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Further Notes on the "Companion"

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NUMBER 2
SEPTEMBER
1957

The RADIO Constructor

RADIO · TELEVISION · AUDIO · ELECTRONICS

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

Included in this issue
EASILY SET-UP & CALIBRATED VALVE VOLTMETER
A SENSITIVE SIGNAL TRACER
"THREE-DEE" 3 TRANSISTOR RECEIVER
SIMPLIFIED LOW DISTORTION DETECTOR
A CIGAR BOX RADIO
ADD-ON A.F. AMPLITUDE LIMITER

DATA Publications 1/9

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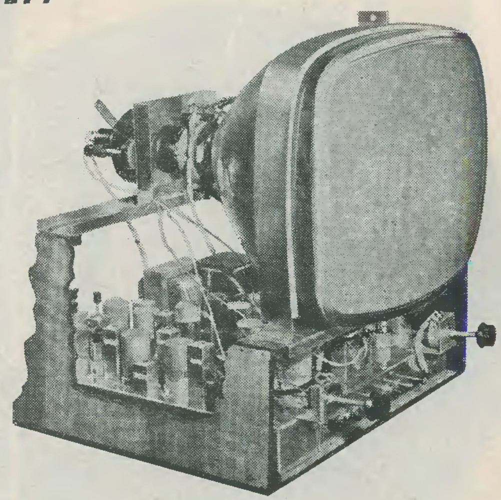
These Televisors use a double wound mains transformer which gives you complete safety from contact with the mains supply when handling the chassis or controls.



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Build in 5 easy stages. Full Construction details available. Instruction Book 3/6 post free.

Console Cabinets with full-length doors for 14in., 16in. and 17in. tubes. Price **£14.14.0.**

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A completely new design with the **all star** feature from the firm with 45 years of experience in the supply of designs for the home constructor.

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- ★ Size only 8" x 8" x $4\frac{1}{2}$"
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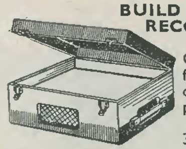
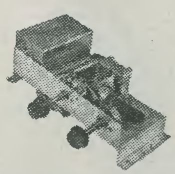
Batteries Extra. H.T. 10/– (type B126) or equivalent. L.T. 1/6 (type AD35) or equivalent.

BUILD YOUR OWN RECORD PLAYER



Compact Amplifier, A.C. mains only . . . **£2.19.6** p. & c. 2/6

3-speed Single Player, B.S.R. TU8 . . . **£4.12.6** p. & c. 2/6



PC2 De Luxe Cabinet, **£2.15.6** p. & c. 3/–

7" x 4" Elliptical Speaker **£1.1.0** p. & c. 1/6

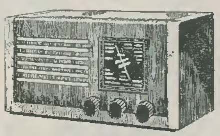
The Teletron "COMPANION"

3 Transistor Pocket Receiver

Plastic Cabinet complete with drilled chassis **8/6.** Ferrite Inductor FX25 **15/–.** Ardente Transformers D240 & D239 **10/–** each. Wavechange switch **1/3.** Transistor R. F. **21/–.** Transistor Audio **10/–** each. Construction Book 6d.

This receiver may be built for **89/6** *Complete p. & p. 1/6*

2-BAND T.R.F. RECEIVER



MAY BE BUILT FOR **£5.15.0** Plus 3/– Pkg. & Post

3-Band Superhet Receiver may be built for £7.19.6 plus pkg. and carr. 3/–. These two receivers use the latest type circuitry and are fitted into attractive cabinets 12" x $6\frac{1}{2}$" x $5\frac{1}{2}$" in either walnut or ivory bakelite or wood. Individual instruction books **1/–** each, post free.

The new Premier WIDE ANGLE TELEVISOR "The Mayfair." Construction Book 3/6 post free.

CONDENSERS. Mica or S. Mica. All pref. values. 3pF to 1000pF, **6d.** each. Ceramic types, 2.2pF to 5,000pF, **9d.** each. Tubulars, 450V, Hunts and T.C.C. 0.0005, 0.001, 0.005, 0.01 and 0.1, 350V, **9d.**; 0.02, 0.05, 0.1, 500V Hunts, T.C.C., **1/–**; 0.25 Hunts, **1/6**; 0.5 Hunts, **1/9**; 0.001 6kV T.C.C., **5/6**; 0.001 20kV T.C.C., **9/6.**

8" P.M. SPEAKER. Ex mfrs. units: Rola, Elac, Celestion, etc. All reconditioned and guaranteed. Ideal ext. unit. Bargain **7/6.** *Carriage* 1/6

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

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

RESISTORS. Pref. values 10 ohms 10 megohms, 20% tol., $\frac{1}{4}$W, **3d.**; $\frac{1}{2}$W, **5d.**; 1W, **6d.**; 2W, **9d.**; 10% tol., $\frac{1}{2}$W, **9d.**; 5% tol., $\frac{1}{2}$W, **1/–**; 1% hi-stab., $\frac{1}{2}$W, **2/–**

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

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

LOUDSPEAKERS. P.M. 3 ohm. $2\frac{1}{2}$" Elac, **16/6**; $3\frac{1}{2}$" Goodmans, **18/6**; 5" Celes., **17/6**; 6" Celes., **18/6**; 7" x 4" Goodmans, **18/6**; 8" Elac, **20/–**; 10" R. and A., **25/–**

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

VOL. CONTROLS. Log ratios 10kΩ-2MΩ, long spindles, 1 year guar. Midget Ediswan type, no switch **3/–**, s.p. switch **4/–**, d.p. switch **4/9**. Lin. ratios less sw. **3/–**

MAINS TRANSFORMERS. Made in our own workshops to top grade spec. Fully interleaved and impregnated. We shall be glad to quote for your specials.

