches of horrible brittle plastic between the bit of the knob that you handle and the point where it couples to the shaft. I'm not saying that you should treat the knob as though it's going to fall to pieces in your hands, mum, but there's no sense in tempting fate. You know," continued Smithy, completely forgetting the fault Dick had presented for his attention, "the fragile knobs that manufacturers put on sets these days really give me the willies. Indeed, if there's one thing that has taken the fun out of servicing it's knobs!"

Dick, perceiving that Smithy had mounted one of his favourite hobby-horses, hastily interrupted him.

"We're on Channel 8."

"Are we?" said Smithy absent-mindedly. "Oh, yes, so we are. Right, now, let's have a look. This time we get our picture, but only just, with the fine tuner hard over at its *low* capacity end. What I think is happening here is that the fine tuner has got a pretty wide range on Band III, and it's not to be unexpected that we can just raise Channel 9 on the extreme end of Channel 8. The signal is rather weak because the r.f. coils are, obviously, adjusted for Channel 8."

"What do I do now?" asked Dick. "Re-align the oscillator cores on Channel 9 and the Band I channel and send the set out again?"

"How long has the receiver been in the customer's house?"

"Just about a week, I should guess," said Dick, examining the card wedged into its back.

"The weather *has* been a bit damp over the last few months," said Smithy, returning to his bench.

Dick looked a little baffled at this apparently inconsequential remark.

"But what shall I *do*?" he asked again.

"I should switch the set back—gently this time—to the Band I channel," said Smithy over his shoulder. "And pop it on soak with a locked picture for twelve hours or so. *Then* re-align the oscillator cores and send it out. I would say that the receiver was stored before sale in a dampish place, with the result that enough moisture got into the tuner to increase the internal stray capacities and throw the oscillator off tune. Very probably, the oscillator cores on the two local channels were re-aligned when the set was installed in the customer's house. Now that the set's started to dry out again with use, the oscillator cores want to go back to the position they held when they were aligned in the factory. If you put the set on soak you should dry the tuner out sufficiently for it to become stable again."

"Well, that's a queer howdyedo," remarked Dick.

"Not really," said Smithy. "You've got an oscillator running at 200-odd megs in that tuner. It doesn't take much to throw it off a wee bit."

"Why have the set soak with a locked picture?"

"Because," said Smithy patiently, "you then keep the line timebase running at correct frequency and there is less risk of e.h.t. voltage variation. If the e.h.t. voltage rose too high over long periods something might go quite unnecessarily pop. Incidentally, I'm surprised to note that your customary curiosity hasn't caused you to ask why I told you to try Band I after your announcement that the set had slipped a channel."

"I did miss that," admitted Dick. "What was the reason?"

"It was that I didn't want a repetition of a true case I heard about recently where the tuner had slipped a channel on both Band III and Band I. The service engineer on the job swapped two tuners unsuccessfully before he found the fault."

"What was it?"

"The tuner knob had been fitted incorrectly with the little plastic slip which shows the channel numbers!"

Dick laughed.

"Well, I can't say I'd fall for that one."

"I'm not so certain," remarked Smithy. "Anyway, you'd better get that set on soak."

Reedy Output

Dick did as he was bid, and the Serviceman was allowed to continue uninterrupted with his own job as his assistant selected yet another television receiver from the rack.

"Smithy," he called out after a moment.

The Serviceman placed his screwdriver down on the bench with quite unnecessary violence.

"What is it now?"

"I've got a set like what you talked about last month," replied his assistant ungrammatically. "Listen, it's giving a thin and reedy sound output."

"Your first horrible sentence," remarked Smithy dispassionately, as he wearily walked over again to his assistant's bench, "reminds me of the little boy in bed who said: 'What did you bring that book I don't like to be read to out of from up for?'."

However, Smithy's comments on syntax were lost on Dick, who was interested only in his faulty receiver. He turned its volume control to full, whereupon the sound of weak and high-pitched music came from the cabinet. Smithy applied his ear to the speaker, and then to the back of the cabinet.

"What you've got there," he said, "is an o/c loudspeaker speech coil circuit. The sound you can hear is coming from the unloaded a.f. output transformer!"

"You mean, the output tranny is operating as a loudspeaker?"

"That's right. It makes a very insensitive speaker and it is hardly in the hi-fi class, but it can still give an audible output. I should turn down the volume before you break down the primary. There are probably some pretty fantastic a.f. voltages appearing across it if its secondary isn't loaded."

Obediently, Dick turned the volume control half-way back, whereupon the weak and tinny sound of music became inaudible.

"Well, the speaker secondary circuit *looks* O.K.," he remarked, after a quick visual examination. "There are two leads well and truly soldered to the speaker transformer tags, and these go to two pins which are fully inserted into two sockets at the speaker. And the wires from the sockets to the speaker are perfectly soldered as well."

"I should waggle the pins about a bit," said Smithy laconically.

"But they're fully inserted into the sockets."

Smithy sighed. Dick could be very trying at times.

"Just waggle them," he said patiently.

Dick gave the pins an exploratory poke with a screwdriver. Immediately the sound of music at good quality came from the previously silent loudspeaker.

"Well, I'm dashed," remarked Dick.

"So you ought to be," growled Smithy. "The trouble with you is that you don't listen to what your elders and betters see fit to tell you."

With this somewhat pompous statement Smithy strode majestically back to his neglected bench. The dignity of the occasion was, unfortunately, marred as he accidentally caught his feet in the lead to his soldering iron; with the result that it flew smartly into the air and crashed to the floor, to be followed by the clattering fall of its stand. Commendably, Dick maintained a straight face.

"You should always look out," continued Smithy, grinning despite himself as he picked up the lately airborne iron, "for snags of this type in speech coil circuits. These circuits are pretty low impedance, and I've had quite a lot of trouble in the past with speaker plugs and sockets which *look* as though they're making contact but which, in actual fact, are not. In your case I should pull out the plugs and tighten the contacts up a bit before you finally count the set as being fixed."

"Fair enough," said Dick, briskly. "Consider the job done!"

Film Projection

Smithy was in process of finally aligning a receiver when his assistant's startled voice upset his concentration.

"Do you know what time it is?" exclaimed Dick in a shocked voice. "It's nearly lunch time!"

"So it is," remarked Smithy equably, as he finally adjusted the r.f. trimmer. "Dear me, the time *does* fly when you're busy."

"Well, I've certainly been busy, myself," said Dick boastfully. "The successful repair of a radio and two TVs isn't bad for a beginner."

Smithy forebore to answer this last remark.

"I suppose it won't kill us to have a break for the next few minutes or so," he remarked, after a moment. "Besides, I've got a letter I want to read out to you concerning our recent conversation on film signals.[1] Do you remember?"

"Shall I forget? After you told me that signals appear near the end of each part to warn the operator that a change-over is due, I haven't enjoyed a single film. I've been looking for signals in the top right-hand corner ever since."

"Well," replied Smithy, "listen to what my correspondent has to say.[2] 'As a cinema projectionist I was very interested to read January's episode of the *In Your Workshop* series.

" 'As a conscientious operator I would like to raise a cry at your expression "big scratches in the film emulsion, and all sorts of things like that". This is like accusing a serviceman of joining a flexible p.v.c. lead to the end of a resistor with a "twisted" connection, no sleeving, and stretching the wire around a valve pin to keep the joint taut off the chassis! All the more respectable cinemas nowadays are equipped with a stencil device which clamps the film and makes a neat cue almost indistinguishable from a printed one.

" 'Several modern theatres do not use cues at all, but are equipped with electronic apparatus which not only makes change-overs automatically but also performs all the other important operations, such as closing and opening curtains, switching sound disc/film, raising and dimming lighting (by saturable reactors); in fact, running the whole show automatically.

" 'The heart of the device is a thyratron (GT1C) actuated by short lengths (about ⅜in) of metallic adhesive tape stuck on the edge of the film by the projectionist beforehand. Contact is made over the two halves of a split roller, which are connected in the grid circuit of the valve. As a mark passes over the roller, the grid bias is lowered, allowing an electrolytic of large capacity to discharge through the valve, closing relays in the anode circuit.

" 'Hoping these remarks have given you a fraction of the interest that *In Your Workshop* gives to me.

" 'Yours truly,
" 'DAVID FENNER.

" 'P.S.—The interval between cues is 8 secs., not 10.' "

"Well, that's very nice," remarked Dick. "And I always did think that your 10 second figure was wrong. I've been checking with my watch at the cinema and I've made it eight seconds every time."

Smithy looked suspiciously at his assistant, but Dick's expression was completely guileless.

"Also," continued Dick, "the only times I've seen bad scratches on the emulsion has been on Continental 'X' films which have been going around for years."

Smithy looked slightly embarrassed.

"Well, I suppose," he remarked, "that as one gets older one tends to search for film entertainment which is a little more sophisticated than the ordinary run of things. Films," continued the Serviceman, "whose subject matter is a little *meatier* . . ."

By now, Dick had completely failed to retain his straight face, and the remainder of Smithy's remarks were lost in derisive laughter.

[1] "In Your Workshop", January 1960 issue.

[2] This letter was sent by David Fenner of Dunstable, who is a projectionist at the Odeon, Luton.

I.A.R.U. REGION I CONFERENCE

An International Amateur Radio Union (Region I Division) Conference will be held at the Grand Hotel, Folkestone, Kent, from Monday 13th June to Friday 17th June, 1960, with the Radio Society of Great Britain acting as Host Society.

Invitations to attend the Conference have been sent to all subscribing I.A.R.U. Member Societies in Region I and acceptances have been received from Denmark (E.D.R.), Finland (S.R.A.L.), France (R.E.F.), Germany (D.A.R.C.), Ireland (I.R.T.S.), Italy (A.R.I.), the Netherlands (V.E.R.O.N.), Norway (N.R.R.L.), Poland (P.Z.K.), Spain (U.R.E.), Sweden (S.S.A.), Switzerland (U.S.K.A.), Yugoslavia (S.R.J.). Replies are awaited from Belgium (U.B.A.) and Luxembourg (R.L.).

In addition to the delegates officially appointed by the Member Societies, observers will be permitted to attend the Conference provided their names and addresses are submitted to the General Secretary of the R.S.G.B. at least two weeks before the opening of the Conference.

Visitors to the Conference will be accommodated at the Grand Hotel at the specially reduced **inclusive charge of 50s. per day** which will cover service and all meals (breakfast, lunch, afternoon tea and dinner). The hotel —situated on the famous Leas—has a commanding view of the English Channel and is one of the best appointed on the south coast.

The Conference will be opened at 2.30 p.m. on Monday 13th June by the Mayor of Folkestone, after which a Plenary Meeting will be held to elect the chairmen and secretaries of committees. Three main committees will be set up, namely, Administrative and Operational, Technical and V.H.F., plus an *ad hoc* Credentials and Finance Committee.

A tentative programme of events is set out as follows:

Sunday 12th June
Delegates assemble at the Grand Hotel

Monday 13th June
9.30 a.m. Meeting of the Executive Committee
2.30 p.m. Official Opening
3.00 p.m. Plenary Meeting
4.00 p.m. Meetings of main Committees
5.00 p.m. Meeting of Credentials and Finance Committee
9.00 p.m. Film show "The Geneva Radio Conference" by Major Per-Anders Kinnman, SM5ZD (Vice-Chairman Executive Committee)

Tuesday 14th June
9.30-5.30 p.m. Meetings of Committees
9.00 p.m. Display of colour transparencies by Mr. Arthur Milne, G2MI, and Dr. Arthur C. Gee, G2UK

Wednesday 15th June
9.30-5.30 p.m. Meetings of Committees
8.00 p.m. Evening Coach Trip

Thursday 16th June
9.30 a.m.-12.30 p.m. Free for shopping
2.30 p.m. Visit to Canterbury and the Weald of Kent as guests of the Mayor and Corporation of Folkestone

Friday 17th June
9.30—5.30 p.m. Plenary Meetings
7.30 p.m. Conference Dinner

Saturday 18th June
Delegates depart

The cost of the Conference Dinner is not expected to exceed 21s. a head.

The Folkestone Corporation is to issue trilingual privilege tickets which will enable delegates, observers, and their ladies to enjoy many local facilities free of charge.

Further details can be obtained from the General Secretary of the R.S.G.B. (Mr. John Clarricoats, O.B.E.), 28 Little Russell Street, London, W.C.1.

UNDERSTANDING TELEVISION

PART 28

By W. G. MORLEY

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

In last month's article in this series we discussed the construction of the line output transformer, and dealt with line output stage circuits which differ from the more conventional arrangements described earlier. We now carry on to methods of improving e.h.t. voltage regulation, to the question of interference generated by the line output stage, and to width controls.

Improving E.H.T. Regulation

Several circuit devices may be encountered in television line output stages whose function is that of improving e.h.t. regulation and of keeping e.h.t. voltage stable despite changes in mains supply voltage or long-term line output valve aging.

The simplest, and probably most frequently encountered, stabilising circuit takes advantage of the Metrosil (manufactured by Associated Electrical Industries), a device whose resistance decreases sharply as the voltage applied to it increases.[1] It is usual to connect a Metrosil rod of suitable rating directly between the cathode of the e.h.t. rectifier and chassis. If, for any reason, e.h.t. voltage rises, the Metrosil rod draws an increased current which counteracts the rise. The reverse action—reduced current through the Metrosil rod—occurs if e.h.t. voltage drops. Thus, a stabilising effect takes place.

Another, more complex, technique which has been introduced in recent receivers employs a Voltage Dependent Resistor (V.D.R.).[2] As with the Metrosil, the resistance of a V.D.R. decreases as the voltage across it increases. Use is made of this property to cause varying grid bias voltages to be applied to the grid of the line output valve, these bias voltages being such as to counteract the effects of rises or falls in e.h.t. voltage. A typical basic circuit application appears in Fig. 163. In this diagram flyback pulses having an amplitude around 1,500 volts are taken from a tap in the anode winding of the line output transformer and are fed, via C_1, to the V.D.R. The resistance of the particular type of V.D.R. used in this application drops steeply around 1,000 volts, with the result that C_1 becomes charged such that the tips of the pulses take up a position, when measured on the upper terminal of the V.D.R., approximately 1,000 volts above chassis, as in Fig. 164 (*a*). If, for some reason, the e.h.t. voltage rises, the flyback pulses will increase in amplitude, as they do in Fig. 164 (*b*). However, the steeply falling resistance of the V.D.R. around 1,000 volts causes the tips of these higher-amplitude pulses, as measured on the V.D.R. upper terminal, to take up a position which is only slightly higher than that held in Fig. 164 (*a*.)

[1] The current flowing through a Metrosil product varies as the fourth or fifth power of the voltage applied across it.

[2] Voltage Dependent Resistors for the application described here are manufactured under the trade name Varites, by Mullard Ltd.

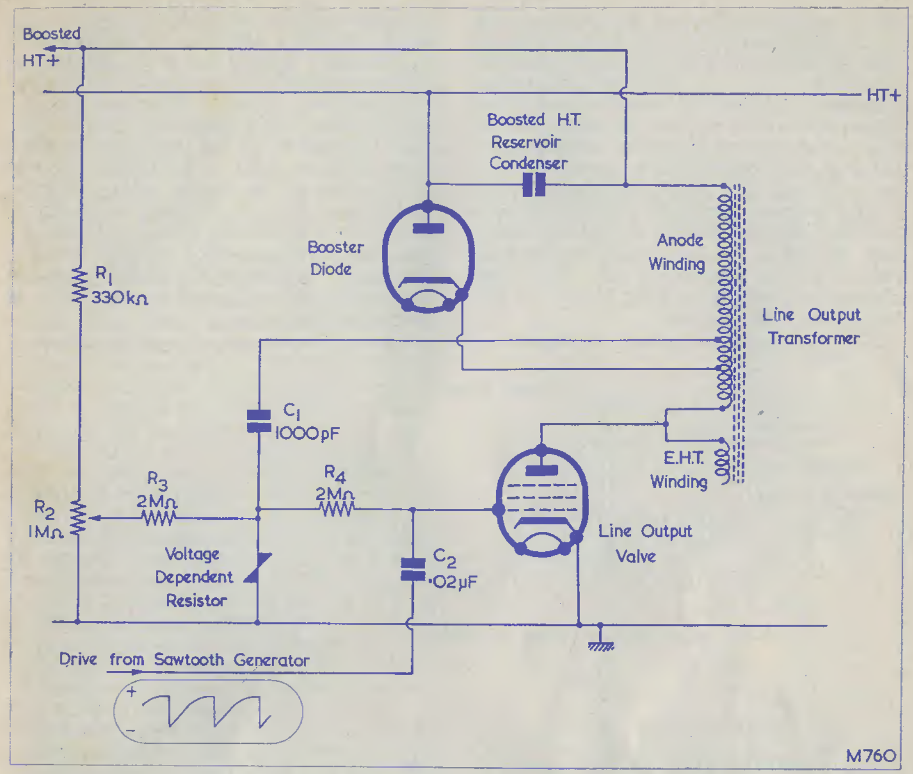


Fig. 163. Basic circuit of a line output stage having its e.h.t. voltage stabilised with the aid of a Voltage Dependent Resistor

(The effect of the V.D.R. is rather similar to that of a diode which is cut off below 1,000 volts and which commences to conduct at that figure; with the exception that the increase in current through the V.D.R. due to increasing voltage is not as abrupt as it would be with the diode.) It will be noted, in Fig. 164 (*b*), that the waveform between pulses is shifted to a significantly lower potential than it held in Fig. 164 (*a*). Since the pulses occupy a very small fraction in time of each cycle the average voltage of the waveform is very close to the voltage existing between pulses. In consequence the average voltage in Fig. 164 (*b*) is also markedly lower than is that in Fig. 164 (*a*). The circuit diagram of Fig. 163 shows that the voltage on the upper terminal of the V.D.R. is applied to R_4. This resistor, in combination with C_2 (whose lower plate connects to the relatively low impedance of the preceding "sawtooth-forming circuit"), causes the pulses to be removed and the average voltage of the waveform to be applied to the line output grid. We thus have the case where, when flyback pulses increase in amplitude, the grid bias of the line output valve is made to go negative. In other words, a stabilising loop has been set up by means of which an increase in e.h.t. voltage causes a counteracting decrease in line output valve anode current. The resistors R_1, R_2 and R_3 in Fig. 163 are used to initially set up the V.D.R. to its correct operating point, and to ensure that the average voltage applied to the line output valve grid is within its control range.

Line Output Stage Interference

Due to the relatively high potentials and frequencies involved in line output circuit operation, this stage is liable to give rise to parasitic oscillations which, on being picked up by the aerial or early circuits in the receiver, appear on the cathode ray tube screen as interference. When they exist, such parasitic oscillations normally occur at the same point during the deflection cycle, whereupon they appear at the same position on each line reproduced by the cathode ray tube. The result is a fixed vertical bar or line (normally white in positive modulation receivers and black in negative modulation receivers) on the picture. Parasitic oscillation bars may occur anywhere on the picture, although they usually tend to appear between the left-hand side and the centre. They should not be confused with the vertical *striations* (stripes) caused by leakage reactance ringing in the line output transformer, (which will be discussed later). The latter always have highest amplitude on the left-hand side of the picture.

of by connecting a very high frequency tuned circuit (usually a pair of short parallel rods, or "resonant lines") to grid and anode, whereupon oscillations occur at the frequency of the tuned circuit. Reverting to line output stages, the supposition is made that, since the anode of the line output valve might at some point in the deflection cycle be negative of its screen grid, the basic requirement of a Barkhausen oscillator is brought into existence. Barkhausen oscillations may, in consequence, occur at resonant frequencies dictated by the circuit constants around the valve including, especially, its connecting leads.[3]

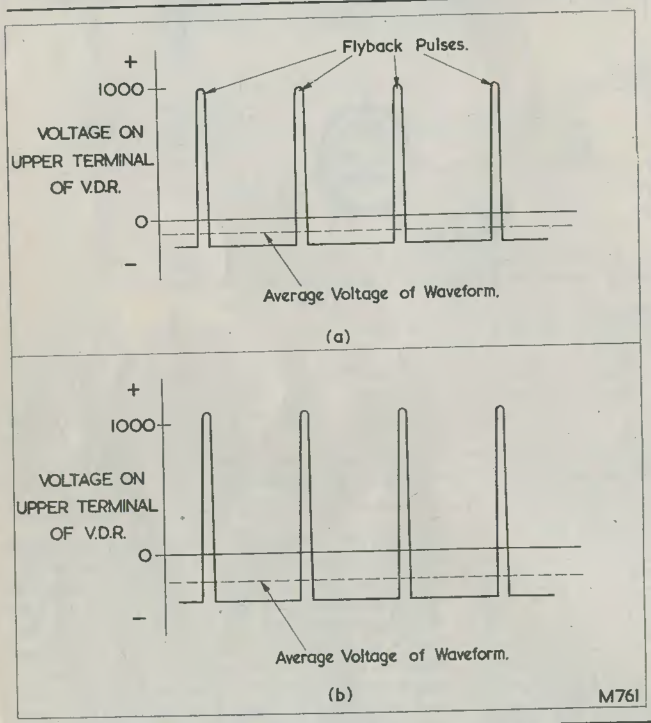


Fig. 164. The voltages appearing across the V.D.R. of Fig. 163. The flyback pulses increase in amplitude in (b) but, because of the steeply falling resistance of the V.D.R. around 1,000 volts, their tips take up a position only slightly higher than that in (a). In consequence, the average voltage in (b) is more negative than it is in (a)

Line output stage parasitic oscillations are frequently described as Barkhausen oscillations. The basic Barkhausen (more accurately Barkhausen-Kurtz) oscillator employs a triode whose grid is positive and its anode negative of cathode. The inertia of electrons emitted from the cathode causes many of them to pass through the wires of the positive grid, only to be repelled by the negative anode. Many of the repelled electrons again pass through the grid, to become repelled once more by new electrons from the cathode. This continual movement back and forth of electrons may be taken advantage

It would seem, in practice, that at least some of the cyclic interference produced by the line output stage is the result of Barkhausen oscillations, and especial care has to be taken during design to prevent the occurrence of such oscillations. Apart from the obvious course of paying especial attention to valve operating conditions, the more usual methods of obviating oscillations consist of inserting small chokes in series

[3] The valve conditions referred to here would also theoretically cause dynatron oscillations. However, it appears unlikely that dynatron oscillations occur in practice.

with the anode of the line output valve and, less frequently, with the cathode of the booster diode. Such chokes are normally inserted in the flying leads to these electrodes, being positioned close to the appropriate valve connector. It is, also, very common practice to connect a resistor having a value between 400Ω and 1kΩ between the grid of the line output valve and its drive circuit, this resistor being mounted close to the appropriate valve pin.