80 OHM CABLE, CO-AXIAL. Special. Semi-air spaced polythene standard $\frac{1}{4}$" dia. Stranded core. Feeder losses cut 50%, **9d.** yd. Standard Grade A Coax. Polythene insulated $\frac{1}{4}$" dia., **8d.** yd.

ELECTROLYTICS—ALL TYPES—NEW STOCK

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

MIDGET TRANSISTOR TYPES. 2μF, 4μF, 8μF 6V, **3/9**; 6μF, 10μF, 16μF 3V, **3/9**; 32μF $1\frac{1}{2}$V, **3/9**

I.F. TRANSFORMER, 465 kc/s. Brand new ex-manufacturer's midget i.f.t., size $2\frac{1}{2}$" x $\frac{3}{4}$" x $\frac{3}{4}$", dust core tuning. Litz wound coils, high-Q. Bargain offer **7/6** pair

VALVES—NEW BOXED—ALL GUARANTEED

1R5, 1T4, **7/6**; 1S5, 1S4, **7/6**; 3S4, 3V4, **8/–**; 5Z4, **9/6**; 6AT6, **8/6**; 6K7, **6/6**; 6K8, **8/6**; 6Q7, **8/6**; 6SN7, **8/6**; 6V6, **7/6**; 6X4, **7/6**; 6X5, **7/6**; 7C5, **9/–**; 7Y4, **8/6**; DAF96, **9/–**; DF96, **9/–**; DK96, **9/–**; DL96, **9/–**; 35L6, **10/6**; EABC80, **9/6**; EB91, **6/6**; EBC41, **10/6**; EBC33, **8/6**; ECC84, **12/6**; ECH42, **10/6**; ECH81, **10/6**; ECL80, **10/6**; EF41, **10/6**; EF80, **10/6**; EF86, **12/6**; EF91, **8/6**; EY51, **10/6**; EZ40, **8/6**; EZ80, **8/6**; MU14, **9/6**; PCC84, **10/6**; PCF80, **10/6**; PCF82, **10/6**; PCL83, **12/6**; PL81, **11/6**; PL82, **10/–**; PL83, **11/6**; PY80, **9/6**; PY81, **9/6**; PY82, **8/6**; U22, **8/6**; U25, **11/6**; UY41, **8/6**

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THO 2188. Hours 9 a.m.-6 p.m., 1 p.m. Wed. Terms: C.W.O. or C.O.D. Post and packing up to $\frac{1}{2}$lb **7d.**, 1lb **1/1**, 3lb **1/6**, 5lb **2/–**, 10lb **2/9**. Bargain lists **3d.**

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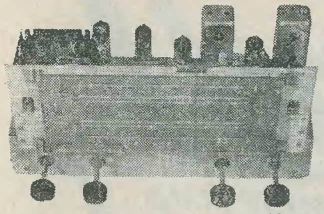
Receivers, Transmitters, Televisors, Hi-Fi Amplifiers, Test Gear, Tape Recorders, and Transistor Equipment

HOME-BUILT Live Television Station and Studio. Live Radio Station talking to the World.

Win an Eddystone Communications Receiver (See next month's issue)

FURTHER DETAILS FROM P. A. THOROGOOD, G4KD, 35 GIBBS GREEN, EDGWARE, MIDDX.



1957 RADIOGRAM CHASSIS

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

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

BRAND NEW £10.10.0 Carr. 4/6

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

Recommended for above Chassis

R.C.S. SCOOP

HIGH FIDELITY AUTOCHANGER

COLLARO 1957 MODEL RC456
For 7", 10", 12" Records 16, 33, 45, 78 r.p.m.
4 SPEEDS — 10 RECORDS
WITH STUDIO "O" PICK-UP
BRAND NEW IN MAKER'S BOXES
OUR PRICE £9.15.0 Post free
Terms: Deposit **£5.5** and 6 monthly payments of **£1**

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

1957 MODELS
Brand new and fully guaranteed 12 months
NOT JOB LINE REJECT STOCK

Designed to play 16, 33, 45, 78 r.p.m. Records 7", 10", 12". Lightweight Xtal pick-up, turnover head, two separate sapphire styli, for standard and L.P. Each plays 2,000 records. Voltage 200/250 a.c.

OUR PRICE £8.15.0 each. Post free

Terms: Deposit **£5** and 5 monthly payments of **£1.** Space required 14" x 12½". 5" above and 3" below.