In a number of magazines covering television servicing it has been stated that Barkhausen oscillations in receivers under repair have been successfully cleared by fitting permanent magnets close to the line output valve envelope. These magnets are intended to alter the paths taken up by electrons inside the valve and to modify, therefore, the Barkhausen effect.

Other causes of line output stage interference are frequently such obvious faults as corona or poor connections in the line output stage or transformer, the latter causing the appearance of small sparks. The effects of interference of this type may be evident during the flyback period only, with the result that no visible effects may be seen on the cathode ray tube screen. Such interference may, however, be picked up on a neighbouring receiver tuned to another transmitter and whose line sawtooth generator is not, in consequence, exactly in synchronism with that of the interfering receiver. In such a case the interference will be evident as a vertical bar moving randomly from side to side of the picture.

A further type of interference from line output stages is that resulting from r.f. radiation. Unless the line output stage is adequately screened, harmonics of the line frequency may cause interference on the lower frequency bands of neighbouring radio receivers.

Width Controls

The function of a width control is that of varying the width of the picture reproduced on the cathode ray tube screen, this being done in most instances by varying the sawtooth currents flowing in the line deflector coils. Ideally, a width control should not cause alterations in line linearity. In practice, however, there is almost always a slight interdependence between width and line linearity controls inasmuch that an adjustment of one requires a compensatory adjustment in the other. In a good design this interdependence is kept to a low order, and small changes may be made in width control settings without seriously affecting linearity. It is also possible for large width control adjustments to vary the e.h.t. voltage generated by the line output stage. In this instance it is usual practice to ensure that correct e.h.t. voltage is obtained when the

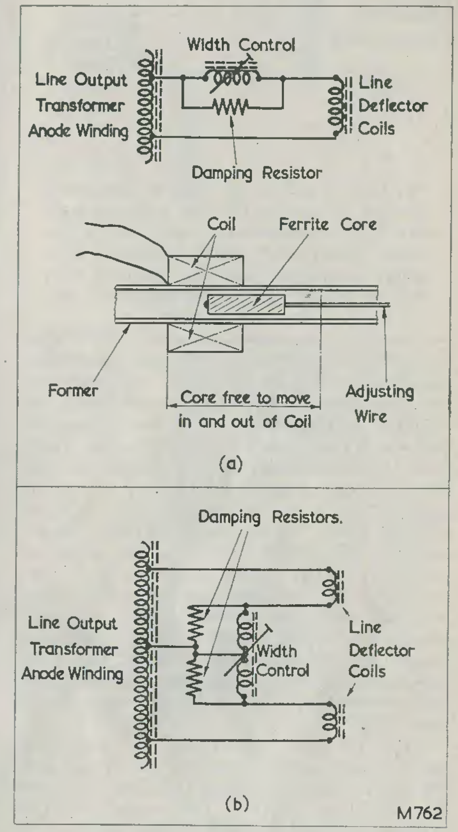


Fig. 165 (a). A Series reactance width control. Varying degrees of core insertion into the coil cause different reactances to appear in series with the line deflector coils, thereby controlling the sawtooth current flowing in them. A cross-section through a typical assembly is also shown. (b) Occasionally, the width control coils may be wound in two sections, as shown here

width control is at the design centre setting for the run of receivers being produced.[4]

The width control arrangements employed

[4] "Design centre" refers to the conditions existing when all components are in the centre of their tolerance.

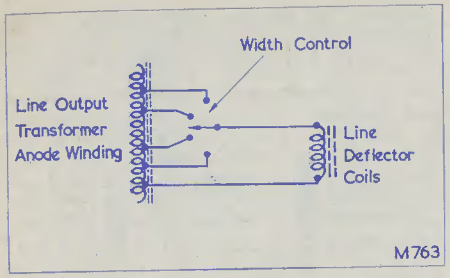


Fig. 166. A control of width is sometimes effected by tapping the line deflector coils into different numbers of turns in the line output transformer anode winding. Usually, the variable taps are obtained with the aid of a short-circuiting plug and socket assembly

in domestic television receivers vary considerably so far as principles of operation are concerned. They may, nevertheless, be roughly categorised into the following different types: circuit arrangements which insert a variable reactance in series with the line deflector coils, circuits which allow the deflector coils to be tapped into different sections of the line output transformer anode winding, circuits which vary the inductive constants in the "sawtooth-forming circuit" provided by the line output transformer winding and the deflector coils, circuits which alter line output valve operating conditions, and devices which vary the deflection efficiency of the line deflector coils. We shall deal with the controls in this order.

Fig. 165 (*a*) illustrates a commonly encountered width control of the type which inserts variable reactance in series with the line deflector coils. The width control consists of a coil, together with a ferrite core, which is capable of being moved in or out of it.[5] When the ferrite core is fully in the coil the latter offers maximum inductance. In consequence, moving the ferrite core in and out of the coil causes the latter to present a varying reactance in series with the line deflector coils, thereby altering the current which flows through them. A control of picture width results. Unless precautions are taken, the width control coil of Fig. 165 (*a*) is liable to be shock-excited by the rapid change of current which occurs in the flyback period, with the result that ringing currents may become superimposed upon the sawtooth current fed to the deflector coils by the line output transformer. Ringing is obviated by connecting a low-value damping resistor (normally 1 to 3kΩ) across the coil. There is also the fact that the effective inductance of the coil may reduce as current increases owing to the greater magnetising force exerted on the core. Different amounts of core insertion can, therefore, offer different degrees of change in inductance during the scan period, with the result that adjustments of the width control cause alterations in linearity. This effect may be reduced by using a fairly large core, typical examples having diameters of the order of ¼-inch, and by designing so that only a small amount of core insertion is needed for correct width in the average receiver of a production run. Occasionally the circuit arrangement of Fig. 165 (*b*) is employed in order to reduce the effect of varying inductance. In this diagram two coils with equal numbers of turns are employed in the width control, the current flowing in one being in the opposite direction to that in the other. Due to this, the total magnetising force on the core decreases considerably, thereby reducing changes in linearity for changes in width control setting. A basic disadvantage with the series reactance width control of Fig. 165 (*a*) or (*b*) is that it incurs an unavoidable waste of power, the line output valve and transformer having to provide scanning power greater than that needed for full picture width in order to make up for that lost in the series width control.

Fig. 166 illustrates a width control circuit arrangement which allows the line deflector coils to be tapped into different numbers of turns in the line output transformer anode winding, maximum width being given when the deflector coils tap into the greatest number of turns. This method of width control causes picture width to be varied in discrete steps, and does not allow for incremental adjustment between taps. A step-by-step adjustment of this type is acceptable enough in practice owing to the usual custom of slightly "overscanning" the picture reproduced by the cathode ray tube.[6] The width control of Fig. 166 is adjusted to the lowest tap which causes overscanning, the viewer being unconscious of the amount of overscan. Tapping into the line output transformer winding is usually achieved with the aid of a simple short-circuiting plug and socket assembly, the socket being made such that the plug may be inserted into a number of different positions corresponding to different line output transformer tappings. The circuit of Fig. 166 has the advantage that no scanning power is wasted. On the other hand, it possesses the disadvantage that the line output transformer anode winding has to have a relatively large number of taps, thereby increasing winding time in production, and complicating mechanical design.

[5] The term "ferrite" is applied to non-ferric (non-iron) magnetic materials such as Ferroxcube or Ferramic, in order to differentiate them from dust-iron materials (such as are used in r.f. and i.f. coils).

[6] When a picture is "overscanned" its edges fall outside the mask area, or outside the screen area if a "push-through" method of cathode ray tube presentation is employed.

Fig. 167 (*a*) illustrates a width control circuit which alters the effective inductance of the line output transformer anode winding, thereby varying the constants of the "sawtooth-forming circuit" formed by the anode winding and line deflector coils. A coil with an adjustable ferrite core is connected across part of the anode winding of the line output transformer. The combined inductance of the anode winding, deflector coils and width control coil is then at its greatest when the core of the coil is fully inserted, this setting corresponding to maximum width. No scanning power is needlessly dissipated with this arrangement. A minor disadvantage with the parallel width coil of Fig. 167 (*a*) is that it usually requires a relatively high range of inductance variation if it is to exert sufficient control, and this results in the coil having to be wound with many more turns than would be required for the series reactance control. There is also the fact that, being ferrite cored, varying currents in the coil are liable to cause varying inductances, with consequent effects on line linearity. It is not necessary to damp the parallel width control coil to prevent ringing, as its inductance and stray capacity enter into the composite inductance and stray capacity offered by the anode winding and deflector coils.

Frequently, the width control arrangements of Figs. 165 (*a*) and 167 (*a*) are combined together in the manner shown in Fig. 167 (*b*). In this arrangement two sets of coils are wound on one former, along the inside of which a ferrite core is free to move. The two windings are so positioned that as the core leaves one coil it commences to enter the other. When the core is fully inserted into the series coil, L_2, this offers maximum reactance to the flow of deflector coil current. At the same time the core is fully out of the parallel coil, L_1, with the result that the latter causes minimum effective inductance to be offered by the line output transformer anode winding. Both L_1 and L_2 are, in consequence, in conditions which correspond to minimum width. As the core is moved out of L_2 and into L_1, the former offers less series reactance whilst the latter causes the effective inductance offered by the anode winding to increase. In consequence, the picture reproduced by the cathode ray tube widens. When the core is completely out of L_2 and fully inserted into L_1, the former offers minimum series reactance and the latter maximum inductance. Picture width is, then, at its maximum. By combining the two types of width control in this fashion it becomes possible for each to have a reduced range of control with the result that, under practical conditions, each coil requires fewer turns than it would if it

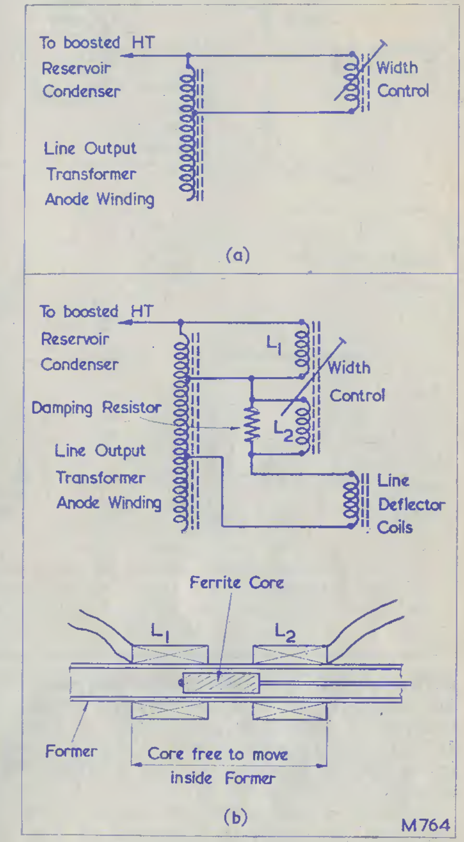


Fig. 167 (a). A width control consisting of a ferrite cored coil connected across part of the line output transformer anode winding. The ferrite core is capable of being moved in and out of the coil, as in Fig. 165 (a), thereby varying its inductance and, in consequence, the combined inductance of the anode winding and line deflector coils. In order to reduce the potentials above chassis existing on the coil, it is usual to tap it into the boosted h.t. reservoir condenser end of the winding. (b) Frequently, the series reactance control of Fig. 165 (a) is combined with that of Fig. 167 (a) in the manner shown here. The ferrite core moves out of one coil into the other as shown in the cross-sectional view

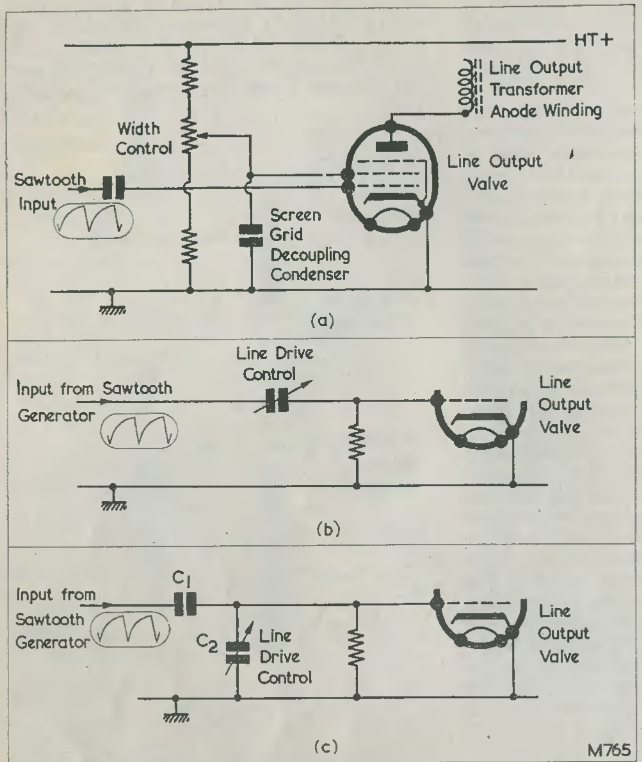


Fig. 168 (*a*) *A width control which varies line output valve operating conditions. By altering screen-grid potential, the potentiometer controls the anode current drawn by the valve.* (*b*) *A line drive control which alters the amplitude of the sawtooth waveform applied to the line output valve.* (*c*) *A version of* (*b*) *which enables the moving vanes of the variable condenser to be at chassis potential*

were employed on its own and that magnetising forces on the core are correspondingly lowered. Occasionally, the circuit of Fig. 165 (*b*) is combined with that of Fig. 167 (*a*) in a similar manner to the composite arrangement of Fig. 167 (*b*).

A circuit which varies line output valve operating conditions is illustrated in Fig. 168 (*a*). In this diagram the width control consists of a potentiometer which varies the screen grid potential of the line output valve. In so doing it controls the anode current drawn by the valve during the scan period of the cycle and, therefore, the magnitude of the current flowing through the line output transformer anode winding and the deflector coils. A control of width is thereby effected. This particular arrangement has been occasionally employed, mainly in American receivers. Another type of width control which falls more or less in the same category is shown in Fig. 168 (*b*). This control should, more accurately, be described as a "drive control", as it varies the amplitude of the sawtooth waveform applied to the line output valve grid. The control is provided by a variable condenser and it offers a variable reactance in series with the output of the sawtooth generator. Another version of this circuit is illustrated in Fig. 168 (*c*). In this case the variable condenser C_2 forms a condenser potentiometer with the fixed condenser C_1. When C_2 is at maximum capacity, it offers least reactance and the input waveform to the output valve grid has minimum amplitude. The circuit of Fig. 168 (*c*) has the advantage over that of Fig. 168 (*b*) that the moving vanes of the variable condenser may be at chassis potential, thereby easing assembly problems. Both of the arrangements of Figs. 168 (*b*) and (*c*) are common in American receivers. Their main function is that of ensuring that the line output stage works under correct conditions, insofar as line output valve anode current and e.h.t. voltage are concerned, and they assist in providing a control of picture width.

Fig. 169 illustrates a device which varies the deflection efficiency of the line deflector coils. The control consists basically of a thin-wall cylinder of non-magnetic metal, such as brass or copper, which is free to slide partly under the deflector coil assembly

on the cathode ray tube neck. The changing magnetic field generated by the line deflector coils induces currents in the cylinder which, in their turn, generate an opposing field. As the cylinder is moved into the space between the deflector coils and the tube neck the opposing field it produces increases, with the result that line deflection of the electron beam decreases. A control of picture width is, in consequence, conveniently available by movement of the cylinder, maximum insertion corresponding to minimum width. The cylinder also produces a magnetic field opposing that generated by the frame deflection coils but, since the rate of change of field in this instance is much lower, the currents induced in the cylinder and, hence, the opposing field, are considerably smaller. For the amounts of insertion employed in practical designs the effect of the cylinder on frame deflection efficiency is negligible. The device of Fig. 169 has been used extensively in recent years, especially in American receivers, and it has the advantages of considerable cheapness and simplicity. In practical applications it is usual to design the deflector circuit such that only a small amount of insertion of the cylinder is necessary for correct width. This is to prevent unnecessary dissipation of deflection power, and to avoid excessive induced current flow in the cylinder and resultant overheating.

Next Month

The writer had hoped to discuss line linearity controls and to introduce the subject of deflector coils this month, but we have already come to the end of our available space. We shall, in consequence, carry on to line linearity circuits and deflector coil assemblies in next month's issue.

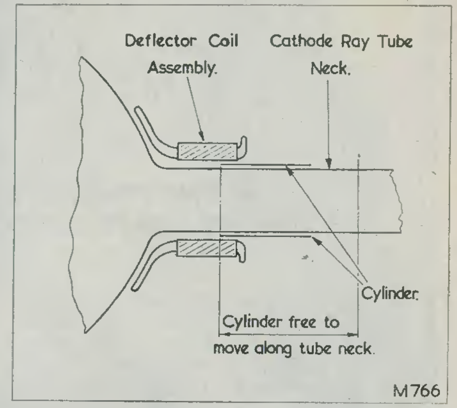


Fig. 169. *Cross-sectional view showing a type of width control assembly in which a thin-wall metal cylinder is moved along the cathode ray tube neck, partly under the deflector coil assembly. The line deflector coils induce currents in the cylinder which, in their turn, generate an opposing field; the effect being greater as the cylinder is inserted further under the deflector coil assembly*

A Simple Morse Practice *Buzzer*

For the beginner needing morse practice, this simple buzzer may prove useful. The few components required are all cheap, and readily obtainable. They are: a small Morse key, a single *low* resistance earphone, a single carbon microphone insert, a three volt cycle lamp battery, a short length of insulation tape and some bell flex. A glance at Fig. 1 will give an idea how it functions.

As will be seen, the single earpiece and carbon microphone are physically strapped together (insulation tape does this nicely), and these and the Morse key are all series-connected with the battery. On pressing the key, the circuit is completed, and due to the close proximity of the microphone to earphone, a loud audio note will be produced. The tone, though not quite T9, is perfectly easy to copy, and much useful code practice is possible using this simple arrangement.

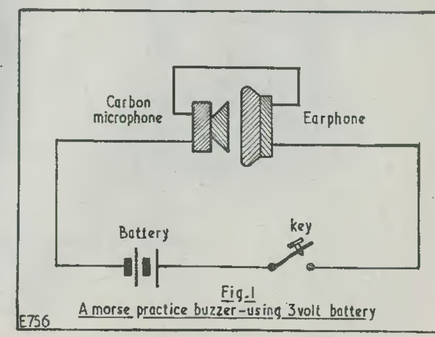


Fig. 1
A morse practice buzzer-using 3volt battery

The LITON

A PHOTO-ELECTRIC PARKING LIGHT SWITCH

Described by J. M. Ankers

Part 2

The parking light assembly, described in the last issue, is only capable of switching on or off a 6 or 12V single bulb. With suitable modifications, and the addition of a secondary relay, the unit may be used to control either a parking light or the side and tail lights, according to the car owner's requirements, simply by operating an integral switch.

Before further continuing with a descrip-

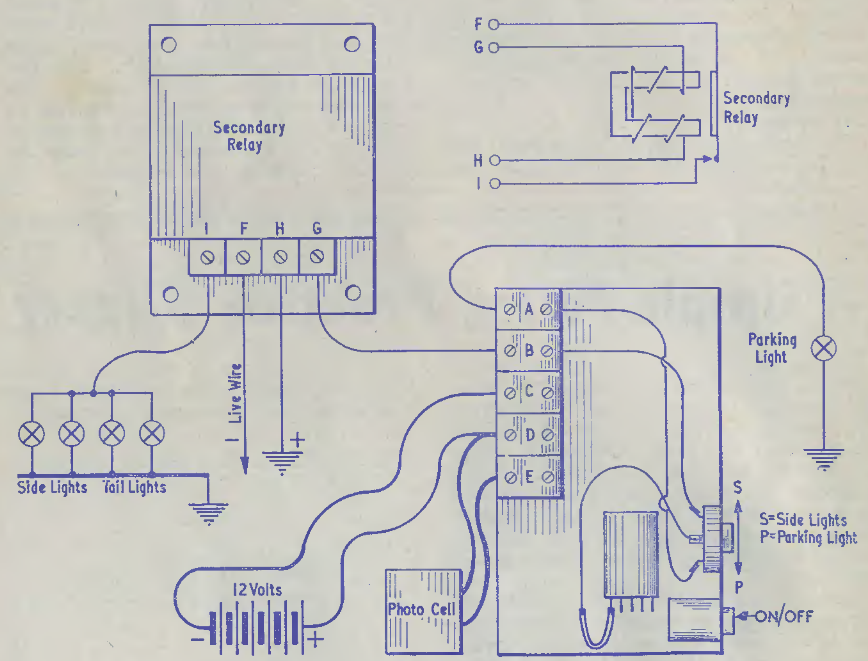
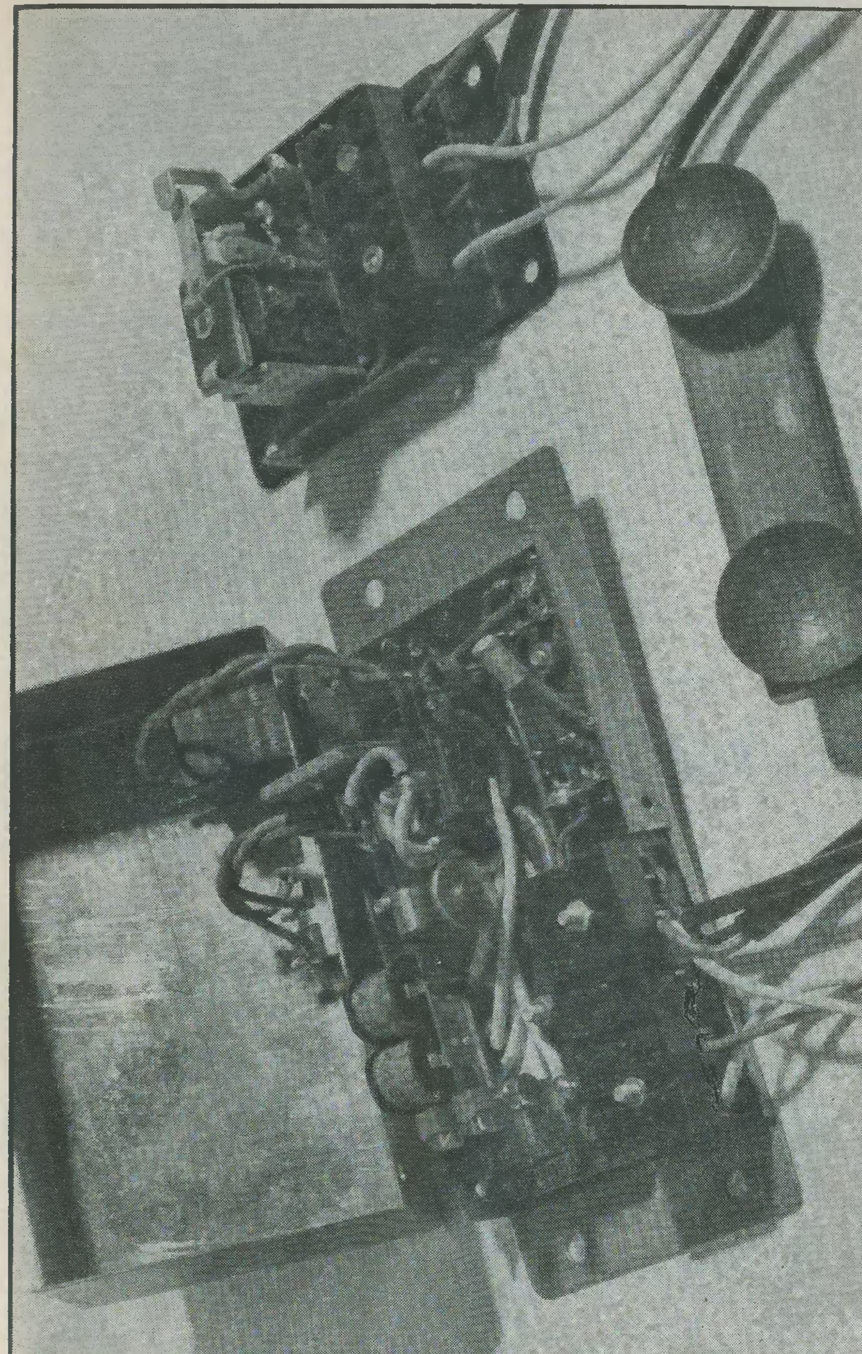


DIAGRAM OF CONNECTIONS OF SECONDARY RELAY
[12 VOLTS POSITIVE TERMINAL EARTHED]
FIG. 8

G 619



tion of these alterations and additions, a word or two about adjusting the relay of the original unit may not come amiss. The relays themselves are adjusted correctly as supplied, but the do-it-yourself fraternity being of an experimental nature, the relays are often altered in an attempt to "improve" the action. The usual result is that the "improver" is unable to correctly re-set the relay with the end result being—no result! The most reliable operation is obtained when the relay is adjusted to pull at $4mA \pm 0.5mA$ and to release at $2mA \pm 0.5mA$. The gap should be set at about 0.004 in.; which, for those who have some, is the thickness of a one-pound note!

After completing the assembly, as described, some constructors are unable to get the switch working at all. It has been found from experience that the most common cause of a non-working unit is that the transistor, or the photocell, has been connected the wrong way round. Connecting the full voltage to the photocell will, in most cases, permanently damage the cell.

Modifications

In Fig. 8 all the modifications and additions to the original unit are shown. The position of the added slide-switch may be clearly seen. The sequence of these modifications is as follows.

(1) Remove the link between contacts (B) and (D) on the connecting block of the "Liton" unit. (See Fig. 4, page 689, April issue.)

(2) Connect a wire from terminal (1) of the "Liton" relay to the centre of the slide switch instead of to (A) of the terminal block.

(3) Connect the terminal of the changeover switch, near the on/off switch, to (A) on the connecting block, and the terminal furthest from the on/off switch, to (B) on the connecting block.

(4) Join (B) to (G) on the added secondary relay block.

(5) Connect the live and neutral wires to (F) and (H).

(6) With a length of wire, join (I) to one wire of the car wiring going to the side and tail lights.

(7) Connect the parking light between (A) and chassis.

The modifications are now completed. Moving the slider switch towards (P) will operate the parking light; and towards (S), side lights and tail lights. The secondary relay can, of course, be mounted under the bonnet and not necessarily in the car body itself. *(To be continued)*

Useful Power Unit

By **J. HILLMAN**

Description

This unit is intended for use with various pieces of test gear and avoids having to use power packs for each unit. It will supply 350 volts at 80mA h.t., 1kV at 1mA e.h.t., 4 or 6 volts at 4 amps l.t., 6 volts 1.5 amps for supplying c.r.t. heaters.

Construction

First take a piece of aluminium 9in by 8in and mark off as in Fig. 1. Drill the holes first and then bend the edges at right-angles. Now paint with black crackle paint and put aside to dry. Take a piece of aluminium 15in by 12in and mark off as in Fig. 3 and cut out as shown, then bend the sides and back at right-angles to form the chassis. Place the front panel up to the chassis and mark off holes to join the two pieces together, after having bolted the chassis at its corners. The finished unit should now appear as in Fig. 4.

Mount the components as shown in Figs. 5 and 6, and cut out the holes from the bunt of the chassis as shown in Fig. 2, then moack the valveholders. The warning light is mounted at the left side of the front panel, whilst the mains switch is mounted on the right. The sockets at the bottom of the front panel are, reading from left to right, 0V, 4V, 6V, l.t.; 1kV e.h.t.; h.t.+; h.t.–.

Wire up as shown in Fig. 7; note that only the middle socket at the back of the chassis carries the e.h.t. and c.r.t. heaters—the other two are wired in parallel for h.t. and l.t.

If only 600 volts e.h.t. are required, then the 0.1μF condenser at pin 4 of the 5Z4G and the final K3/25 rectifier can be removed. A warning light is wired across the 6V heater winding to indicate when the unit is switched on. The h.t. circuit is protected by a 100mA fuse in the h.t.– side and the mains transformer is protected by two 1 amp fuses in the leads from the transformer to the switch.

No cover is used for the top of the chassis

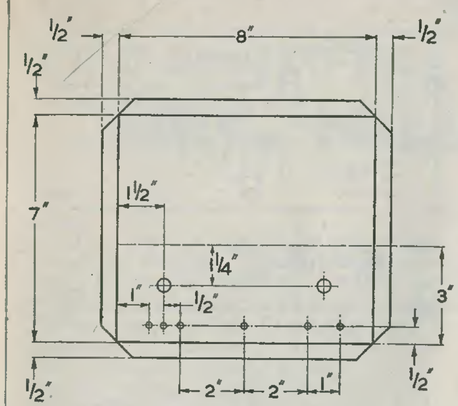


FIG.1
Front Panel

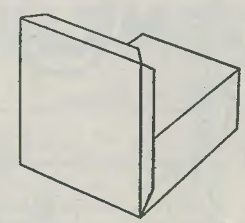


FIG.4

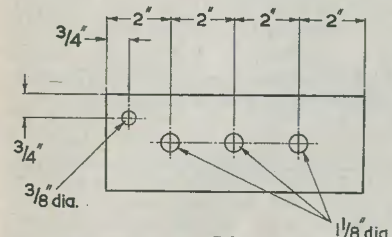


FIG.2
Back Panel

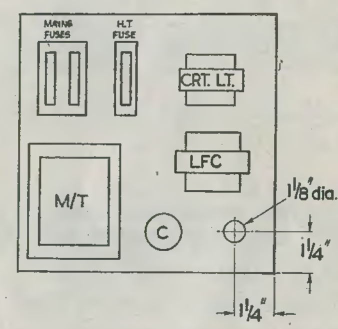


FIG.5
Above-chassis Layout

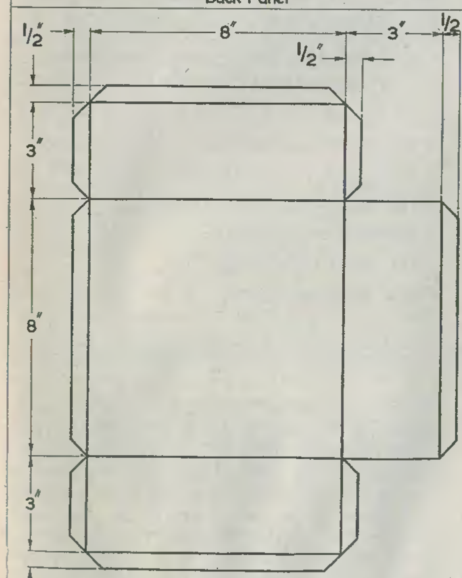


FIG.3.
Chassis

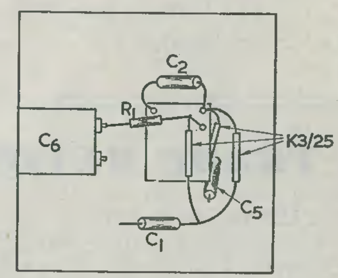


FIG.6
Below-chassis Layout

M738

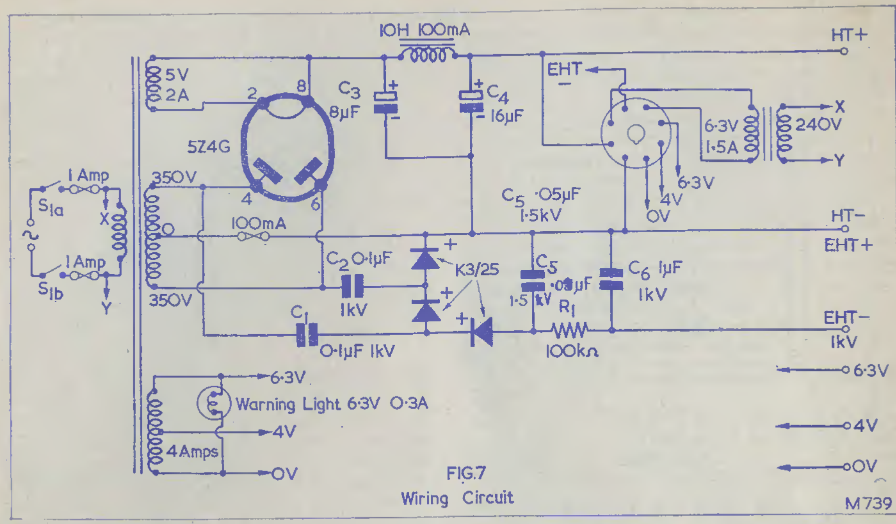


FIG.7 Wiring Circuit

as it was not felt necessary, but if one is used then make sure that adequate ventilation is provided. A suitable cover can be made out of perforated zinc sheet, as this gives plenty of ventilation as well as protection.

Components List

- 1 mains transformer 350–0–350V 80mA 5V 2A; 0, 4, 6V, 4 amps, Elstone
- 1 d.p.s.t. toggle switch
- 1 twin fuseholder, baseboard type
- 1 single fuseholder, baseboard type
- 2 1 amp $1\frac{1}{4}$in glass fuses
- 1 100mA glass fuse
- 1 10H 100mA l.f. choke
- C_3, C_4 1 8+16uF can elect. 450V wkg
- 3 K3/25 e.h.t. rectifiers
- C_1, C_2 2 0.1µF 1kV tubular condensers
- C_5 1 0.05µF 1.5kV tubular condenser
- C_6 1 1µF 1kV block paper condenser
- R_1 1 resistor 100kΩ
- 1 5Z4G valve
- 4 int. octal valveholders
- 1 6.3V 1.5A l.t. transformer
- 1 red panel light—Radiospares
- 1 bulb 6.3V 0.3A m.e.s.
- 3 int. octal valve plugs
- 6 wander plug sockets

TRADE REVIEW

STEADFAST PAD SAW

J. Stead & Co. Ltd., Manor Works, Cricket Inn Road, Sheffield 2, have forwarded to us, for test purposes, this latest addition to their well-known range of high grade tools. This multi-purpose pocket tool incorporates two padsaw blades, together with a knife edge cutter, contained within a translucent amber plastic handle—this being specially designed and shaped to give a strong and comfortable grip. The coarse tooth padsaw is for cutting soft materials whilst the fine tooth blade is that for hard materials. All three blades, when not in use, fit snugly within the plastic handle—the whole tool then being contained in a strong plastic wallet. Spare blades are available and the complete pad saw may be obtained from most tool dealers and ironmongers at 6s. each.

Further notes on the A.C. MILLIVOLTMETER

By A. Bartlett Still

It has become apparent from correspondence that the type of instrument described in the February issue was of interest to a wide range of readers, and the Editor has suggested that I take this opportunity to clarify a few points and answer one or two queries that have been raised.

The two voltage amplifying stages of the amplifier circuit (Fig. 1, February 1960, page 520) seems to have been accepted as straightforward, but it is believed that some further explanation of the input and output stages would be helpful. The input cathode follower was quoted as having an input impedance of 10MΩ. This is not a calculated figure, but was measured by the simple device of applying a suitable signal to give an f.s.d. reading on the meter. Series resistance was then inserted in the input, making a potential divider with the internal input impedance, until the reading dropped to half scale. At this point the series resistance must equal the input impedance. The output impedance (1,000 ohms) can be similarly checked, though in this instance the test resistance should be in parallel with the meter, as an additional load. It should be noted that although these figures can be calculated, this is difficult, due to the fact that the valve information available will probably not be correct for the conditions of use that apply here.

Another query concerns the conditions of use of the attenuator, and the function of the resistor R_3 (or R_4). The attenuator is of the ladder type, having a constant input impedance of 68kΩ; this being, in fact, the cathode load of V_1. This figure of 68kΩ, and the attenuation of 10dB per step, is only correct if the network of 100kΩ and 150kΩ resistors continues for an infinite number of steps on either side. To simulate this we have AR_1 of 200kΩ, as also are R_3 and R_4. With this arrangement the operating conditions of V_1 do not vary, although the attenuator represents the cathode load which, in itself, means that there is no attenuator insertion loss.

The meter shown was built up around a 100µA movement, but it is not necessary to insist on this. Any value up to 1mA can be used without affecting the calibration of the amplifier in any way, but it should be remembered that the type of rectifier used will affect the frequency response, not of the amplifier but of the indicator.

Calibration of the completed instrument does not seem to have been completely understood. I suspect that readers cannot believe it is so simple! Here is the complete procedure, step by step, taking an AVO as a standard.

(1) Connect the AVO and the Indicator to (say) a 6.3V transformer winding and adjust the meter series resistance as necessary.

(2) With the attenuator all in, connect the AVO to the output of the amplifier and apply the 6.3V signal to the input. Adjust the 1MΩ preset R_{13} until the AVO reads correctly. Replace the AVO by the Indicator as a check.

(3) Check the value of R_{13} as set (about 500–600kΩ) and replace by 100kΩ preset together with appropriate fixed resistor. Repeat 1 and 2.

(4) Switch to Attenuate, apply a known signal of 20–30V, and, with the attenuator all out, set R_6 to give a voltage drop of 10dB.

It will have been noted that SW_1 has three positions. The central, off, position will be found very useful for isolating the indicator to prevent damage to the movement.

With the meter disconnected, the Amplifier unit can be used in a variety of ways. The 30V r.m.s. limitation on input and output is due to the saturation level of the cathode followers. The lower limit of signal handling is dictated by noise. On the unit described, this was equal to an input of 150µV with a minimum output of 5mV. The setting of the humdinger R_{24} will have an effect on the noise voltage, and this may be adjusted as necessary.

The scaling of the Indicator was not too clear in the photograph, so a word or two may be helpful. The original scale on the meter was 0–10 x 50 divisions. This is used for the 10V, 1V, and 100mV ranges. To this was added a second scale in Indian ink, 0–3, used for 3V, 300mV and 30mV. Care should be taken to try and maintain the correct ratio, 3.16, between the two scales. Depending on the type of work to which the unit will be put, and the steadiness of the hand, consideration can be given to a third scale of decibels.

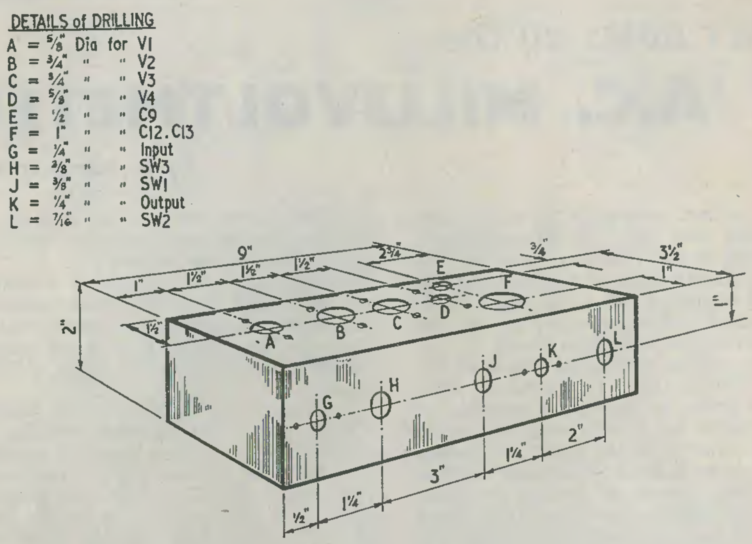


FIG.4. DETAILS OF CHASSIS. AMPLIFIER UNIT

Suggested material DURAL ·048 thick—
Bottom cover ·032 thick (fixed with self—tapping screws)

G613

The original instrument was made up of components gleaned from various sources, and it was for this reason that details were not given of the chassis. As some interest has been expressed, however, Fig. 4 gives the major dimensions and may be found of assistance to some readers. It is suggested that in the event of a steel chassis being used, packing, such as a piece of hardboard be used under the transformer. This will be found to effect a marked reduction in the induced hum voltage.

BRITISH SOUND RECORDING ASSOCIATION

Almost every year since 1948, the British Sound Recording Association has held an "Amateur Competition", in which its members have entered equipment which they have constructed themselves.

This year for the first time, it is renamed the "Home Constructors Competition", and will include a section for work by non-members of the Association.

Entries are invited for this competition, which will be held at the Royal Society of Arts, London, on Saturday 21st May, 1960. There are two classes as follows:

(*a*) Entries submitted by B.S.R.A. members. In addition to the President's Trophy, there will be the *Wireless World* award of 10 guineas and the Guy R. Fountain award of technical books to the value of 10 guineas.

(*b*) Entries submitted by non-members. The winner in this class will receive the *Hi-Fi News* award of 10 guineas.