B.S.R. MONARCH. 3-speed Motor and Turntable with selecting switch for 33, 45 and 78 r.p.m. records, 100-120V and 200-250V a.c. 50 c.p.s. Also **B.S.R. MONARCH** Lightweight Pick-up with Acos Xtal turnover head, separate sapphire stylus for L.P. and standard records. **SPECIAL OFFER THE TWO £4.12.6,** post 2/6. 14" x 12½" Cut Out board **6/–**

AMPLIFIER RECORD-PLAYER CABINETS
Cabinet size 18½" x 13½" x 8½" high, with motor board 14" x 12½" **£3.3.0** Post 3/–

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

NEW AND ENLARGED SHOWROOMS NOW OPEN

C.R.T. ISOLATION TRANSFORMERS
For Cathode Ray Tubes having heater-cathode short circuit for C.R. Tubes with falling emission.
Type A. Low leakage windings. Ratio 1:1.25 giving a 25% boost on secondary: 2V, 4V, 6.3V, 10.3V, 13.3V, **10/6** each; ditto with mains primaries, **12/6** each. All with tag panel and solder tags.
Type B. Mains input 220/240V. Low Capacity. Multi Output 2, 4, 6.3, 7.3, 10 and 13V.' Input has two taps which increase output volts by 25% and 50% respectively. This transformer is suitable for all cathode ray tubes. With tag panel, **21/–** each.
Type C. Low capacity wound transformer for use with 2V tubes with falling emission. Input 220/240V. Output 2-2¼-2½-2¾-3V at 2A. With tag panel, **17/6** each.
All isolation transformers are individually boxed, labelled and clearly marked with relevant data.
NOTE.—It is essential to use mains primary types with T.V. receivers having series connected heaters.

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

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

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

HEATER TRANS. Tapped 200/250V 6.3V 1½A, **7/6**
ALADDIN FORMERS and cores. ¼" **8d.**; ⅜" **10d.**
0.3" FORMERS 5937/8 and Cans TV1/2. ¾" sq. x 2⅜" and ¾" sq. x 1⅜", **2/–** complete with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6:1, **2/3**
TYANA. Midget Soldering Iron. 200/220V or 230/250V, **16/9.** **SOLON MIDGET IRON,** 25W, **24/–**
MAINS DROPPERS. 3" x 1¼". Three adj. sliders, 0.3A 750 ohms, **4/3**; 0.2A 1,000 ohms, **4/3**
LINE CORD. 0.3A 60 ohms, per foot; 0.2A 100 ohms, per foot, 2-way, **6d.** per foot; 3-way **7d.** per foot

MIKE TRANSF. Ratio 50:1, **3/9** each; 100:1, **10/6**
LOUDSPEAKERS. P.M. 3 ohm. 2½" square, **17/6** 5" R.A. **17/6,** 7" x 4" Goodmans **21/–**, 3½" sq. Elac, **21/–**, 8" Plessey **19/6,** 6½" Goodmans **18/6,** 10" R.A. **30/–**, 12" Plessey **30/–**, 8" M.E. 2.5K field tapped, O.P. transformer **24/6.** **TSL TWEETER LSH75 8/6.**
CRYSTAL DIODES. G.E.C. **2/–**; GEX34 **4/–**; **40 CIRCUITS FOR GERMANIUM DIODES, 3/–**
CRYSTAL SET, Complete Kit **12/6.** Construction Book **1/–**.
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**; 3-gang 500pF, **7/6**

SUPERHET COIL PACK 27/6
Miniature size 2½" x 2¾" x 1½". High Q dust cored coils. Short, Med., Long. Gram. switching with connection diagram and circuit. 465 Kc/s I.F.

Written guarantee with every purchase

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

Volume Controls

Midget size
Long spindles. Guaranteed 1 year. All values 10,000 ohms to 2 Meg. No. S2. S.P.Sw. D.P.Sw.
3/– **4/–** **4/9**
Linear or Log Tracks

80 Ω Coaxial cable

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

STANDARD QUALITY
¼" Co-axial **8d.** yd.

Co-axial Plugs **1/–** **Double Socket** **1/3**
Sockets **1/–** **Outlet Boxes** **4/6**
Balanced Twin Feeder per yd., **6d.** 80Ω or 300Ω.
Twin Screened Balanced Feeder, 1/– yd., 80 ohms.
Trimmers Ceramic, 30, 50, 70pF, **9d.**; 100pF, 150pF, **1/3**; 250pF, **1/6**; 600pF, 750pF, **1/9.** Philips **1/–** each

BLACK CRACKLE PAINT. Air drying, **3/–** tin
P.V.C. CONN. WIRE, 10 colours, single or stranded, **2d.** yd. Sleeving ½ mm. **2d.**, ¾ mm. **3d.**, 6 mm. **5d.** yd.
5" RADIO SCREWDRIVERS, 6d. each
NEON MAINS TESTER SCREWDRIVERS 5/6
MULTICORE SOLDER, 60/40, 18 s.w.g., **3d.**, 16 s.w.g., **4d.** yd., ¼ lb **2/6.**

Sentercel Rectifiers. E.H.T. Type Fly-back. Voltages: K3/25 2kV, **5/–**; K3/40 3.2kV, **7/–**; K3/45 3.6kV, **7/6**; K3/50V 4kV, **8/–**; K3/100 8kV, **14/6.**
Mains Type RM1, 125V 60mA, **5/–**; RM2 100mA, **6/–**; RM3 120mA, **8/–**; RM4 250V 275mA, **16/–** RM5 **20/–**
Miniature Contact Cooled Rectifiers. 250V 50mA, **8/6**; 250V 85mA, **9/6.**
Coils. Wearite "P" type, **3/–** each. Osmor Midget "Q" type adj. dust core, from **4/–** each. All ranges.
Teletron. L. & Med. T.R.F., with reaction, **3/6**
Ferrite Rod Aerials. M.W., **8/9**; M. & L., **12/6.**
T.R.F. Coils A/HF, **7/–** pair. **H.F. Chokes, 2/6**