Apparatus submitted for the competition should be associated with the recording and reproduction of sound, including appropriate test equipment. Exhibits will be judged on the score of technical originality, suitability for purpose, design and finish.

Application forms may be obtained from the Association offices at "Greenways", 40 Fairfield Way, Ewell, Surrey, and entries should be submitted not later than 14th May, 1960.

A Point-to-Point Two

A miniature A.C.–D.C. Receiver for LW, MW & SW

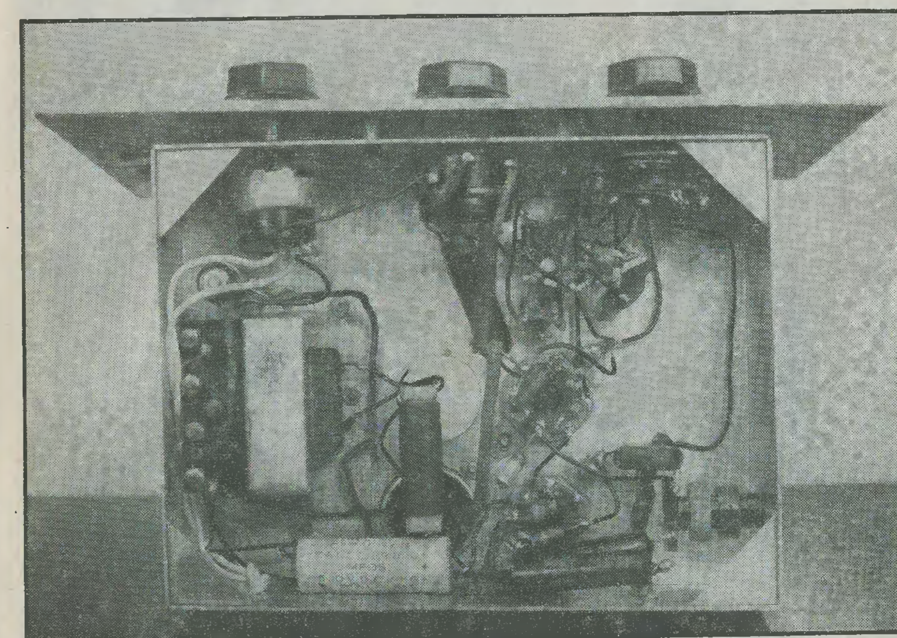
By **A. S. CARPENTER**

Here is a little receiver eminently suitable for the kitchen, sick room, garage, etc. It is not an ambitious design; rather one which is simple to make and easy to operate. It is capable, too, of giving a wide range of listening pleasure—also it is cheap to construct.

Fig. 1 reveals the circuit—a two valve arrangement, V_1 being a leaky grid demodulator plus audio amplifier, feeding into V_2 the output pentode.

To improve sensitivity, regeneration is employed; and whilst the writer confesses a dislike of this type of feedback he has to admit that the method employed results in extremely smooth control so that there is no sudden changeover from full sensitivity to ear-splitting oscillation. The control components chosen make this possible and the oscillation point is reached gently.

Three wavebands are covered: Short, 15–50 metres; Medium, 190–560 metres; and Long, 1,000–2,000 metres. For these ranges three miniature iron-cored coils are employed, the secondaries acting normally as the tuned windings and the primaries as reaction coils. Those specified have been chosen deliberately—they are h.f. coils in each case. Normal aerial types are, of course, available; but by using the former



Underside chassis view of the point-to-point receiver showing the main component layout

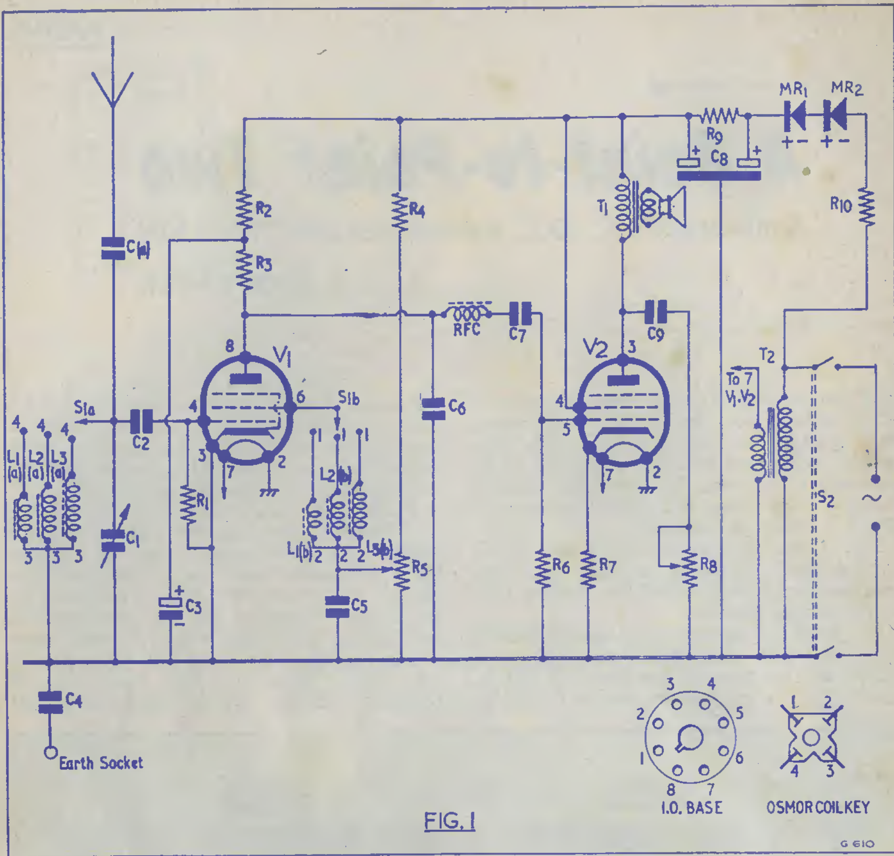


FIG. 1

Components List

Capacitors

C_a	100pF mica
C_1	500pF variable
$C_{2,\ 6}$	100pF mica
C_3	8μF electrolytic 350 volts
C_4	2,000pF 1,000 volts
$C_{5,\ 7,\ 9}$	0.01μF
C_8	16+16μF electrolytic 350 volts, can $1\frac{1}{4}$in diameter

Resistors

R_1	4.7MΩ
R_2	4.7kΩ
$R_{3,\ 6}$	470kΩ
R_4	47kΩ 1 watt
R_5	5kΩ potentiometer, wirewound
R_7	470Ω 1 watt
R_8	250kΩ potentiometer and d.p. switch
R_9	1.5kΩ, 3 watt
R_{10}	100Ω, $\frac{1}{4}$ watt

Miscellaneous

L_1	Osmor QHF2
L_2	Osmor QHF11
L_3	Osmor QHF12
V_1	6SH7
V_2	6G6

Two metal rectifiers, RM2—125 volt, 100mA
Output transformer, 10kΩ—3Ω
Filament transformer, 230 volts; 6.3 volts, 1.5 amp.
Chassis 8in x 6in x $2\frac{1}{2}$in
Speaker, 5in, Truvox
RFC—Osmor, QC1
Two International Octal valveholders
Sundries: nuts, screws, solder tags, non-metallic speaker fret, connecting wire, etc.

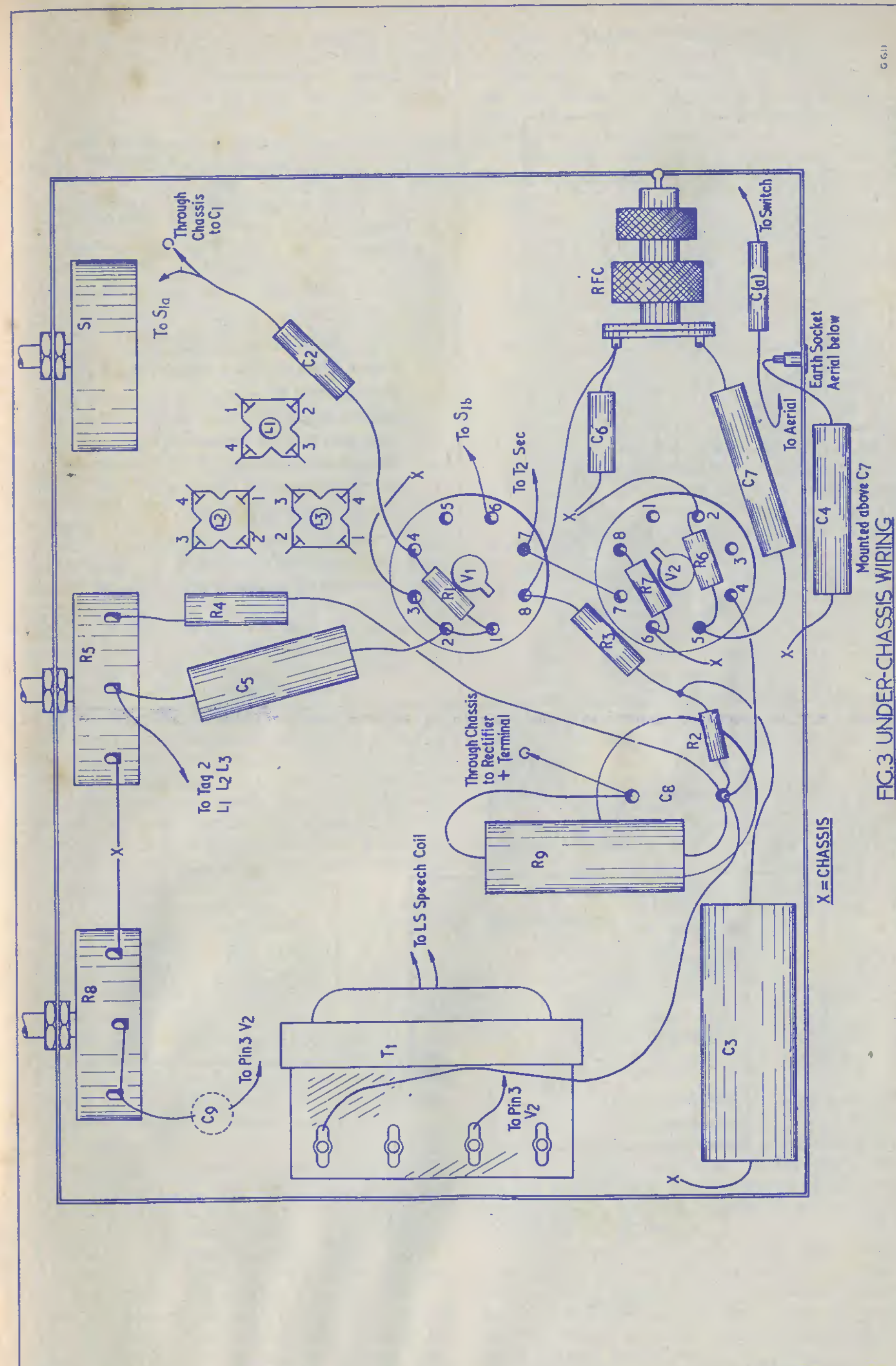


FIG.3 UNDER-CHASSIS WIRING

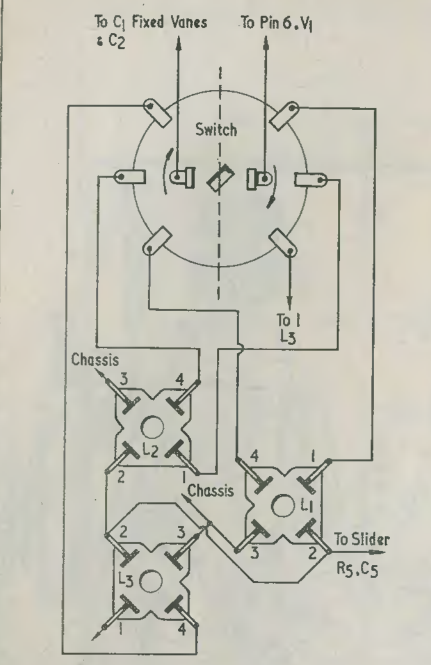
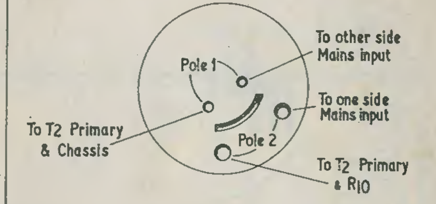


FIG. 4



ABOVE CHASSIS CONNECTIONS

Positive terminal MR_2— neg. terminal MR_1
Positive terminal MR_1 — R_9
Negative terminal MR_2 - R_{10}
Fixed Vanes $C_1 - C_2$ & W/C Switch
Moving Vanes C_1 – Chassis
One side T_2 Secondary – Pins 7, V_1, V_2
One side T_2 Secondary – Chassis
One side T_2 Primary — Chassis & S_2
One side T_2 Primary — R_{10} & S_2
Speech Coil LS to Secondary T_1

FIG. 5

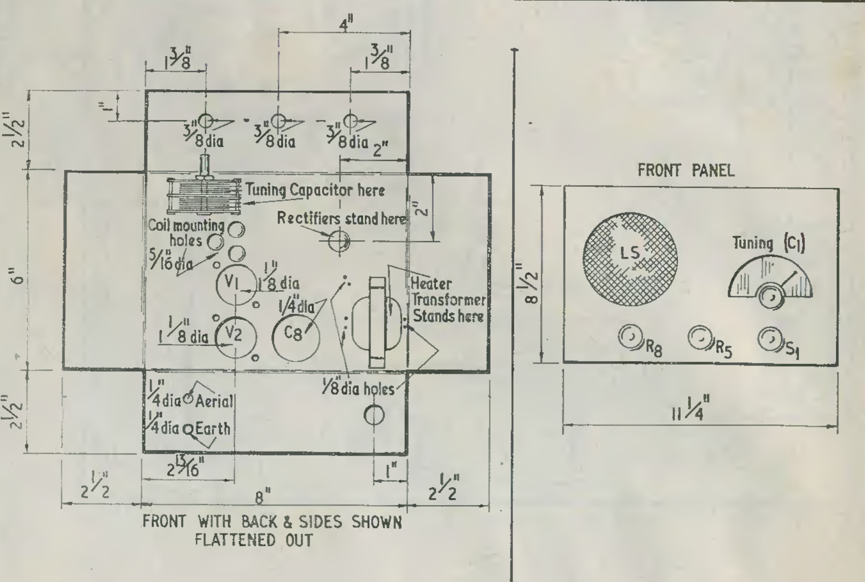


FIG. 2

G 612

variety the inclusion of an r.f. stage at a later date is considerably facilitated. This possibility has, in fact, been borne in mind and the layout arranged so that sufficient space is available.

It will be observed that R_1 has been made high. Nowadays the use of high value leaks is frowned upon and modern leaky grid demodulators (if there is such a thing) usually have a leak of approximately 250kΩ, whereas in the early days of radio 3 to 5 megohms was common. However, we are not concerned so much here with quality as with quantity; the high value used keeps damping of the tuned circuit small and also improves the audio output. The anode load is fairly high, too.

The efficiency of the choke used is sufficient to render the inclusion of a filtering capacitor at its far end unnecessary. If a choke is not used a considerable amount of r.f. will be passed on to V_2.

The output stage is normal and the tone control circuit is not absolutely necessary. In the prototype the on/off switch is incorporated in this control, but a rotary switch would suit just as well; even a toggle type could be fitted provided it is a two-pole type. The cathode bias resistor, R_7, is shown unbypassed; a small improvement in gain can be achieved by connecting a 50μF, 25 volt electrolytic capacitor across it.

Mains rectification is half-wave, two 125 volt metal rectifiers being connected in series and fed from the primary of T_2 via R_{10}. R_{10} is included as an h.t. protector and the value specified will carry 50mA quite comfortably without overheating. Should a fault develop, such as a breakdown in C_8 causing a virtual short-circuit, R_{10} will soon burn out due to the increased current flow.

Any heater transformer with a suitable input rating and a secondary rated at 6.3 volts, 1.5A can be used.

Construction is quite easy. A chassis drilling diagram is shown (Fig. 2), also a point-to-point diagram (Fig. 3), and these also show the positions of the components. Fig. 4 gives the coil and switch wiring connections. Note the way the coils are oriented to achieve short, tidy wiring. For the connections to the on/off switch, see Fig. 5.

Fix solder tags at the points marked "X" and wire the receiver up according to the plans, taking care that the coil tags do not get overheated—a hot iron and a joint made as quickly as possible will do least damage. A panel of insulating material, 11¼in x 8½in, is bolted to the front of the chassis and on this is mounted the speaker and the dial.

All screws used on the panel, such as those used for holding the loudspeaker, should be countersunk into the panel material and then covered with hard wax, to prevent possible shocks, since the chassis is "live".

The dial can be drawn up by hand if desired, or one of the Panel Signs transfers used (the latter, in this instance, is best affixed to stiff card first).

Setting up is simplicity itself, but before inserting the mains plug several checks must be made:

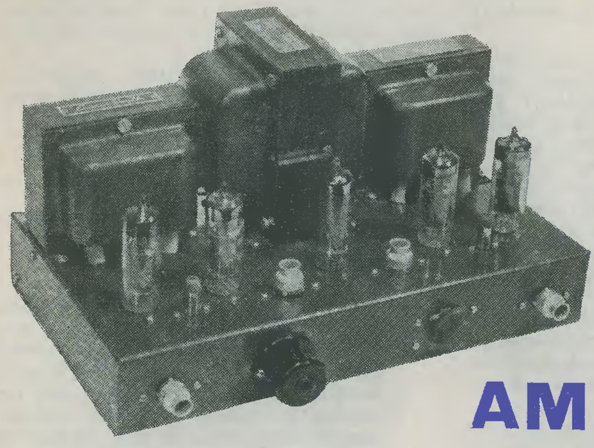
(1) Ensure that there is no direct connection between h.t. line and chassis.
(2) Ensure that both valve grids are grounded via their leaks.
(3) Ensure that the rectifiers are connected the right way round.
(4) Check the wiring associated with T_2 very carefully.
(5) **Make certain that the mains neutral and not "line" is connected to the chassis via the switch. This can easily be mistaken when a two-pin plug is used but the appropriate socket can easily be located by means of a low wattage electric light bulb. If one terminal of this is connected to earth (not a gas pipe) and the other to the mains terminal sockets in turn it will be observed that on one of them the bulb lights brilliantly while the other merely causes a glow; sometimes, in fact, it will not light at all. The neutral wire is thus easily recognised. But be warned further. If a two-pin plug is to be used with a three-pin adaptor, quite often the interior wiring of the adaptor is crossed over so be careful.**

If all is in order, switch on and connect an aerial. No difficulty should be found in locating various transmissions. A point worthy of note is that the iron cores of $L_{1, 2, 3}$ affect to some extent the reaction; that is, coupling between the primaries and the secondaries can be varied by rotating the cores, so adjust for optimum results.

The tuning capacitor used in the prototype is a vintage variety. Single gangs are easily obtainable, or alternatively a small dielectric type could be used or one section of a twin gang. The latter method is preferable if inclusion of an r.f. stage at a later date is contemplated.

Note that an earth socket is provided and connected to chassis through C_{47} **On no account must this capacitor be omitted, neither must C (a) be omitted. Remember, the chassis is in contact with the mains supply and should not be touched at any time when the receiver is switched on.**

Constructors will have their own ideas regarding a cabinet and one should be made at the earliest opportunity. Metal should not be used for obvious reasons, also all grub screws, metal pointer, etc., within hands' reach should be isolated.



THE COOPER-SMITH HIGH-FIDELITY STEREO MAIN AMPLIFIER

TECHNICAL SPECIFICATION

Input Sensitivity
800mV for full output
Power Output
6 Watts rated, 9 Watts peak (each channel)
Harmonic Distortion
Better than 0.2% at 6 Watts
Frequency Response
30 c/s–30,000 c/s at 1W
40 c/s–25,000 c/s at 6W
Hum and Noise
−80dB
Negative Feedback
15dB
Output Impedances
3.75Ω, 7.5Ω, 15Ω
Valves
Ultra-linear ECL82s (4), EZ81
Mains Input
200–210, 220–230, 240–250V a.c.
Mains Socket for Motor. Output Socket for Control Unit
Dimensions Length 12in
Width 7in
Height 6¾in
Weight 17½lb

CIRCUIT DESCRIPTION
(*See Fig.* 1)

The circuit is, in fact, a double version of the "back end" of the now famous Cooper-Smith "Prodigy" amplifier with a single heavy duty power supply. Similar output transformers have been used, resulting in a stereo amplifier with an extremely low level of distortion, and an output more than adequate for domestic use, in view of the fact that its output capabilities are equal to those of a 12–15W monaural amplifier. Except for the power supply and R_{18}, the two channels are exactly similar and all further remarks will apply to both.

The input is applied to the grid of the triode portion of V_1, which forms one half of the "paraphase" phase inverter. The action of this is as follows: after amplification the signal leaves the anode of V_1 180° out of phase and is fed via C_4/R_9 to the grid of the pentode section. A portion of the signal is then tapped off and applied to the triode grid of V_2, is amplified, and then fed via C_5 and R_{12} to the pentode section of V_2.

The benefits of push-pull amplification are many, the chief one being that each half-cycle of the signal is amplified separately. In order for this to be done successfully, the impulses reaching the output valves must be 180° out of phase. This has been achieved in this amplifier in the following manner. Let us say that the input to the grid of V_1 is "going negative". Now in a valve amplifier the signal leaving the anode is always out of phase with that applied to its grid, so our signal will be positive when it reaches the pentode grid (pin 3) and will return to negative at the pentode anode. We now have an amplified version of the original negative signal—no overall phase reversal has taken place.

The other half of our push-pull amplifier must now be provided, the output of which

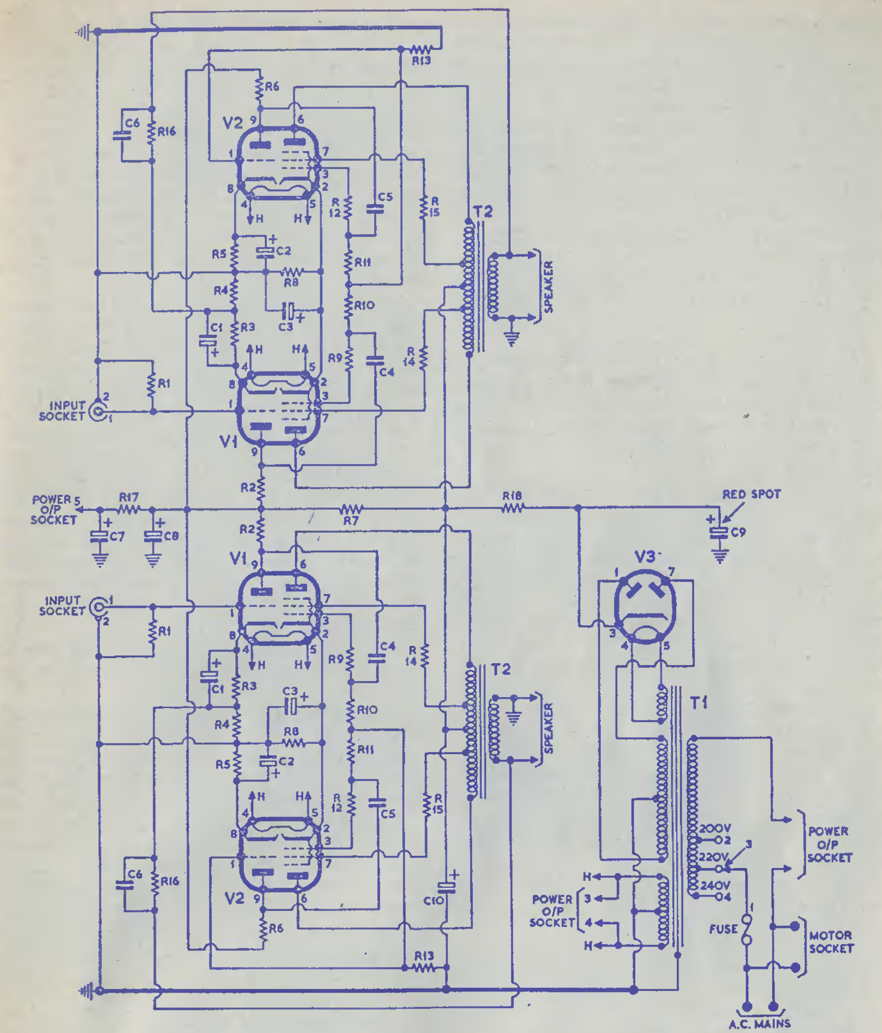


Fig. 1
THEORETICAL DIAGRAM
SMA1

must be opposite in phase. Therefore the input to this half must be *positive*. We have only a single input source, and that is negative, so we have to find a positive source —the anode of triode V_1 being the nearest. This positive signal is now fed to the triode grid (pin 1) of V_2. Amplification takes place in the same manner as in the first half, except that the output will be positive. Our phase reversal is now complete and when the signal is applied to our input socket, the negative half-cycles will be amplified by V_1 and the positive by V_2.

As well as being 180° out of phase, the amplified signals must also be equal in amplitude. The circuit used in this case is one which has been in use for many years and which has proved highly successful in its present application.

The pentode sections of the ECL82's are connected in the well-known "ultra-linear" fashion, where the screens are connected to tappings on the output transformer windings 43% from the centre tap. This arrangement leads to a more nearly linear operation of the output valves, resulting in an output stage closely resembling triodes as regards distortion and pentodes regarding efficiency. Negative feedback is connected from the output transformer secondary to the cathodes of the input stage via a potential divider formed by R_{16}/R_4.

The benefits of negative feedback may be summarised as follows:

(1) Decreased hum and noise.
(2) Increased and more level frequency response.
(3) Decreased overall distortion.
(4) Higher loudspeaker damping factor.

All these benefits are obtained without sacrificing anything other than input sensitivity, and as voltage amplification is cheap and easy to obtain, no sacrifice has really been made at all.

The power supply is conventional but for one point. To obtain a greater degree of smoothing, the h.t.+ supply to the output transformer is taken from the low side of the smoothing resistor R_{18} and not, as in some designs, straight from the rectifier cathode. This results in a slightly higher impedance power supply, but it has been found to be in no way detrimental in this instance.

The mains transformer (Electro-Voice type A246) is made specially for this amplifier with the high degree of regulation necessary for good quality amplification, and is fitted with an electrostatic shield between primary and secondary (brown lead). It is finished in bronze (as are the output transformers) to match the chassis.

The output voltages are as follows:

H.T. 250–0–250V at 120mA (orange–white–orange)
Valve heaters 3.15–0–3.15V at 5A (white–pink–white)
Rectifier heater 6.3V at 1A (mauve–mauve)
Inputs—Common (black)
200V (yellow)
220V (green)
240V (red)

The output transformers, as stated above, are of the same type as used in the "Prodigy" amplifier, the specification being as follows:

Primary 10,000Ω anode to anode, ultra-linear taps 43%.
Secondary wound in three separate sections.
Speaker matching achieved by series-parallel arrangement, 15Ω, 7.5Ω, 3.75Ω.
Primary inductance 58 Henrys at 30V 50 c/s.
Leakage inductance 0.5mH at 1V, 1,000 c/s.

CONSTRUCTION

First fit all the sockets to the chassis with the screws and nuts provided. Fig 2 shows their respective positions when viewed from the underside of the chassis, one side of which is flattened in the drawing to show the components more clearly. All sockets are fitted from the inside except that for the mains. Note that on the loudspeaker output sockets numbers 3 and 4 are wider apart than 1 and 2 and that the blank position on all the valve sockets points towards the group board.

Next take the two output transformers (T_2) and cut all the secondary leads (those covered with sleeving) down to about 5in in length, snip about ¼in of the sleeving from each, and carefully scrape *all* the enamel off the wires. (Do not remove the length of plastic sleeve; this indicates the "double yellow" lead referred to.) The leads may now be tinned, and after making sure that the solder has run all round each wire, the transformers should be bolted to the chassis with the 2BA screws and nuts, first passing the leads through the holes provided. Reference to the drawing shows which colour goes through each hole. Fit an earthing tag under the nut as shown.

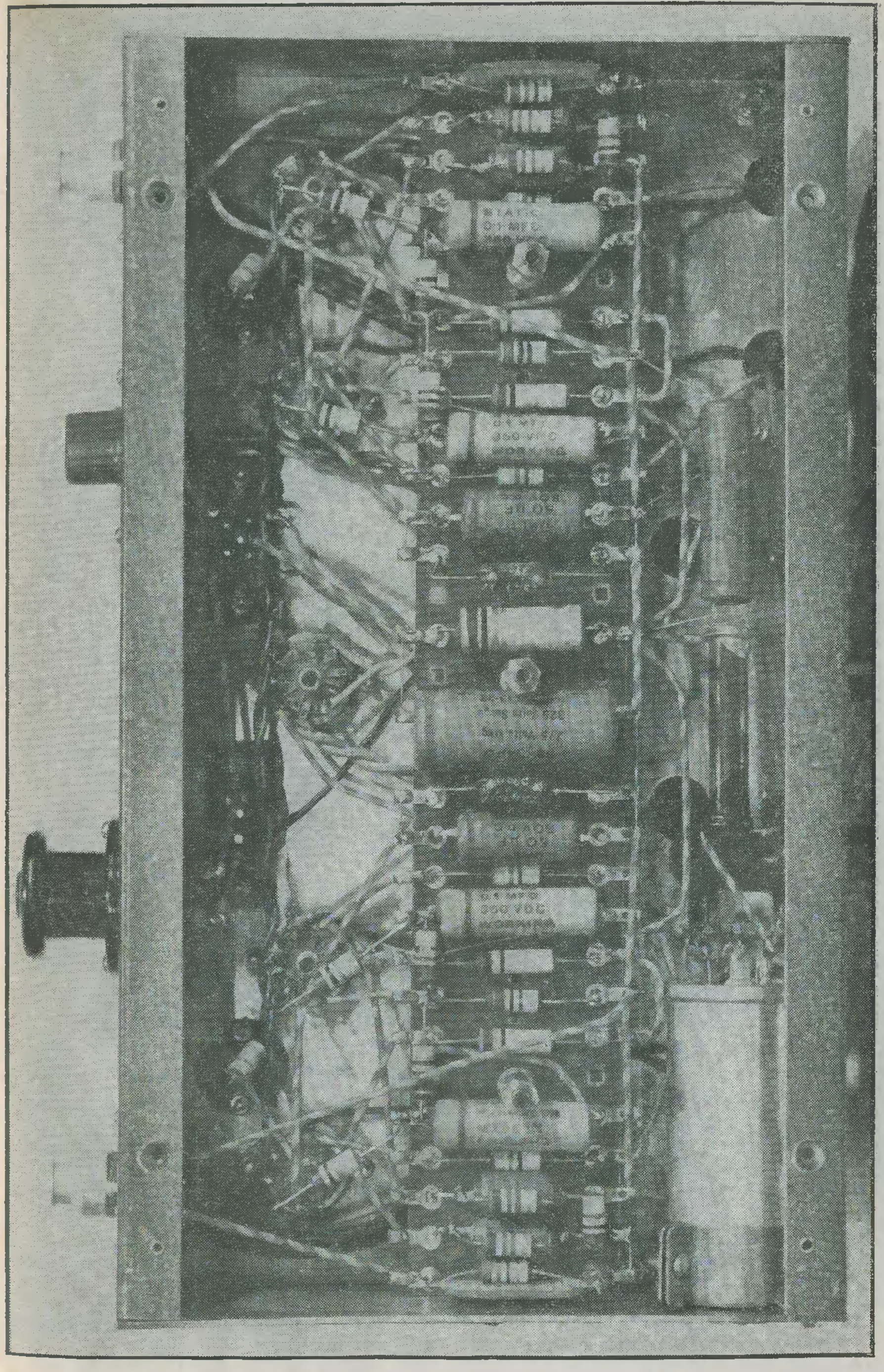
The mains transformer (T_1) should now be fitted in the same way, but do *not* cut the leads first.

The clip for the 50+50μF capacitor having been bolted to the side of the chassis, the capacitor R_{9-10}, with the resistor R_{18} firmly attached, can now be fitted in place, with the red spot furthest from the side of the chassis.

All the wiring shown in Fig. 2 should be completed before fitting the group board. The wiring sequence is given below. Check with the drawing after each operation. Valve heater leads should be twisted; other pairs of leads look neater if so treated.

T_1 leads:
White pair—3 and 4 on power output socket
Mauve pair—4 and 5 on V_3
Orange pair—1 and 7 on V_3
Pink, brown and white—earthing tag
Yellow, green and red—2, 3 and 4 on mains selector
Black—1 on motor socket and mains plug

T_2 leads (both):
Blue pair—5 on loudspeaker output socket
Single yellow—4 on loudspeaker output socket
Double yellow—3 on loudspeaker output socket
Brown pair—2 on loudspeaker output socket
Red—1 on loudspeaker output socket



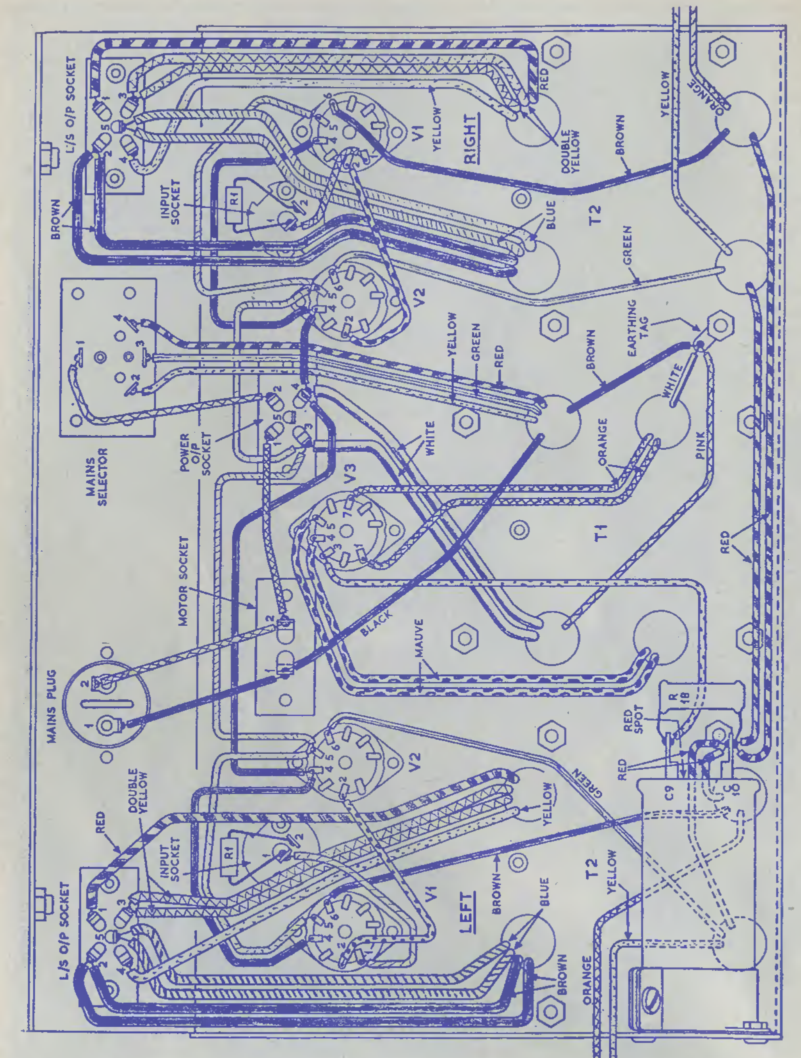


Fig. 2 PRELIMINARY WIRING

Green flex—6 on V_2
Brown flex—6 on V_1
All red flex—C_{10} (50+50μF capacitor, tag nearest chassis)

Heater leads (use the twisted flex provided):
4 and 5 on V_1 and V_2 (both)—3 and 4 on power output socket

Rest of wiring:
C_9 (red spot)—3 on V_3
2 on V_1—2 on V_2 (both)
1 on V_1—1 on input socket (both)
2 on mains plug—2 on motor socket—1 on power output socket
2 on power output socket—1 on mains selector
1 on input socket—R_1 (yellow/mauve/yellow)—2 on input socket (both)

Wiring the Group Board

This can be done before fitting in chassis or *in situ*. Refer to Fig. 3 and fit capacitors and resistors as follows:

A1 C_6 (3,000pF)/R_{16} (blue/grey/brown)—B1
A2 C_1 (50μF 12V)/R_3 (brown/red/red)—B2 (red end to A)
A3 C_2 (50μF 12V)/R_5 (brown/red/red)—B3 (red end to A)
B2 R_4 (brown/black/brown)—B3
A4 R_{14} (yellow/mauve/black)—B4
A5 C_4 (0.1μF)—B5 (either way round—keep away from fixing holes)
A6 R_2 (brown/black/yellow)—B6
A7 R_{13} (brown/black/green)—B7
A8 R_6 (brown/black/yellow)—B8
A9 C_5 (0.1μF)—B9
A5 R_{10} (brown/black/green)—A7
A9 R_{11} (brown/black/green)—A7
A10 R_{15} (yellow/mauve/black)—B10
A11 C_3 (50μF 25V)—B11 (red end to A)
A12 R_8 (390Ω)—B12

Repeat above from other end

A13 C_7 (32μF)—B13 (red end to A)
A14 R_{17} (brown/black/orange, smaller of the two large ones)—B14

Wire up as follows (both ends):
A6—B5
A8—B9

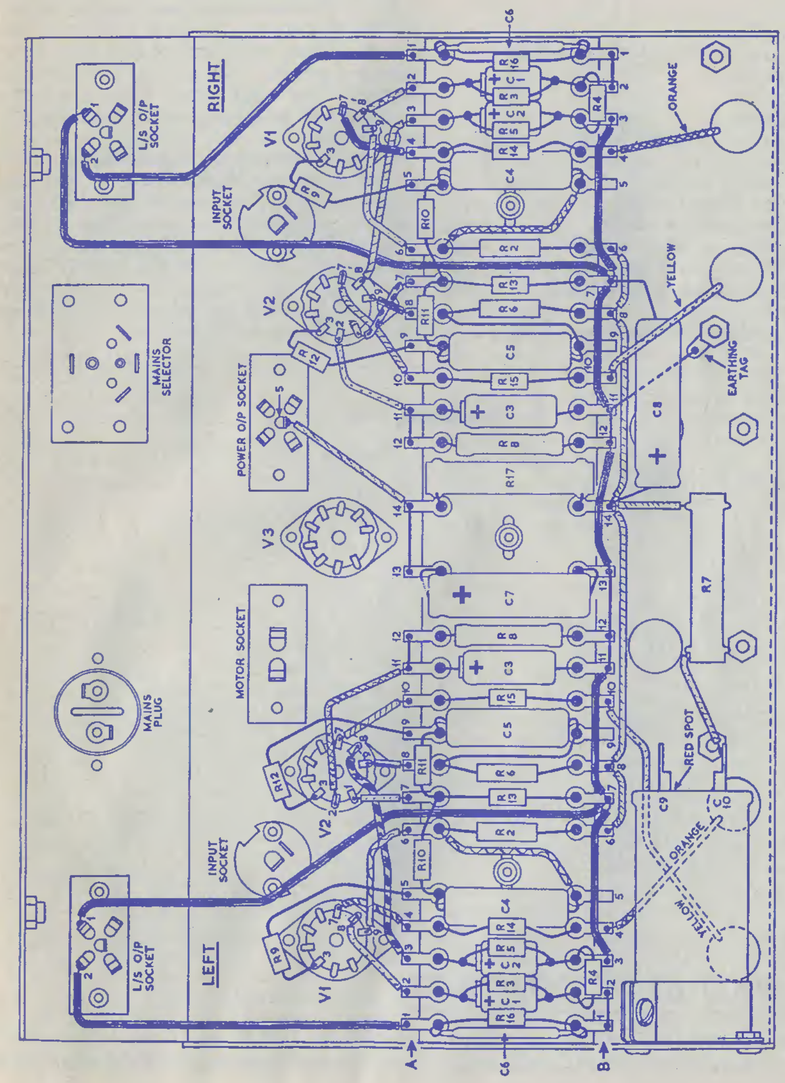


Fig. 3 COMPLETION OF WIRING

A11—A12
B1—B2
B3—B7—B11—B12—B13
B6—B8—B14
Connect A13 to A14

To fit group board, adjust the three loose nuts to about $\frac{1}{2}$in from the chassis, then place washers on them. Fit group board in position, then three more washers and finally secure with three more nuts. Wiring can then be completed as follows:

A1—2 on loudspeaker output socket
A2—8 on V_1
A3—8 on V_2
A4—7 on V_1
A5—R_9 (brown/black/orange)—3 on V_1
A6—9 on V_1
A7—1 on V_2
A8—9 on V_2
A9—R_{12} (brown/black/orange)—3 on V_2
A10—7 on V_2
A11—2 on V_2
Orange flex from T_2—B4
Yellow flex from T_2—B10
Repeat above on other channel
B11 (right only)—earthing tag
B14—C_8 (8μF)—B7 (right only) (red end to B14)
B14—R_7 (brown/black/orange)—C_{10}
A14—5 on power output socket
B7—1 on loudspeaker output socket

CHECK FOR DRY JOINTS!

Fitting the Base Plate

Screw three nuts on the group board mounting screws and adjust so that the base plate just rests on them when fitted. Secure with three more nuts. The chassis is fitted with 4BA locknuts for securing to cabinet.

Connecting Loudspeakers

The main amplifier, as described, is matched to two 15Ω loudspeakers. Connections to the speaker plugs are as follows:

Short the two wider spaced plugs (3 and 4 on the socket) by soldering a piece of wire across. Then solder the speaker leads to the opposite pair (1 and 2). No 5 is not connected. The plug from your right-hand speaker will go to the socket marked "R" and *vice versa*.

If 3Ω speakers are used the leads will go to the same two plugs (1 and 2), but short 1 to 3 and 2 to 4 instead of 3 and 4. It will also be necessary to change the feedback resistor R_{16} to 470Ω and the capacitor C_6 to 4,000pF. For 7Ω or 8Ω speakers short out 3 and 4 on the plug and connect leads to 1 and 5. 2 will not be used. Change R_{16} to 560Ω, C_6 to 3,500pF.