Condensers. New stock. 0.001µF 7kV T.C.C., **5/6**; ditto 20kV, **9/6**; 100pF to 500pF Micas, **6d.**; Tubular 500V 0.001 to 0.01µF, **9d.**; 0.05, 0.1, **1/–**; 0.25, **1/6**; 0.5, **1/9**; 0.1/350V, **9d.**; 0.1/600V, **1/3**; 0.1/2,000V, **4/–**
Ceramic Conds. 500V 0.3pF to 0.01µF, **10d.**
Silver Mica Condensers. 10% 5pF to 500pF, **1/–**; 600pF to 3,000pF, **1/3**; ditto 1% 1.5pF to 500pF, **1/9**; 515pF to 5,000pF, **2/–**.

NEW ELECTROLYTICS. FAMOUS MAKES

TUBULAR		TUBULAR		CAN TYPES	
1/350V	2/–	100/25V	3/–	8+16/450V	5/–
2/450V	2/3	8+8/500V	6/–	16+16/500V	6/–
4/450V	2/–	16+16/500V	6/–	6,000µF 6V	6/6
8/450V	2/3	**CAN TYPES**		32+32/350V	4/6
8/500V	2/9	Clips	3d.	32+32/450V	6/6
16/450V	3/6	16/450V	3/6	64+120/275V	7/6
16/500V	4/–	32/350V	4/–	60+100/350V	11/6
32/450V	5/6	64/350V	5/6	100+200/275V	
25/25V	1/9	100/275V	5/6		10/6
50/25V	1/9	50+50/350V	7/–	1,000+1,000/6V	
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6J6	7/6	35Z4	10/6	EL32	5/6	UY41	8/6
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The

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incorporating THE RADIO AMATEUR

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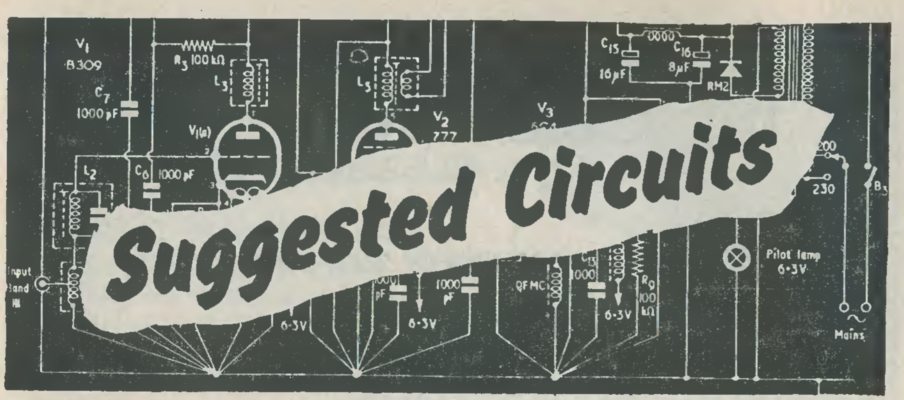


The circuits presented in this series have been designed by G. A. FRENCH, *specially for the enthusiast who needs only the circuit and essential relevant data*

No. 82. AN ADD-ON A.F. AMPLITUDE LIMITER

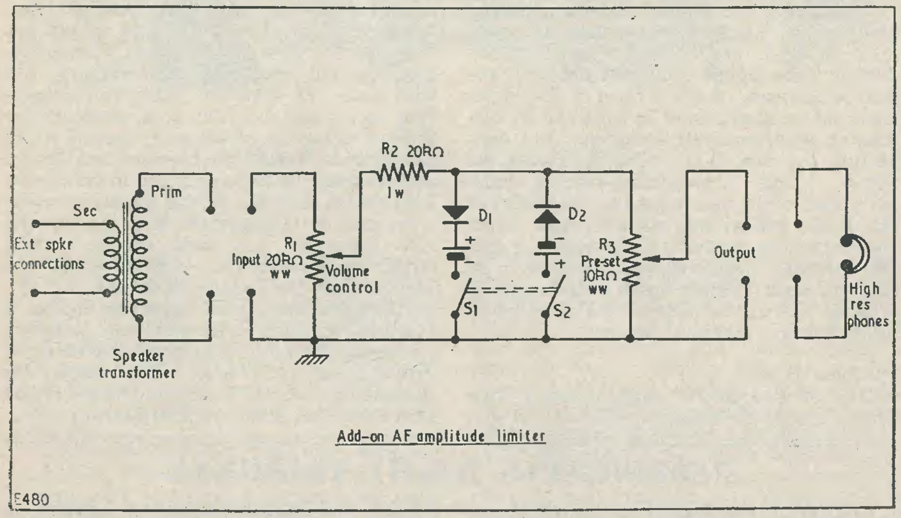
An interesting request recently reached the writer via the Editor of *The Radio Constructor*. The correspondent making the request stated that he had fitted up a circuit by means of which the output of a sound receiver could be applied to a pair of headphones for the benefit of a friend who was rather hard of hearing. The headphones were of high-impedance type, and were coupled to the extension loudspeaker sockets of the receiver via an output transformer connected in such a manner that what was originally its primary now fed the headphones. The arrangement worked quite well so far as speech was concerned, but music, due to the B.B.C.'s frequent habit of broadcasting this at considerably higher levels than speech, was at times so loud as to be almost unbearable for the person wearing the headphones. The worst cases of discomfort occurred whenever an introductory loud burst of music followed a period of relatively quiet speech. The correspondent asked for details of a simple limiter circuit which could overcome this trouble.