Components List

Resistors

R_1	470kΩ $\frac{1}{4}$W (2)
R_2, R_6	*100kΩ $\frac{1}{2}$W (2 pairs)
R_3, R_5	1.2kΩ $\frac{1}{4}$W (4)
R_4	100Ω $\frac{1}{4}$W (2)
R_7	10kΩ 2W
R_8	390Ω 3W (2)
R_9, R_{12}	10kΩ $\frac{1}{4}$W (4)
R_{10}, R_{11}, R_{13}	*1MΩ $\frac{1}{4}$W (2 sets)
R_{14}, R_{15}	47Ω $\frac{1}{4}$W (4)
R_{16}	680Ω $\frac{1}{4}$W (2)
R_{17}	10kΩ 1W
R_{18}	200Ω 10W

* *Matched to within* 5%

Capacitors

C_1, C_2	50μF 12V (4)
C_3	50μF 50V (2)
C_4, C_5	0.1μF 350V (4)
C_6	3,000pF mica (2)
C_7	32μF 275V
C_8	8μF 350V
C_9, C_{10}	50+50μF 350V

Valves

V_1, V_2	ECL82 (4)
V_3	EZ81

Miscellaneous

Mains Transformer R_1 (see text)
Output transformer T_2 (see text) (2)
Voltage selector, fused
Mains plug and socket
Output plug and socket (2) 5-pin
Power output plug and socket 5-pin
Motor plug and socket 2-pin
Coaxial plug and socket (2)
Valveholders, 9-pin (5)
Nuts, screws, solder tags
Wire, 22 s.w.g., tinned copper (3 yds.)
Flex, twin, heater wiring (18in)
Sleeving, 1mm (2 yds)
Chassis, base plate, tagboard, screws with nuts and washers

FIRST PAØ RTTY CONTACT

The first two-way RTTY QSO was made by PAØFB and G2UK on March 16th on the 80 metre band. Subsequent QSOs have since been made between PAØFB and G3CQE and G2UK.

RADIO ~~~~ Topics

By Recorder

There are few things as annoying as finding that the various parts of an assembly, after purchase, don't "fit together". The bits which fail to achieve a satisfactory marriage may consist of nuts which are tight or loose on the accompanying bolts, valves which don't reliably fit their holders (and, believe it or not, one of the harder things to mass-produce, even these days, is a valveholder which is 100 per cent satisfactory!), or other parts of similar type. Problems of this nature used to be infinitely more troublesome in the early days of radio than they are at present; and the main reason for their reduction has been that engineers, somewhere, have sat down and started work on drawing up standards which have closely defined such things as physical dimensions, chemical make-up and electrical properties of the component parts intended for electronic equipment. Today, the radio industry works to standards which cover almost every item of manufacture from the hardness of the mild steel from which chassis are stamped out to the activity and possible corrosive qualities of the flux with which joints are soldered.

The manner in which standards, whether published or "generally accepted", come into being provides a fascinating background to technological progress. In many cases, what later becomes a published standard requirement may well have originally been the arbitrary choice of a designer which, because of general approval, became "accepted in the trade". To take an example, it is standard practice, in this country and in the States, for most potentiometer spindles and the like to have diameters of a quarter of an inch. It isn't *essential*, however, for such a diameter to be used. What has happened here is that, many years ago, somebody commenced to use quarter-inch spindles (possibly because of readily-available quarter-inch stock) and, since this dimension proved to be convenient for most purposes, it became generally accepted. I know of an instance in recent years when a new type of insulated wire was introduced to the market. The manufacturers quoted maximum diameters, including insulation, for the various gauges of wire in their range, but no minimum diameters. An engineer working for a firm using the wire found it necessary to set a standard for minimum as well as maximum diameters so that physical tolerances on coils wound with the wire could be evaluated. He suggested suitable figures, together with the means of calculating them from a consideration of the appropriate gauge, to the wire-maker. These figures were considered acceptable by the wire-manufacturer, who then advised all other users of the new set of limits applying to the product. And, in that manner, a standard was born!

Some of the more important standards in this country are published by the British Standards Institution. British Standard specifications are drawn up after extensive consultation between manufacturers, consumers, distributors and other bodies who may be affected or who are in a position to offer advice. Frequently, a British Standard specification incorporates requirements which have been common trade practice for many years before the specification was published. Alternatively, it is possible for a British Standard specification to lay down a single requirement where, previously, individual manufacturers have been following slightly different but, nevertheless, incompatible practices. It is in cases of this second type where the issuing of published standards is most valuable. It should be pointed out, however, that neither manufacturers nor consumers are ever bulldozed by a British Standard specification into accepting requirements with which they cannot agree. A British Standard specification is only published if it has the substantial support of the manufacturers and users concerned.

It is generally agreed in the electronics trade that standardisation is wholly beneficial. Even if it does mean that the sockets of the radio set made by one manufacturer are capable of taking somebody else's valves as well as his own!

Hi-Fi Plugs and Sockets

A typical instance of the introduction of a standard has occurred in recent months, this being the result of work carried out by the recently formed Audio Manufacturers' Group of B.R.E.M.A. The A.M.G., which was formed in May 1959 and which includes such names as E. K. Cole Ltd., Decca Record Co. Ltd., Jason Motor and Electronic Co., and Standard Telephones and Cables Ltd., has applied itself to making good two of the main deficiencies in the audio equipment field. The first of these was a standard method of measuring and expressing the performance of amplifiers, and the second a standard range of inter-unit connectors. At the time of writing, work is still in progress on the first project, although it is hoped to publish recommendations shortly. So far as the second project is concerned a published standard* has now become available.

In its introduction the A.M.G. standard states that its requirements apply only to apparatus employing a double wound mains transformer, so that both mains leads are isolated from the chassis. The first section of the standard concerns the mains input wiring. The mains cable may either be permanently connected into the chassis with connections which are not accessible to the user under operating conditions and secured with a clamp to relieve strain, or it may be connected via a 3-way 5-amp socket and chassis-mounted plug, the latter having recessed pins. Dimensions for the plug and socket are specified in the standard. A 1.5-amp 3-way plug and socket should be used for mains outlets to auxiliary units such as gram motors.

Inter-unit power wiring between main amplifier and pre-amplifier or mixer unit should employ International Octal connectors. Such connectors may be fitted at both ends of the cable, or at the power amplifier end only. In each plug and socket assembly, the plug must always be that which is on the "dead" side of the junction. The accompanying table shows the recommended connections to be made to the pins of the octal connectors. These pins enable the main on-off switch to be fitted to the pre-amplifier control panel, pins 1 and 4 carrying the mains input to the pre-amplifier on/off switch, and pins 5 and 6 returning the switched supply to the mains transformer in the power amplifier. Where a radio tuner unit requiring h.t. and heater power is to be supplied from the main amplifier the same arrangements are employed, with the exception that pins 1, 4, 5 and 6 are not used.

A.M.G. Recommended Pinning for Audio Amplifier Interconnections

Pin Number	Service
1	Mains (N) from supply
2	Heater
3	H.T. positive
4	Mains (L) from supply
5	Mains (L) to transformer
6	Mains (N) to transformer
7	Heater
8	H.T. negative and Earth

As may be seen from the table, the interconnections via the octal plugs and sockets do not cater for a.f. In domestic installations, a.f. coupling between pre-amplifier or mixer unit and power amplifier should be obtained with the use of "phono-plugs". Microphone inputs for domestic installations should be made via jack-plugs and sockets. Screw terminals or a terminal block should be provided for loudspeaker connections. Alternatively, where frequent disconnection and re-connection of the loudspeaker is liable to occur and output power is low, a non-reversible two-pin plug and socket of the type employed for balanced aerial input connections may be employed. The final requirement in the standard is that all sockets shall be marked with their functions and that, where stereo channels are employed, the left-hand channel shall be colour coded grey and the right-hand channel brown.

And there it is, a group of manufacturers has got together and has created a standard where previously no standard existed. As time goes by we will almost certainly see hi-fi amplifiers confirm to the requirements of this standard. In years to come, people will be wiring up power supply sockets in the manner defined in the table, because it is "accepted practice", without even realising that, back in 1960, a group of people decided to recommend an arbitrary method of making interconnections!

The Collecting Instinct

Every now and again at this time of the year the do-it-yourself magazines tend to publish those look-Spring-is-here-and-now's-the-time-to-clear-out-all-that-junk sort of article. I'm afraid that exhortations of this nature leave me absolutely cold because, whilst I *do* have a clear-out every now and again, I only do so when the space problem is getting quite impossible. And, even then, only junk of the most antedeluvian order gets thrown out.

Still, I'm not as bad as a friend of mine. He produced a box of odds and ends some weeks ago which really took me back through the years. Whilst they weren't of that era wherein constructors had to assemble their own tuning condensers, they represented a period which was not all that much later. Part of my friend's collection consisted of four-pin valveholders in which the four individual sockets were coupled to their terminals via a complicated spiral of springy metal. These valveholders were really *sprung*. If a valve inserted in one were tapped it would vibrate for at least half a minute before settling down. There were several of those beautifully-made and very solid Ferranti intervalve transformers. The collection boasted also one of those large Telsen medium and long wave coils with a series aerial condenser on the top, and wound with bright green cotton-covered wire. And, of course, all components had bright, shiny, nickel-plated terminals. The vintage was 1930 (a good year, that!) when, I sometimes think, radio had rather more enchantment than it has now. But all that statement means is that I'm becoming a bit of a fuddy-duddy.

Of course, in those days you built a radio which was then liable to become the centre of the family circle's ether-borne entertainment; whereas nowadays the one-eyed monster has caused many radio sets to be relegated to the background. But I am forgetting the very considerable enthusiasm for home-constructed television sets which became apparent in the years following the war, this being particularly strong when wide-angle tubes were introduced in 1952. *The Radio Constructor* launched two very successful wide-angle designs around that time, many of which are still giving yeoman service. When Band III came on the air, this magazine also covered, amongst other designs, the construction of the highly popular cascode Teletron converter. So, perhaps I had better qualify my statement concerning home-construction and the telly by saying that what the home-constructor is waiting for always is something new to get his teeth into. Look out, Bands IV and V!

The Tunnel Diode

Finally, a few words about the latest semi-conductor device to enter the electronic field. If you haven't heard about the tunnel diode yet you soon will. Already, at least one firm of semi-conductor manufacturers in this country is actively carrying out development work prior to going into production on this new device. The tunnel diode, invented in 1958 by a Japanese scientist, Leo Esaki, is a two-terminal unit which, when biased in a certain way, exhibits negative resistance. The manner in which the diode functions is complex, but it can be stated that the currents which appear when the negative resistance effect takes place are not composed of electrons in physical movement—as occurs in a valve or transistor. Instead, particles disappear in one section of the diode and pop up instantaneously in another, this constituting the "tunnelling current". The process is far quicker than occurs when electrons move in transistors and valves and, because of this, tunnel diodes are theoretically capable of oscillation at 100,000 Mc/s. Due to their high speed of operation, tunnel diodes will first of all probably find their way into calculating machines and the like. This application will then provide a sufficiently large market to enable manufacturers to iron out production problems. Eventually, they should be as readily available as germanium rectifier diodes are now. To give an idea of what tunnel diodes can do, General Electric engineers in America have built a miniature f.m. transmitter which consists of a tuned circuit, a resistor, a microphone, and a tunnel diode, together with a battery to put the diode on its correct biasing point. The negative resistance of the diode counteracts the losses in the tuned circuit, whereupon the latter just oscillates!

We shall be hearing a lot more about the tunnel diode in the future. In all seriousness I think that it may well represent almost as big a step forward in practical electronics as was provided by the transistor.

* *Recommended Standard Practice For Plugs, Sockets and Connectors For Use With Audio Amplifying Equipment*, publication no. AMG/1—January 1960.

Next Month . . .

The "REGENT"

A 4-Valve Portable Battery Operated Receiver Incorporating Low Consumption Valves, Printed Circuit and Ferrite Rod Aerial

RTTY In Theory and Practice

by J. B. Tuke, G3BST

PART 1

THE RADIO TELEPRINTER SYSTEM OF COMmunication as applied to Amateur Radio offers a number of very definite advantages. These are: (*a*) high speed of communication exceeding that available on CW; (*b*) a printed record of the printed material is available; (*c*) more effective use is made of the permitted power compared to A_3 transmission, resulting in greater intelligibility at the receiving end; (*d*) freedom from certain types of interference; (*e*) absence of "shock effect" at the transmitting terminal which may, in some cases, reduce TVI.

However, before consigning all A_1 and A_3 equipment to the nearest scrap heap, it would be as well to note some of the disadvantages as well. From the amateur's point of view these are (*a*) the necessity to own (and therefore service) a teleprinter; (*b*) in order to make full use of advantage (*a*) one must be able to type—or rather teleprint since there are some minor differences; (*c*) more complicated receiving apparatus is required and a slight modification must be made to the transmitter; (*d*) the transmitter is run under "key-down A_1" conditions throughout the whole transmission, so that valves and components must be run within normal manufacturer's ratings.

Each of the advantages and disadvantages listed above are due to some particular peculiarity of the system and if, therefore, we study it (mainly from the amateur's viewpoint) in detail it will be possible to assess it as a communication system intelligently.

The printer itself is the first essential, and a short study should be made of its method of working. From a practical point of view this can be followed by turning the machine over by hand and watching the various mechanical actions. One will rapidly come to the conclusion that its inventor must have been a mechanical genius of the first order.

Let us, at this point, look upon the teleprinter as two completely separate instruments—a transmitter and receiver, driven by a common motor. The result of the mechanical functions of the keyboard is to move a single-pole-double-throw switch into alternate positions—these positions being known conventionally as Mark and Space. The "at rest" position is Mark; the alternate, Space. If, while a letter on the keyboard is depressed, the mechanical action is followed slowly, it is found that subsequent to the engagement of a pawl and ratchet the initial move of the switch is from Mark to Space, following which there will be five further movements which may be to Mark or Space according to which keyboard character was depressed. For example, depression of the letter Y results in, first, the initial Space which precedes all characters and then the sequence Mark, Space, Mark, Space, Mark, whereas if the letter R is depressed the sequence (again after the initial Space) is Space, Mark, Space, Mark, Space. It will further be observed that following every character there is a definite "rest" period with the switch in the Mark position, and that the next character cannot be depressed until that period is completed.

We may now represent this action graphically—imagining the Mark contact on the switch to be connected to a positive voltage and the Space to a negative voltage, while the centre moving tongue is connected to a centre zero meter. The resultant voltage/time graph for depressing the letter Y is shown in Fig. 1.

At this point it would be appropriate to give the initial Space and the final Mark signals which are present on all characters their correct names—they are called the Start and Stop signals respectively. The reason for this will be seen as study of the system progresses.

The dispositions of the Mark and Space signals in between Start and Stop, which represent the character depressed on the keyboard, follow a definite international code —known as the Murray Code. It should not be forgotten that there are other versions of this method of signalling—due sometimes to the particular model of teleprinter in use, or to the country from which the signals originate. It is quite possible when intercepting random radioteleprinter signals to receive strings of meaningless characters due, not to a different language, but to the use of a different code. However, completely different codes are mostly used by Eastern countries and need not concern us here. It should, however, be borne in mind that different models of teleprinter have slightly different character representations—mostly those on the "Figure Shift" or connected with non-typing mechanical functions of page-copy printers. Some incompatibility is to be expected, therefore, when operating old type 3 machines in connection with modern page-copy machines.

To return to the operation of the transmitting keyboard, it will be obvious that the speed at which the switch movement (and therefore the speed at which the Mark and Space signals) are transmitted will be dependent only on one thing—the speed of the motor. It will have no connection whatever with the speed at which the teleprinter keyboard is being manipulated by the operator.

If the mechanical action of the switch and therefore its voltage output is followed in relation to time, it will be found that the Start and the following five signals are all the same length, while the Stop signal is half as long again. If we consider the length of the Start signal as one unit, then the entire character sequence will consist of $7\frac{1}{2}$ units —that is, Start, 5-Mark/Space, Stop. Consequently this particular teleprinter code is quite often called the $7\frac{1}{2}$-unit code.

In the British system the motor speed is such that the length of one unit is 20 milliseconds. This means that any device handling the signals transmitted by the teleprinter must be capable of responding accurately to a signal of 20 m.sec length. While signals longer than 20 m.sec may appear due to Mark following Mark, or Space following Space, signals shorter than 20 m.sec cannot occur with this particular motor speed. Since the length of the basic signalling unit is obviously of prime importance, telegraph engineers use a term called the Baud to describe it. The speed of operation of any particular system in Bauds is equal to the number of basic signalling units which could (theoretically) be transmitted in one second. In the case under discussion this will be $\frac{1}{0.02}$ (since 20 m.sec equals 0.02 seconds)—that is 50. We can, therefore, say that our teleprinter is operating at a speed of 50 bauds, which as we will see later tells us all about the speed at which any relays in the circuit between transmitter and receiver may have to operate, and also about the bandwidth requirements.

The American system uses 45.5 bauds —that is to say, the basic signalling element is slightly longer. In order to be compatible with that system it would be necessary for the owner of a British machine to slow down the motor slightly, thereby lengthening the signalling element—and this may be done by adjustment to the motor governor.

Referring back once more to our own British system, we have said that the basic signalling element is 20 m.sec long and that each character is $7\frac{1}{2}$ units in length. A single character transmission will therefore occupy $7\frac{1}{2}$ x 20 m.sec=150 m.sec (0.15 sec). Providing a series of such characters were depressed by a "perfect" operator, each commencing at exactly the instant the previous one had finished, the maximum number of characters which could be sent in one minute would be $\frac{60}{0.15}=400$. The average "word" may be said to consist of five letters plus a space, making six in all, and the maximum number of words per minute that the system can handle is therefore $\frac{400}{6}=66.6$ w.p.m. From a practical point of view, if 55 w.p.m. can be maintained then one can be well satisfied with one's teleprinting prowess. The near-maximum speeds can only be continuously maintained by automatic transmission equipment, which is unlikely to concern the amateur at present.

Having studied the essentials of the transmission side, let us now turn and brush up our knowledge about the receiving mechanism.

It will be known that incoming signals from a "distant" printer keyboard are fed to an electromagnet which is normally neutrally biased—that is to say, it will lie at rest in either position. Turning the machine

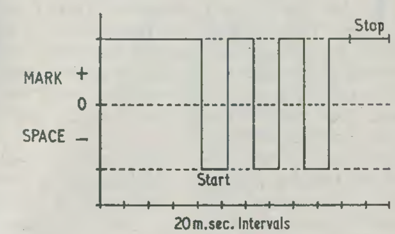


FIG. 1

over by hand will reveal that in one position no printing action takes place since the pawl and ratchet mechanism is disengaged and the main camshaft does not rotate. This is the magnet position corresponding to the transmission of a Mark signal from the distant machine. Directly the magnet moves over to the opposite, or Space position, the pawl and ratchet engages and receiving action commences. This magnet movement will, of course, be as the result of the "Start" signal from the distant printer. The magnet now operates a striker blade which, according to whether it is in the Mark or Space position will, via a pin, move any of five fingers on the receiving mechanism, causing them to be pushed inward if a Mark signal is received. Once the five fingers have been set up at the end of the character transmission, they operate a series of slotted circular combs deciding which bell crank may be allowed to fall. This in turn controls the position of the rotating typehead and therefore which letter will be printed. During this time the magnet has returned to the Mark position as a result of the distant Stop signal, and nothing further happens until the next Start signal is received. It should be noticed that the character now set up will be printed during the early part of the succeeding character transmission—so that the printed character is always "one behind".

The letter/figure shift is operated by a certain Mark/Space combination (sometimes different for different models) and its action is to operate a sixth comb, thereby doubling the number of characters already obtainable. Those with experience of typing only who are interested in the teleprinting system should note that once the "Figures" key has been operated, the instrument is on figures until the "Letter shift" key is depressed. On the type 3 machine these keys are called "Letter Space" and "Figure Space". It is impossible to transmit G3BST exactly as written—it will appear as G 3 BST. On the page copy printer the operation of figure and letter shifts are not associated with the space bar, and do not operate the carriage, so that a combination of letters and figures without the intervening spaces is possible. These characters are the "Non-typing mechanical functions" mentioned earlier. Having now studied—albeit rather briefly—the action of transmitting and receiving separately, it is suggested (as already recommended in earlier articles) that keyboard and receiving mechanism should be connected together and the machine operated by turning the motor over by hand—the "modus operandi" will then become perfectly clear.

While direct connection between transmitting and receiving portions of the teleprinter present no difficulty, reference to Fig. 1 reminds us that we are dealing with what is, in fact, practically a square waveform. We can, therefore, expect trouble when we attempt to transmit this waveform down a long line, or over a radio link. The type of trouble that occurs, how serious it is, and what can be done about it will be discussed in the next article.

RADIO

INCREASING TUNING INDICATOR SENSITIVITY

by **A. G. PILLIDGE**

MOST READERS WILL BE FAMILIAR WITH the reasons why accurate tuning of an f.m. receiver is necessary. The problem of providing a simple and sensitive indicator is not easily solved, however, and many constructors will have felt, with the writer, that the conventional "magic eye" circuit is rather inadequate.