Although the above instance does not represent a widespread requirement, the writer feels that the solution which was passed on to the correspondent would also make a suitable subject for inclusion in this series of articles. Quite a number of radio enthusiasts are interested in short wave work, etc., and many employ headphones in conjunction with mains receivers having, so far as this application is concerned, an unnecessarily high degree of a.f. output power. Long periods of listening under such conditions can at times be fatiguing, and especially so when reception is subject to interference from static and unwanted powerful transmitters. A noise limiter of the type to be described in this article should prove to have quite a definite value for the short wave listener, in addition to the advantages conferred in the previous case.

The Circuit

This month's Suggested Circuit is depicted in the diagram which accompanies this article, and, as may be seen, represents a very simple and inexpensive design. The limiter unit proper is contained between the "Input" and "Output" terminals illustrated; and the diagram also shows how an additional

speaker transformer may be connected up when the associated headphones are intended to be run from the extension loudspeaker sockets of a conventional domestic receiver. When the transformer is connected in the manner illustrated it converts the low impedance output at the extension loudspeaker sockets to the high impedance needed by the phones and the limiter unit. For the limiter unit to function correctly it is necessary for the headphones to be of "high-resistance" type (preferably 2,000 ohms per phone), and for the a.f. output of the receiver to have power in reserve. This last requirement is due to the fact that a loss in output level occurs in the noise limiter circuit.



Add-on AF amplitude limiter

The operation of the unit is extremely simple. The a.f. appearing at the slider of the volume control R_1 is applied to the two crystal diodes, D_1 and D_2, via resistor R_2. Both D_1 and D_2 work with voltage delays, these being provided by the 1.4 volt cells with which they are connected in series. When the level of a.f. tapped off by R_1 exceeds a value of 2.8 volts peak to peak, both diodes conduct, thereby applying an effective resistance across the circuit which is equal to their forward resistances in series with the internal resistances of the delay cells. The resistance applied when the diodes conduct is much lower than that of R_2 (plus any resistance between the top end of the track of R_1 and its slider) with the result that a.f. voltages above the delay level are heavily attenuated. The amplitude-limited a.f. is then fed to the pre-set potentiometer R_3, this being adjusted, as described below, to provide a comfortable level in the headphones.

Setting-Up

The setting-up of the unit should not raise any difficulties provided that it is borne in mind that the a.f. voltage at which limiting occurs is fixed, and that the purpose of the adjustments is to enable individual requirements to conform to this fixed level.

After the unit has been assembled, it should be connected to the receiver with which it is to be used and checked for correct operation. Initial testing should be carried out with both R_1 and R_3 set to maximum, i.e., with their sliders at the top ends of their tracks. Using, preferably, a source of programme having a fairly constant level, the receiver volume control should then be turned up until the level at which limiting takes place is found. R_3 is next adjusted at this limiting level, its final setting being that which provides a volume level in the phones which is equivalent to the maximum tolerable. The unit is then ready for use, future alterations to volume being made either by adjusting the receiver volume control or R_1.

When the limiter is used in conjunction with a domestic receiver, it may be found advisable to site the unit such that the person wearing the headphones may adjust R_1 himself. Changes in the setting of R_1 will not, of course, alter the output level available from the receiver loudspeaker. It must be stated that some distortion will occur when the a.f. applied to the unit reaches limiting level, but this should not be too unpleasant in character and is, in any case, far more tolerable than excessive headphone volume. If desired, the listener using the headphones can, of course, adjust R_1 such that the volume falls below the limiting level during the time in which loud music is being broadcast.

Due to its inherent simplicity, the circuit can be altered in one or two ways to meet particular circumstances without detracting from its performance. For instance, if it is found that limiting occurs at too low a level, all that is required is to raise the delay voltages by employing 3, or 4.5, volt batteries in place of the single cells shown in the diagram. When the unit is used with short wave receivers, it may become possible to delete the volume control, R_1, as this component might then merely be duplicating the function of the volume control in the receiver itself. When R_1 is deleted, the upper input terminal connects directly to R_2.

Attempts at altering the circuit to make it limit at a.f. voltages lower than 2.8 volts peak to peak are liable to prove rather difficult if the simple circuitry employed here is to be retained. A crude form of limiting at lower a.f. voltages *could* be obtained by dispensing with the cells altogether and connecting the two diodes directly across the circuit. This arrangement would take advantage of the non-linear characteristics of the diodes insofar that their forward resistances would be greater at lower than at higher a.f. voltages. However, an arrangement of this type does not have much to commend it, because a certain amount of distortion would be evident at all volume levels.