Undoubtedly the best solution is a null point indicator such as that published in *The Radio Constructor* and reprinted in the "Jason" tuner handbook. This method, however, entails the use of a double triode and a milliameter and will add substantially to the cost of building a tuner.

The tuning indicator circuit described here provides a considerable increase in sensitivity compared with the usual circuit, but costs little more. The argument which led to its use is as follows.

Let us begin with the usual arrangement, shown in Fig. 1. Here a negative voltage derived from the ratio-detector reservoir capacitor is applied to the grid of a "magic eye" tuning indicator. The negative voltage is, in theory, almost constant over the ratio-detector pass-band but, in practice, a shallow peak usually occurs at the mid point. The tuning indicator should show this peak. It does so, but for two reasons the indication

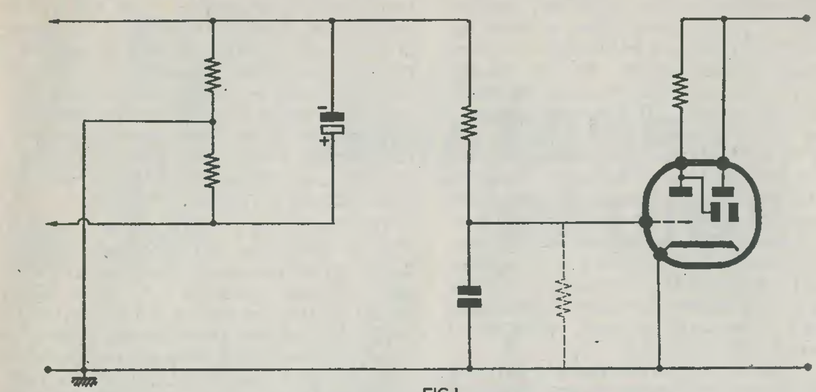


FIG.1.
Normal Indicator Connection.

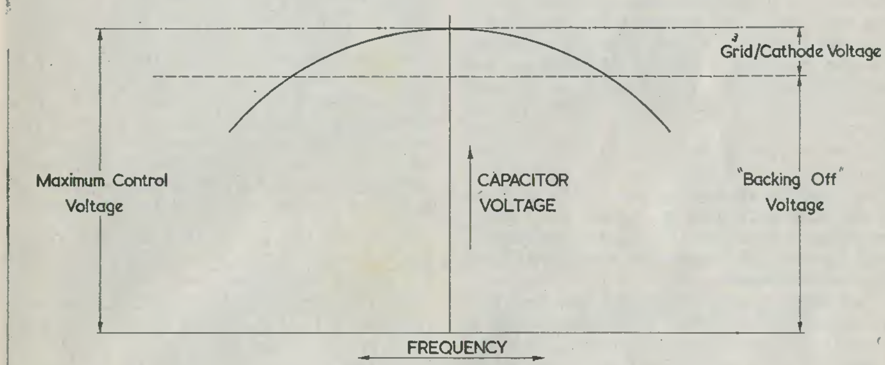


FIG.2.
Diagram of "Backing Off" Method.

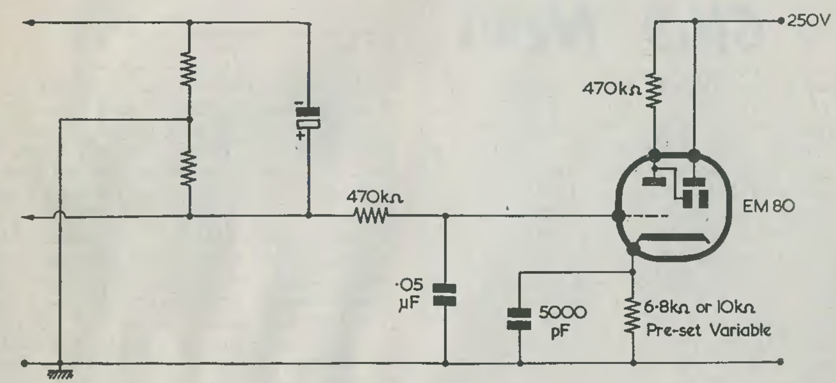


FIG.3.
Indicator with Cathode Bias.

M722

is often a very poor one. In the first place the grid voltage may be sufficient, particularly with a "local" transmitter, to close the eye. For this reason the eye is often fed from a voltage divider (given by the dotted resistor in Fig. 1) which reduces the sensitivity of the system. The second reason is that the triode grids of most indicators are wound with "variable—mu" characteristics. This means that the indicator becomes progressively less sensitive as the eye closes and leaves us with the dismal alternatives of either working the indicator in its least sensitive region or reducing the applied voltage (and hence the sensitivity) to bring the eye to a more sensitive state. In each case the result is the same—a poor indication of the correct tuning point.

The variation of reservoir capacitor voltage with i.f. frequency is shown diagrammatically in Fig. 2. It is fairly obvious that if we could "back off" part of this voltage as shown by the horizontal dotted line, we could work the indicator in its sensitive region. This "backing off" could be achieved by applying a positive potential to the grid of the indicator, but the practical problems of doing so are quite considerable. In particular, no positive potential must be allowed to "leak back" to the ratio-detector, or its a.m. limiting properties will be drastically upset. A more promising way of achieving the same thing is to apply a *negative* voltage to the cathode of the indicator. This is, in fact, quite easily arranged—particularly in "new construction" —but may not be so simple when modifying existing equipment.

In a receiver with a *balanced* ratio detector, however, another "twist" can be given to the circuit which gets round the above difficulties. Suppose that a *positive* voltage is applied to the cathode of the indicator. This can be done merely by putting a resistor in the cathode-earth connection. The eye will now close in the absence of a signal. If now the grid is supplied from the *positive* side of the reservoir capacitor, the eye will open as a signal is tuned in. By suitable choice of the cathode resistor the eye can be brought to its most sensitive state (i.e. nearly open) when the receiver is correctly tuned. This is, in practice as well as in theory, a very great improvement on the circuit of Fig. 1.

The circuit used by the writer is shown in Fig. 3. The value of the cathode resistor is fairly critical and may require adjustment to suit different receivers. A good method would be to substitute a pre-set variable of, say, 10kΩ for the fixed cathode resistor and to adjust this so that the eye is not more than, say, one-fifth closed when the receiver is correctly tuned to any of the three "local" transmissions.

If the receiver must be suitable for use with widely different signal strengths, the indicator can be modified to give variable sensitivity levels. Several possibilities come to mind. For example, the cathode resistor may be split into two parts, one of which can be short-circuited by a single-pole switch. With the switch closed the indicator will work on small signals but will "overload" (i.e. open fully) on strong ones. Opening the switch increases the positive bias and enables the indicator to cope with a strong signal.

It should be noted that the use of the positive side of the balanced ratio-detector for tuning indication does not in any way affect the negative potential required in some receivers for a.v.c. When modifying such a receiver, care must be taken to see that the a.v.c. line remains connected to the negative side of the reservoir capacitor.

Club News . . .

Harlow and District Radio Society. Hon. Sec. B. H. Wynn, "Black Cat", Abbess Roding, Ongar, Essex. A mobile rally is to be held at the Village Hall, Magdalene Laver, near Harlow New Town, Essex, on the 5th of June. Two members of the club will be "on the air" to guide visitors—G3ERN on 160 metres and C3JMA operating on 2 metres. Club members will be very pleased to see anyone who cares to come along. In addition to displays of radio equipment, etc., there will be features of interest for the wives and children. Refreshments will be available at reasonable prices.

Cray Valley Radio Club. Hon. Sec. H. W. Mills, 59 Amherst Drive, St. Mary Cray, Kent. An invitation is extended to all interested in amateur radio transmitting and kindred subjects. Meetings are held on the fourth Tuesday of each month at the Station Hotel, Sidcup, Kent. On 24th May, at 8 p.m., a brains trust session will be held.

Halifax & District Amateur Radio Society. Hon. Sec.: A. Robinson, G3MDW, Candy Cabin, Ogden, Halifax. On 9th April the members paid a visit to a television studio in Manchester and on 12th April they met at the Sportsman Inn, Ogden, to hear a lecture on Fire Prevention. The A.G.M. will be held on 3rd May and an informal meeting on 24th May. A lecture on Workshop Practice will be held on 14th June. New members are welcome and application should be made direct to the Hon. Secretary.

20 YEARS of AMATEUR RADIO

by G5UJ

How long it sounds—20 years—yet how soon it passes, especially when applied to ham radio! Nineteen thirty-six was *the year*, though "tests" were made with an artificial aerial some 12 months earlier, using the callsign 2BSF. But it was in April, 1936, that the writer—using a simple home-built single-valve ECO—managed to raise his first contact, OK2MM, on 7 Mc/s (C.W.).

The input was just eight watts, to an "end-on" aerial sixty-seven feet long! The Rx in use was a "straight" 0–v–1 "home-brewed," and battery-powered! Contacts with OH, SM, LA, OZ, and DL quickly followed using the same rig, until the writer —tiring of "forty"—ventured on to 160! A "Goyder-locked" oscillator (PX4) together with a 2-stage modulator and a carbon mike, produced quite encouraging results, with the 67ft aerial now tuned Marconi fashion against ground. Indeed, some eleven or twelve countries were raised on the key on "top band" within 18 months.

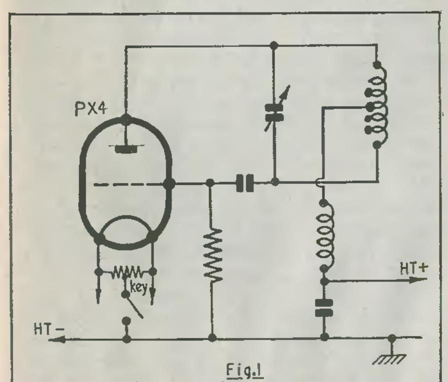


Fig.1 'Series-fed' Hartley oscillator

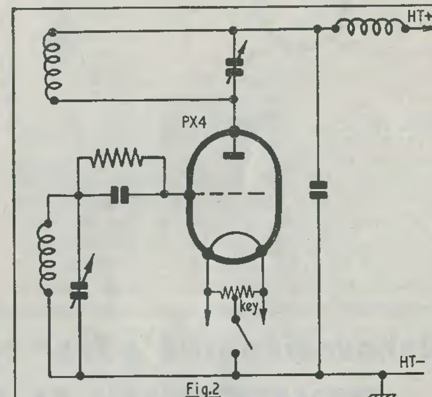


Fig.2 TPTG (tuned-plate tuned-grid) oscillator

During the following three years many popular circuits were tried, with varying results, but power input never exceeded ten or twelve watts. Perhaps the best Dx results were obtained with the series-fed Hartley (shown in Fig. 1). Close in order of efficiency and all-round usefulness was the TPTG, (Fig 2) or when in push-pull termed the TNT (Fig 3).

As will be noted, *all* these oscillators were "self-excited," necessitating very rigid and careful construction, especially in the tank circuits in order to obviate frequency drift. Tone reports—as can be imagined—often left much to be desired, and it was not until the inception of the quartz crystal, as a stable oscillator, that the standard of transmission improved. About this time, also, more efficient power valves became available, such as the Taylor T40 and T55, etc., and the beam-tetrode (6L6) was becoming fashionable.

All this tended to bring about a change for the better in amateur radio, and, broadly

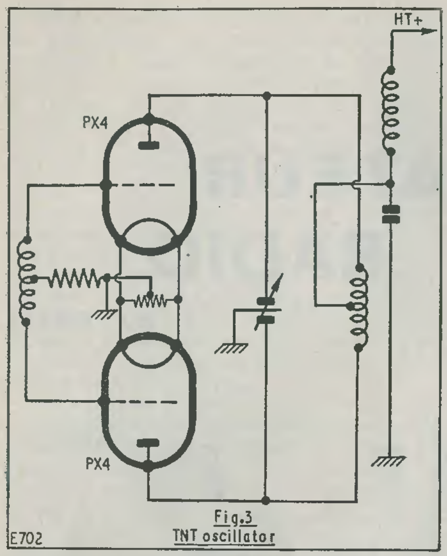


Fig. 3
TNT oscillator

speaking, amateur transmissions generally took on a "new look" as regards quality, and some excellent speech could often be heard on 80m, sometimes bearing comparison with the B.B.C! By this time, however, the shadow of war lay over Europe, and by September 1939 all amateur activity, as such, ceased, and all equipment was impounded for the duration! The termination of hostilities in 1945 saw the return of all impounded gear (February 1946 in the writer's case) and the ban on amateur activity was lifted. In the general scramble to get back "on the air," ten metres came in for a fair share of popularity, and many Dx records were set up; and some firm friendships were made "across the pond" with our friends in W-land! By this time many Ex-service receivers, both British and American, made their appearance, notable amongst which were the AR88/77, BC348/2, and, of course, that "evergreen," the ex-R.A.F. 1155 (still in use at G5UJ)!

Attention now began to turn in the direction of v.h.f. and the 144 Mc/s and 70cm bands became of interest and valves of the 832 and 829B type were becoming familiar. Beam aerials (although long popular in the States) began to make their appearance in G-land, and stacked-arrays were to be seen in many parts of the country. Another innovation was the commercially-built Tx —a thing completely unheard-of in British shacks pre-war. Many really fine jobs were produced.

Which brings us to the present, with its quota of QRM on our "shared"-bands, and which finds the writer wrestling with a couple of transistors in a matchbox! Progress, or second childhood?

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Because of their small physical size and use of R.C.A.'s drift-field construction, these transistors have small effective base width, low feedback capacitance, and a high collector-to-base breakdown voltage features which, for the first time make possible top oscillator and amplifier performance in the f.m. band. In addition, the low-frequency characteristics of these transistors are carefully controlled to ensure dependable performance in the standard a.m. broadcast band. As a result, these transistors provide the equipment designer with a transistor complement which makes practicable quantity produced f.m. and a.m./f.m. radio receivers and tuners having high gain, high sensitivity, excellent stability, good signal-to-noise ratios, and good a.g.c. capabilities.

For example, in a typical f.m. tuner operating at a frequency of 100 Mc/s, the 2N1177 is capable of providing a power gain of 14dB; and the 2N1179, a conversion power gain of 17dB when followed by a 10.7 Mc/s i.f.-amplifier stage.

The 2N1180 in a 3-stage 10.7 Mc/s i.f.-amplifier circuit is capable of providing a useful power gain of 65dB with neutralisation or 57dB without neutralisation.

The 2N1178, when operated in local-oscillator service at a frequency above that of the incoming r.f. signal, can supply a 2N1179 r.f. mixer stage with the required oscillator-injection voltage for optimum mixing throughout the f.m. band.

Is that tube Really Finished?

By P. S. F. JACKSON

WHENEVER THE PICTURE DISAPPEARS, THE service engineer is nearly always asked "Is the tube done?" Whilst this is often the case, a great deal can often be done before finally consigning the tube to the scrap heap.

The first step is to decide if the tube is to blame. If, when the brightness control is turned up, a raster appears and can be controlled, the vision circuits should be suspected. It is worth mentioning that if a raster does not appear when turning the brightness up, the ion trap should be rotated and slid along the tube neck before condemning the tube as faulty or unserviceable. The ion trap position may change as the tube ages. Also, components immediately associated with supplies to the tube should be checked by voltage tests to all electrodes (e.g. the decoupling condenser from a_2 should be checked for short- or open-circuit or resistors to the grid used in frame blanking may be open circuit).

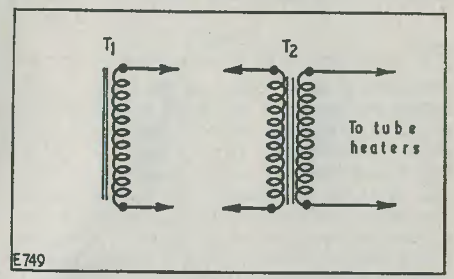
When it is finally decided that the tube is faulty we must now see if anything can be done. Before going further it would be best to see what causes tubes not to deliver the "goods". Summed up, these are:

(1) Shorts between electrodes.
(2) Internal disconnections of electrodes.
(3) Heaters burnt out.
(4) Soft or gassy tubes.
(5) Dry joints in the soldering of the lead-in wires and the pins on the base.
(6) Cathode poisoning.

Some of these may seem pretty deadly, but with a little patience and perseverance it is surprising what can be achieved.

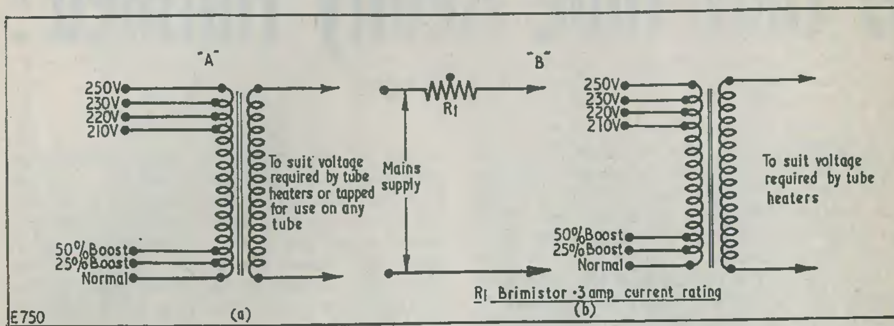
Dealing with them in the above order, the method of removing shorts between electrodes is quite simple and requires nothing else other than high capacity electrolytics such as are commonly used in the smoothing circuits of television receivers. Remove the base holder from the tube and, after charging the electrolytic between h.t. and chassis, apply the leads to the pins of the shorted electrodes. Incidentally, it may be difficult to find which electrodes are shorted as it is only when the tube is "hot" that these shorts may show and cause trouble, and if tested when cold, no reading will be obtained on the meter. To test for this, all connections to the tube except the heaters should be removed and the tube allowed to warm up, then test for shorts. It may take several applications to burn out the short. It is interesting to note that these shorts are caused by an electrolytic action on the metal parts of the tube causing a thin film of deposit between the electrodes.

The next fault cannot be permanently cured except for open-circuited heaters; the latter we will deal with in a moment. When any of the other electrodes become disconnected internally, it is generally caused by an inherent weakness in the metal or welding which has not stood up to the expansion and contraction when the heaters are switched on or off. Often the tube can be made to give temporary service by tapping the base with the handle of a screwdriver. This should be done carefully and not with great force, and whilst looking at the screen to find where to tap. At a certain point flashes will appear on the screen, and the base should be carefully tapped until the picture or raster reappears. The writer had one tube working for some six months after this procedure (without any tapping during that time). If the grid becomes open-circuited the brightness control will have no effect, and the picture will be lost in dazzle. If the cathode is disconnected there will be no raster or picture. In pentode or tetrode tubes, disconnection of the subsidiary anodes will show up as very poor focusing and sometimes



can be cured by increasing the flux of the focus magnet or, in the case of self-focusing tubes, the use of a very weak flux magnet suitably placed (an ion trap magnet has been used with success in a similar situation).

When one looks at the neck of the tube and after scraping away the dirt is dismayed by the absence of the glow from the heaters,



all is not lost. If one of the instruments for welding disconnected heaters is available this can be done without removing the tube; however, not everyone can afford forty-odd pounds for such an instrument, yet it is still possible to salvage what seems a hopeless mess. First, put a shorting link across the

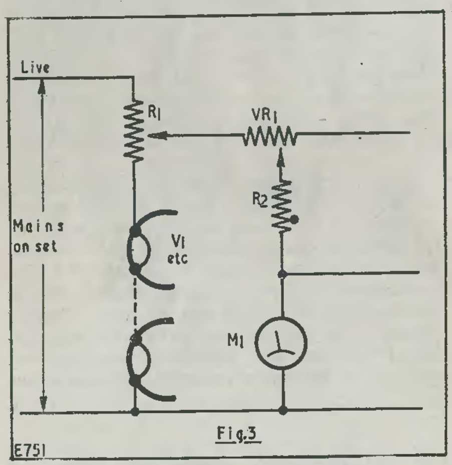


Fig.3

tube holder after removing the tube. Next, connect a length of insulated wire from the live side of mains to one of the heater pins, then another length from a suitable tap on the mains supply so as to obtain 40–50 volts a.c. and, after switching the set on, touch momentarily to the other heater pin, when the heater should start to glow. It is worth trying several times and, if still not successful, increase the voltage. It must be emphasised that to apply this voltage too long may repair the break in the heater and then completely burn it out. Even if a continuity reading across the heaters is obtainable it may mean that the heater is shorted part way up the spiral or hair pin. Great care should be taken, as in a.c./d.c. sets when the tube is in series with the valves to switch on may mean burning out a valve or valves due to excess current of the tube being drawn through the valve chain. As a protection it is wise to use a Brimistor in series with the heaters on a.c./d.c. or in series with the primary of the mains transformer on a.c. sets. However, if the heater is checked by the use of an l.t. transformer of the correct voltage, one can generally judge from the brightness of the heater what the condition is, though it has been known for new tubes to have drawn more current than rated and, whilst they would not work in a.c./d.c. sets, work perfectly in a.c.-only receivers where the heaters are supplied from a transformer.

In the case of a soft or gassy tube, nothing can be done. It shows up as a flat picture, probably defocused, and without correct contrast brightness settings being obtainable. If positive proof is required, connect a 500 microamp meter in series with the cathode, and if the reading is over 275 microamps this tube can only be condemned. Whilst it is possible to get the tube re-getted, this is often not successful as air has filtered into the tube either through a flaw or crack in the glass of the tube or between the glass seal and the metal lead-outs at the base of the tube, the latter being caused by the co-efficients of expansion of the glass lead and metals not being properly matched.

Occasionally a dry joint in the soldering of the pins and the lead-out causes a poor or intermittent picture. The cure is to run some solder down the pins, keeping the iron on long enough to ensure a good joint. In cases where the base has become loose, if twisting gently on the base causes the fault to come and go, one can fix the base in a working position with Sellotape or, as the writer had to do, remove the base and solder the supply leads directly to the lead wires.

A TEST LOUDSPEAKER

by **K. E. Marcus**

The Loudspeaking Headphone

ANNOYED BECAUSE HE HAD TO WEAR headphones for long hours while checking communications gear with only 'phone or line output, the author modified, many years ago, the final stage of an old a.c./d.c. broadcast receiver to act as a "loudspeaking headphone".

In principle this piece of ancilliary equipment was a huge success, as it did away with the wearisome "earblinkers". But physically it was an abomination and it has been the source of quite a few nasty shocks ever since.

The Test Loudspeaker

Again, a few years later, another piece of equipment was knocked together. It consisted of a plug-line, which could be inserted into the 'phone or line jack of the gear under test, and it ended in an output-power meter. A five-position switch laid either the speech coil of a loudspeaker, or a transformer, across this line. Diagram No. 1 shows how this was done.

The transformer itself is the output transformer of an ex-army P.C.R. In position 1 of the switch the speech coil is across the line in parallel with the output meter. In position 3 the 600Ω secondary is across the line and the 3Ω secondary is connected to the speech coil. In position 5 the primary of the output transformer in series with a 4μF paper capacitor is across the line and, again, the 3Ω secondary is connected to the speech coil. In positions 2 and 4 the loudspeaker is disconnected, and the output meter only is in circuit. The plug-line is left floating, being nowhere earthed, except if the gear jack provided an earthing of the plug body.

For years this rather crude piece of equipment has given yeoman service to the author, since it permitted him to align gear to tone and output meter observation, while a flick of the switch to the blind positions allowed correct meter readings. This test loudspeaker was technically a success, but rather unsightly.

The New Test Equipment

There appeared, recently, on the surplus market an RCA loudspeaker in a handsome black crackle steel cabinet, and it was decided to combine the old loudspeaking headphone, this time, of course, in a.c., with the test loudspeaker. This rationalisation produced a very useful piece of laboratory gear, the circuit of which is given in diagram No. 2.

The old five-position switch was fitted into the lower right-hand corner of the front, with the output transformer (T_1) and the block capacitor (C_1) next to it behind the switch inside the steel cabinet. Into the right-hand wall was fitted a jack for the output meter plug. Thus the output meter became mobile, if required. Thereafter the wiring of the old pattern was restored with vastly shortened connections, and tested.

The fitting of a "loudspeaking headphone" into the left half of the cabinet seemed at first to be a bit of a problem, as there is not much room. However, a solution was found finally: there was in the spares box a mains transformer of the Civilian Wartime Receiver, which proved eminently useful for the application in hand. It is a rather sturdy job of 0–200–250V primary, 250–0–250V, 70mA h.t. secondary, plus two heater windings; of these the 4V rectifier winding was left unused. It has a paxolin board fitted on top, which contains a rectifier base; this board was removed and an aluminium platform fitted instead, which was cut to fit snugly into the left-hand corner of the cabinet.

The layout Fig. 3 shows its shape. Near the frontplate an octal valveholder for the KT61 was fitted; above the transformer came one for the 6X5. A pilot lamp holder was soldered across the heater line directly below the KT61, so that the lamp will come opposite the telephone indicator lens, when the unit is inserted into the cabinet. The two electrolytics were fitted near the left side wall to the platform in an insulated manner.

The wiring-up of the amplifier unit should be completed before it is inserted, and must be carried out with care. Since the plug-line is to be left floating again, the chassis **cannot** be used as the reference line, but a **neutral** connecting wire has to be used throughout. It is recommended to check that this neutral line is nowhere in metallic contact with the body of the amplifier unit, which is earthed through the cabinet.

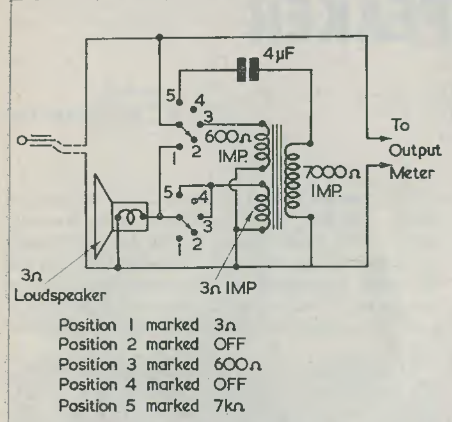


FIG.1. The Original Test Loudspeaker.

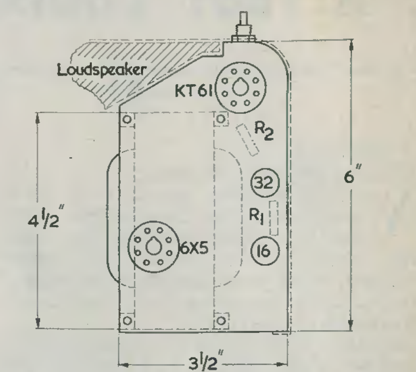


FIG.3.
Amplifier Layout

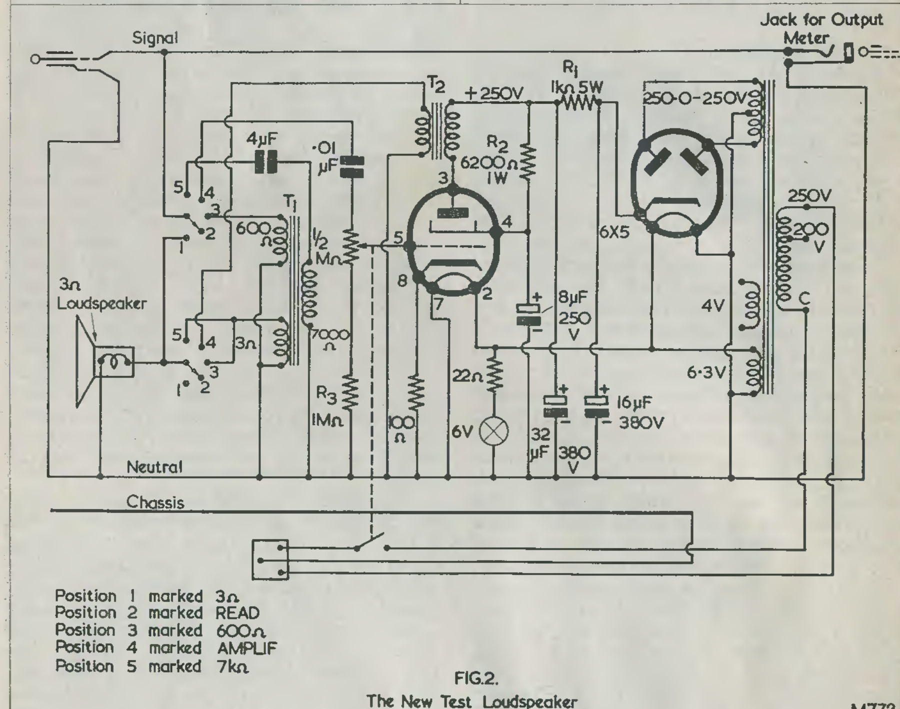


FIG.2.
The New Test Loudspeaker

The Assembly

The volume control plus switch goes into the left-hand lower corner of the frontplate of the cabinet, corresponding to the switch on the other side, and a small telephone indicator lens is fitted about 1in above. With the help of a small paxolin tagstrip fixed to a convenient loudspeaker bolt, the connections to the volume control (C_2 and R_3) can now be completed and C_2 be connected to the loudspeaker switch. For the amplifier facility the position 4 of the switch is used.

The amplifier unit can now be inserted. As there is not much room, the soldering-in of the grid lead from the output valve to the potentiometer slider will prove a little bit of a game of skill and patience; but finally, I trust, the impossible will be achieved, and all that is left to do is to screw another small output transformer (T_2) to the bottom plate and to connect up its primary to flying leads from the output valve anode and from h.t.; while the 3Ω secondary is brought on one side to position 4 on the output side of the switch, on the other to the neutral reference line.

It was first contemplated to use T_1 as the amplifier output transformer as well, but since this would involve nightmarish switching arrangements, a renewed dig into the spares box was undertaken and a serviceable 40:1 transformer unearthed, which filled the bill, and, incidentally, the remaining bottom space inside the cabinet.

The Function

Very weak signals can now be monitored in the amplifier position 4. Due to its short grid base, the KT61 produces a clear tone with about ½V audio on its grid, which, in a 600Ω line, corresponds to a power output of just over 400μW from the gear under test. In this region no output meter gives reliable readings; but because of the clearness of the tone the amplifier allows a first alignment of, say, the i.f.s with a low-level input from the beginning.

With about 2V audio in the plug-line, the output meter is in its proper reading range, and the alignment can now be done by the meter. The strongest signal the amplifier will take without distortion will be about 6V audio in the 600Ω line, of which 4V are supplied to the KT61 by turning down the volume control fully; in this case the power output from the gear under test is about 60mW.

For stronger signals the amplifier can be switched off and the test loudspeaker used directly. In practice the "600Ω" position 3 will be generally acceptable. The monitoring tone comes quite clearly, even if a phone line is mismatched anywhere between 150Ω and 2,500Ω: as soon as the switch is brought into the "reading" position 2 there is no interference by the test loudspeaker to the impedance matching of the output meter and the meter registers correctly.

The same applies to the "3Ω" position 1 and the "7kΩ" position 5. It should be mentioned that both these facilities have been used only very occasionally over the last few years; they were included into the new set-up only to make the equipment as flexible as possible.

The Economic Side

The "bits and pieces" are enumerated in the accompanying list. Since most of them were either available on the surplus market, or, still cheaper, were found in the spares box, the cost of this very useful piece of equipment was very low indeed, most likely below £4.

Components List

	1 RCA loudspeaker in black crackle steel cabinet (surplus)
T_1	1 output transformer (surplus ex-Army PCR, or equivalent) 48:14:1 Prim: 7,000Ω Imp.; 1st Secondary 600Ω Imp.; 2nd Secondary 3Ω Imp.
T_2	1 output transformer 40:1
	1 mains transformer (surplus ex-Civ. Wart. Rec., or equivalent) Prim: 0–240V or as required; HT-Second: 250–0–250V 70mA; Heater-Second: 0–6.3V 2A
	2 valve bases International Octal
	1 valve KT61 (Marconi—GEC)
	1 valve 6X5 (any make)
	1 capacitor electrolytic 16μF 380V upright
	1 capacitor electrolytic 32μF 380V upright
	1 capacitor electrolytic 8μF 250V
C_1	1 capacitor paper 4μF 150V block type
C_2	1 capacitor paper 0.01μF
R_1	1 resistor wirewound enamelled 1kΩ 5W
R_2	1 resistor carbon 6,200Ω 1W
	1 resistor 100Ω ½W
	1 resistor 22Ω ¼W
R_3	1 resistor 1MΩ ½W
	1 lampholder plus bulb 6V
	1 telephone indicator lens, colour as required
	1 paxolin tagstrip, 2 insulated tags
	1 volume control ½MΩ plus switch
	1 switch body 2-pole 5-way
	2 plug-lines with 2-way telephone plugs
	1 telephone jack
	1 mains line with plug
	Piece of aluminium or paxolin, about 6in x 3½in

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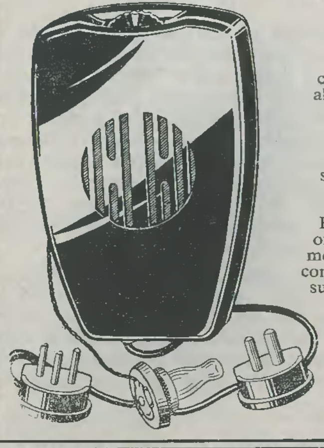

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Precision made in our own works from commercial quality half-hard aluminium of 16 s.w.g. (1/16") thickness. these chassis go all over the world (and off it—in rockets!). Same day service for ANY SIZE, to nearest 1/16" and up to 17" of straightforward two, three or four-sided chassis. Orders for specials dealt with promptly if sent with clear instructions.

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FLANGES. $\frac{1}{4}$", $\frac{3}{8}$" or $\frac{1}{2}$" flanges (inside or outside) **6d.** extra for each bend.

PRICE GUIDE (normal chassis only)

Work out total area of material required, including waste, and refer to table below:

48 sq. in.	4/–	176 sq. in.	8/–	304 sq. in.	12/–
80 sq in.	5/–	208 sq. in.	9/–	336 sq. in.	13/–
112 sq. in.	6/–	240 sq. in.	10/–	368 sq. in.	14/–
144 sq. in.	7/–	272 sq. in.	11/–	and pro rata	
Post 1/3		Post 1/6		Post 1/9	

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PANELS. The same material can be supplied for panels, screens, etc. Any size up to 3ft at **4/6** sq ft. (sq. in. x $\frac{3}{8}$d.). Post, up to 72 sq. in. **9d.,** 108 sq. in. **1/3,** 144 sq. in. **1/6,** 432 sq. in. **1/9,** 576 sq. in **2/–.**

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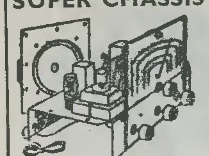

79/6 or 5/1

Initial payment and 19 weeks at 3/11. 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.

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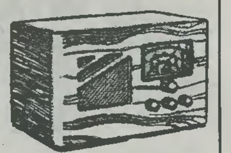

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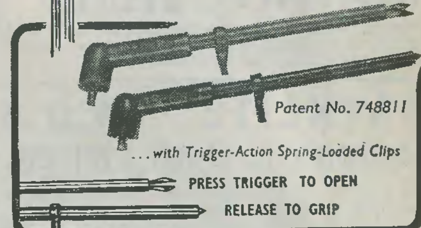

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Receiver Components Kit	57/6	P. & P. 1/6
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Low Loss Semi-air Spaced AERAXIAL, polythene ins.
SPECIAL REDUCED PRICES
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New improved types—mains prim. 200/250V tapped

All isolation transformers now supplied with alternative no boost, plus 25%, and plus 50% boost taps, at no extra charge. All standard individual voltages available: 2V 2A–13V 0.3A (as previously advertised).

Each **12/6** P. & P. 1/6

Small size and tag terminated for easy fitting

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Log. or lin. ratios, 10,000 ohms–2 Megohms. Long spindles. 1 year guarantee. Midget Ediswan type, $1\frac{1}{8}$" dia. No sw. **3/–**, d.p. sw. **4/6**.
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X66, KTW61, DH63, KT63, U50	30/–
6K8G, 6K7G, 6Q7G, 5Z4G, 6V6G	32/6
1R5, 1S5, 1T4, 1S4 (or 3S4 or 3V4)	25/–
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6K8G, 6K7G, 6Q7G, 25L6GT, 25Z5 (or 25Z6G)	35/–
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P.P. **1/–** per set of valves

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FREE COMPLETE LIST AND DATA ON REQUEST
FULLY GUARANTEED

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XA103 4 Mc/s R.F., I.F. amp.	15/– ea.
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Above are direct equivalents of SB344; SB100; SB101, etc.	
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OC72 Power Driver	16/– ea.
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OC170 70 Mc/s Short Wave	35/– ea.
OC139 N.P.N. 4 Mc/s	66/– ea.
OC140 N.P.N. 6 Mc/s	72/– ea.
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OC76 R.C. Switching	15/– ea.
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V15/10P Power Output, 2 watt	15/– ea.
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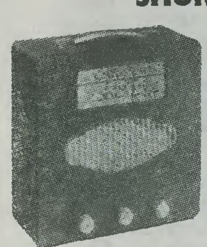

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★ **3 Wavebands (10 to 550 metres)—650 kc/s to 2 Mc/s, 3 to 11 Mc/s, 11 to 30 Mc/s.**
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NOW **£6.15.6** P.P. 3/6, incl. Speaker
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★ ALTERNATE MODEL MEDIUM, LONG AND SHORT WAVEBANDS.

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Latest ACOS 19–4, 2" round Hi-Fi Insert, **14/–.** P.P. 6d.
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Complete with 5 valves. In new condition. These sets are sold without guarantee, but are serviceable.
7 to 9 Mc/s **22/6** P.P. 2/6
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Just right for a day's outing "CONTINENTAL—6"

For Style, Quality Performance and Value for Money

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★ Plessey Printed Circuit
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★ ALL COMPONENTS GUARANTEED
★ Double Tuned IFs

ALL COMPONENTS AVAILABLE SEPARATELY

Total Cost of all Components
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including Cabinet, Battery, Transistors, Car Radio, AVC and all necessary items

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 ease of construction combine to produce a radio equal to any commercial receiver in the 20 gns. class.

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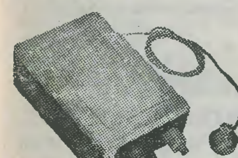
MAJOR—2 *(Two-Transistor Pocket Radio)*



★ 4-stage reflex
★ Medium wave; tunable
★ Very sensitive
★ No aerial or earth
★ Complete layout
★ Over 6 months on one battery
★ $4\frac{1}{2}$" x 3" x $1\frac{1}{4}$"
★ Weight only 4 oz.
★ Personal phone incl.

TOTAL COST **69/6** P.P. 1/6
NEW BOOKLET FREE: All components sold separately.
Ideal for beginner
RECEPTION GUARANTEED ANYWHERE!

MAJOR—3 *(Three-Transistor Radio)*

OUR CUSTOMERS SAY:
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"Excellent reception."
"Surpasses my expectations."

★ 5-stage Reflex Circuit
★ No Aerial or Earth
★ Min. Volume Control
★ 3 Ediswan Transistors
★ Medium Wave Tuning
★ Size $4\frac{1}{2}$" x 3" x $1\frac{1}{4}$"
★ Personal phone

(As described in R.C., Sept. '59)
Total Cost 87/6 P.P. 1/6 NEW BOOKLET FREE
FANTASTIC OUTPUT, TERRIFIC RECEPTION GUARANTEED ANYWHERE

RED-SPOT TRANSISTORS 5/– each
WHITE-SPOT 7/6 each
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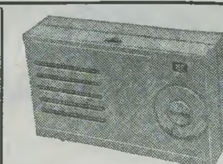

$6\frac{1}{4}$" x $3\frac{3}{4}$" x $1\frac{3}{4}$"

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The Teletron "TRANSIDYNE" 6-transistor superhet

★ Medium and Long Waves
★ $2\frac{1}{2}$" Rola Speaker
★ All Ediswan transistors
★ Marked printed circuit
★ Illustrated instructions

Includes cabinet, battery, transistors, etc.
FREE LEAFLET, BOOKLET 1/– POST FREE
NOW ONLY P.P. 2/– **£9.10.0**

3-TRANSISTOR HEARING AID
High-gain circuit with built-in crystal microphone and battery. Includes miniature earphone. Size 3" x 2" x $\frac{3}{4}$". All components, **89/6.** P.P. 1/–

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Ideal signal peaker or quick fault-finder for receivers, amplifiers, etc. Size $4\frac{1}{2}$" x 3" x $1\frac{1}{4}$". All components, with 'phones, **37/6.** P.P. 1/6. Less 'phones, **32/6.** P.P. 1/6

2 WATT OUTPUT TRANSISTOR AMPLIFIER
For connection to any battery portable to give up to 2W output. Works from 12V battery. Ideal for car radio use. Size $4\frac{1}{2}$" x 3" x $2\frac{1}{4}$", uses power transistor.
All components (less speaker) **52/6.** P.P. 2/–
Ideal for use with Continental, etc.

250mW PUSH-PULL OUTPUT AMPLIFIER
For use with any 2, 3 or 4 transistor, earpiece or headphone radio to give room-filling volume on 3" speaker. All components including 2 Ediswan transistors, speaker, battery, special input socket to take earpiece plug, cabinet, etc., **59/6.** P.P. 1/6.
Ideal for use with Major-2 or Major-3.

TRANSISTOR TRANSMITTER
1.8 to 2 Mc/s coverage. 3 transistors unit size $4\frac{1}{2}$" x 3" x $1\frac{1}{4}$". Range of 3-section rod aerial up to 300 yards. Includes built-in microphone, battery and 3-section rod aerial. All components, **57/6.** P.P. 1/6.

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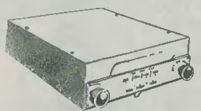

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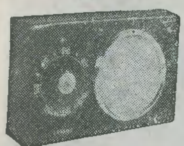

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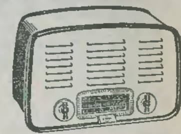

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