Practical Points

One or two minor points need a little further discussion before concluding. It will, for instance, be noted that R_2 is given what may at first sight appear to be the rather large power rating of 1 watt. This rating is necessary due to the fact that the resistor may be called upon to dissipate quite high a.f. powers during loud passages of music. The two diodes, D_1 and D_2, may consist of any reliable type. There is no necessity to employ diodes having high turnover voltages as one diode protects the other in this respect. A good choice of diode would be the OA70, or an equivalent.

Since the internal resistances of the delay cells form part of the limiting network, it is important to use cells in the unit which are fairly large in physical size. Cells intended for normal flash-lamp service should prove adequate for the purposes desired here. Although their terminal voltages should not drop by any noticeable amount during use, their internal resistances may gradually rise with time. It would be worthwhile, therefore, to replace the delay cells whenever the limiting efficiency of the unit appears to be decreasing. It will have been noticed that an on-off switch, S_1–S_2, is provided in the circuit. This switch can be a simple miniature wafer type, and its sole purpose is to protect the cells from the very small reverse current which may otherwise flow through the diodes when the unit is not in use.

Although the circuit diagram depicts a "chassis" connection, it is not really necessary to mount the unit on a metal chassis or to provide any screening. If desired, for instance, the whole circuit could be assembled into a wooden case or similar housing.

PERFORMING RIGHT TRIBUNAL

The Performing Right Tribunal, which was set up under Section 23 of the Copyright Act, 1956, has now taken occupation of the premises allotted to it at Someries House, Regents Park, London, N.W.1. The telephone number is Welbeck 1358–9.

The function of the Tribunal is to determine disputes arising between licensing bodies and persons requiring licences to perform in public or to broadcast copyright works. It also has jurisdiction in the case of the public performance and broadcasting of records and the public performance of television broadcasts.

Communications for the Tribunal should be addressed to the Secretary.

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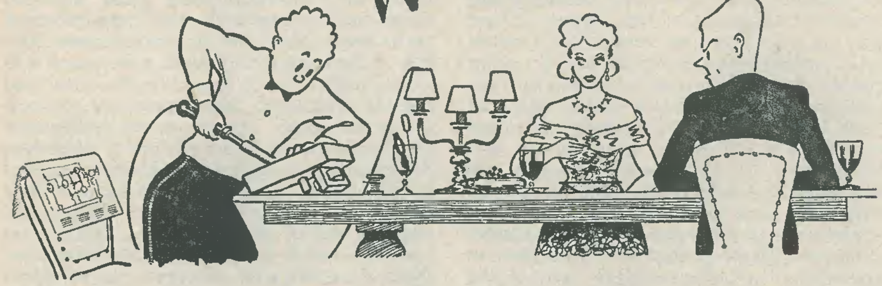
IN YOUR WORKSHOP



Aided by his able assistant Dick, Smithy the Serviceman continues to run the Workshop

JUST FOR ONCE IN A WHILE, THE WORKSHOP was passing through a quiet period. Both Smithy and Dick welcomed the break, and they had spent much of the morning in tidying up their benches and cleaning out the cupboards. They had now settled down for an unhurried cup of tea. They were both quiet, each being occupied with his own thoughts.

"You know, Smithy," Dick said, breaking the silence, "I've been fairly busy in my spare time over the last week or so knocking up a little transistor set for myself. It's going quite nicely now, incidentally, but while I was building it I kept saying to myself that I wasn't really *quite* certain how the transistors I was putting into it worked. In my mind's eye I can just about visualise the idea of electrons and holes moving around in a slab of germanium, and I know from what I've picked up on the subject that a hole merely means the absence of an electron; but, even so, I am still very vague about what exactly does go on in a working transistor. Could you tell me, in a few short sentences, exactly how a transistor amplifies?"

Smithy put down his cup of tea and stared at it for some moments.

"There's a very good film on at the local cinema," he volunteered, at length.

"Come off it, Smithy," protested Dick. "You've never shied away from any of my questions yet!"

"Well, I'm not really trying to avoid answering it," chuckled Smithy. "Only, to my mind, what you want is well-nigh impossible. There aren't many difficulties in explaining how a thermionic valve amplifies, because it is easy to imagine the flow of electrons through a grid which applies a deterrent force when it holds a negative potential relative to cathode. However, the internal processes of a transistor are rather more complicated than are those of a valve, and I just couldn't give you a short explanation without leaving out something important. Perhaps it is the comparative newness of transistors which makes me think that way; and it is possible that, as time goes by, we will find no more difficulty in visualising transistor action than we do when considering the valve. Unfortunately, that state of affairs doesn't appear to exist at the present time. I might add that quite a few supposedly simplified descriptions of transistor operation have been published over the last few years, but I can't say that I very much like the explanations offered in some of these. Anyway, if you're prepared to accept the fact that the rather long description I am about to give you represents the basic facts with very few trimmings, it should, at any rate, help you to get the 'feel' of transistor operation and enable you to work intelligently with these devices."

Dick leaned back comfortably in his chair and prepared to listen.

Germanium

"To start at the beginning," said Smithy, "I have to remind you that the transistors most frequently encountered these days employ germanium made up in crystalline form. An alternative to germanium is silicon (which functions in more or less the same manner), but I shall confine myself here to germanium only. When germanium is in crystalline form, its atoms combine together in a lattice or framework wherein the outer electrons which exist around the nuclei of their parent atoms are nicely balanced out throughout the body of the crystal. These electrons are, of course, held to their nuclei by the ordinary forces which hold an atom together; but, in this case, they are also kept in position by the bonds which hold the crystal lattice together. Normally, the outer electrons of a germanium atom are not held very securely to their nuclei; and they are quite liable to wander away from their parent atoms and join other germanium atoms, thereby causing electrons from these second atoms to similarly wander off. This random movement of electrons occurs even in the crystalline form, but it is usually quite small and insignificant. It is caused by the thermal agitation given at the normal temperatures in which the germanium finds itself. So, if we have a germanium crystal at room temperature, we can safely assume that there is a very small continuous random movement of electrons throughout its structure.

"When one of these wandering electrons travels away from its atom it leaves behind a 'hole,' and this hole will very probably soon be filled in by another wandering electron. This second electron leaves behind a hole in its own atom, which then becomes filled in by a third electron, and so on. As a result, therefore, thermal agitation causes a small movement both of electrons and of holes inside the germanium crystal structure. The holes do not actually move, of course, but since they appear to travel in the reverse direction to the electrons which fill them in, we assume that they *do* move. Also, since the existence of a hole means that a negative electron has departed therefrom, we say that a hole possesses a positive charge.

"As I have just said, the random movement of electrons and holes through a crystal of germanium is not very great. It certainly is not large enough, for instance, to allow us to put pure germanium amongst the ranks of good conductors of electricity. If we so desire, however, we can increase random movement in a crystal of germanium fairly easily; and this we do, not by raising its temperature and thereby the thermal agitation it suffers, but by adding very tiny quantities of impurities to the crystal. One of the impurities we can add is arsenic. Arsenic atoms are very similar to germanium atoms so far as the particular crystal structure we are considering here is concerned, and they enter into the germanium crystal quite readily. However, the arsenic atom has one more electron in its outer ring of electrons than has the germanium atom; with the result that one electron from each arsenic atom remains outside the crystalline structure whilst still being held to its nucleus by the normal forces which hold the arsenic atom together. The attraction given by the arsenic nucleus to this 'spare' electron is not very great, with the result that it is extremely liable to wander off on its own. Since, on its travels, it may join one of the germanium atoms with which it is surrounded, an electron from the latter will become dislodged and repeat the process somewhere else. Because of the addition of the arsenic atoms, with their 'spare' electrons, therefore, the adulterated germanium crystal is now liable to have far more electrons wandering through its structure than it had when it was in the pure state. If they are made to travel in one particular direction, these electrons will, of course, constitute a flow of electric current, in just the same manner as a single-direction movement of electrons in any other material constitutes a flow of electric current. Since electrons are negative particles of electricity, germanium which has been adulterated by arsenic—or by any other impurity which causes a similar release of wandering electrons—is described as N-type germanium.

"A very important point to remember is that, although an arsenic electron which wanders away from its parent atom does so because it doesn't fit into the *germanium* crystalline structure, it still leaves behind an *arsenic* atom having an overall positive charge due to the negative charge it has just lost. I hope you can see that point."

"I think I've got the idea," said Dick. "Electrons which fit into the germanium crystalline structure are held in position not only by the attraction of their nuclei but also by the bonds of the structure itself. The 'odd' arsenic electrons are not held by the bonds of the crystalline structure and are more liable to wander through the crystal in consequence."

"That sums it up fairly well," said Smithy, "and the statement is true enough for the very shallow depth to which we want to delve into the subject just now. The arsenic atoms which provide the crystal with these spare electrons are, incidentally, called 'donor' atoms—an easy name to remember since they 'give' an electron to the structure. I should add that there are other impurities, such as antimony, which have the same effect on germanium as has arsenic.

"Now, it is also possible to find impurities, for addition to the germanium crystal, which have not one more, but one fewer electron than the crystalline structure calls for. Indium, or boron, have atomic make-ups which fall into this class. Impurities of this type enter the crystalline structure of the germanium quite readily, but there is, once again, a certain amount of unbalance. Since the impurity atom is, in this case, one electron *short* of what is required by the structure, an electron from a nearby germanium atom is very liable to take up its position at the impurity atom, leaving behind a hole. A second electron may then travel to fill up this hole, leaving behind another hole, and so on. The nett result is that, by the use of this second class of impurity, we now have a crystal which has a number of *holes* moving throughout its structure. Since holes are equivalent to positive charges of electricity, insofar that they represent the absence of electrons, we call germanium adulterated in this manner P-type. The situation in P-type germanium is almost exactly opposite to that in N-type germanium, and the impurity atoms which attract the extra electrons to themselves are called 'acceptor' atoms—another easy and obvious name to remember. Since acceptor atoms are forced by the crystalline structure to take to themselves one electron more than they would normally have, they acquire a negative charge."

"In fact," said Dick, who had been scribbling on a piece of paper at his side, "you could say:

Electrons moving without stricture
Give an N-type style of mixture
When it's holes which travel free,
Then we call the mixture P!"

Smithy, who had grown used to Dick's ability to produce doggerel almost at will, chuckled at this latest attempt.

"O.K.," he said at length, "I'll agree that that effort is a bit above average. Anyway, it makes a fairly useful mnemonic."

"Fair enough," commented Dick, modestly. "Incidentally, what type is germanium if it is absolutely pure and unadulterated?"

"Well, it hasn't a letter," replied Smithy, "but if it had, I suppose it would be U-type!"

P.N. Barrier

"Anyway," resumed Smithy, "let's get a little closer to the transistor itself. I think I should say at this stage that I'm not going to bother about point contact transistors in this explanation, because they are rather more complicated than junction transistors, and because they are not in any case encountered so often nowadays.

"However, before we tackle the working of a complete junction transistor, we must first of all look at what happens when we join together a block of N-type germanium and a block of P-type germanium (Fig. 1). Now, in this sketch I have shown the wandering

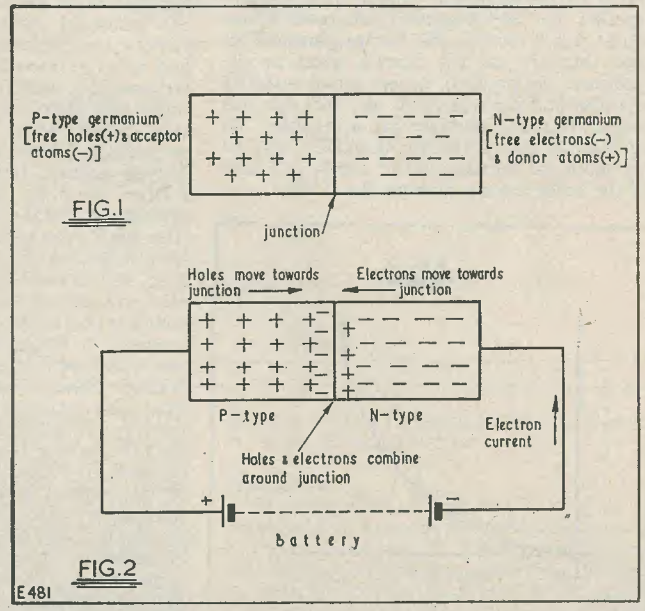


Fig. 1. A block of P-type and N-type germanium joined together. Despite the apparent attraction between them, the free holes in the P-section and the free electrons in the N-section remain on their own sides of the junction barrier. Fig. 2. If a potential having the polarity shown here is connected to the two blocks of germanium, the electrons and holes are assisted in overcoming the barrier at the junction

electrons in the N-type germanium as a number of 'minus' signs, and the wandering holes in the P-type germanium as a number of 'plus' signs. After looking at the diagram, I daresay you might imagine that the first thing that should happen is that the electrons in the N-type germanium would want to cross over to and cancel out the holes in the P-type germanium, and that the holes in the P-type germanium would want to cross over to the N-type block to cancel out the electrons there. But the interesting thing is that this doesn't happen at all. Indeed, we get quite an opposite effect, and what amounts to nothing short of a barrier to both the holes and the electrons appears at the junction of the two types of germanium. The reason for this barrier effect is quite simple to understand if we remember what I was talking about a few minutes ago. What occurs is that electrons attempting to cross over to the P-type germanium are repelled at the junction by the negatively charged acceptor atoms in that germanium. Similarly, holes trying to travel in the reverse direction are repelled by the positively charged donor atoms which exist in the N-type germanium. And thus we get the barrier effect at the junction. In practice, a very small quantity of holes and electrons may get through this barrier, but their numbers are negligible. To all intents and purposes, therefore, all the free electrons remain over on the N side, and all the holes remain over on the P side.

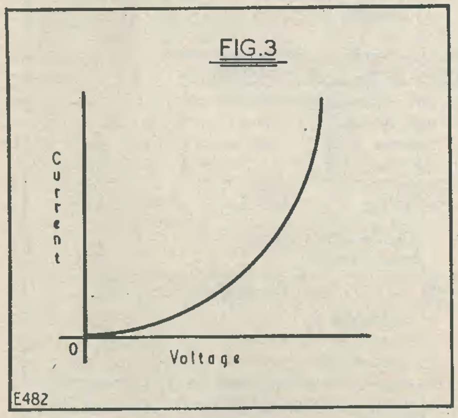


Fig. 3. *A curve showing the relationship between current and voltage given by the arrangement of Fig.* 2

"Another way of explaining the barrier effect at the junction might be given by saying that, whilst both the N and P blocks have free electrons and holes, both blocks are, *overall*, electrically neutral. It is only the crystalline structure, plus its impurity, which causes the large number of wandering electrons and holes in either block. Considered in its entirety, either block has the correct quantity of electrons required by its atoms—even if they do not remain in their proper positions—so that it is completely neutral when considered as a whole. Thus, there is really no reason why the electrons or the holes should want to leave one electrically neutral block to enter another electrically neutral block.

"Next, let's see what happens if we apply a potential, given by a battery, to the two blocks of germanium such that its negative terminal connects to the N block and its positive terminal to the P block (Fig. 2). We now get quite a different state of affairs. This is because the negative terminal of the battery repels the free electrons in the N block, causing them to travel towards the junction; whilst the positive terminal repels the free holes in the P block, causing these also to travel towards the junction. If it is sufficient, the potential difference between the two battery terminals then causes the electrons and holes to overcome the repulsion effect at the junction, with the consequence that both holes and electrons cross over to the other side where they combine and become neutralised. However, electrons leaving the N-type section have to be replaced, and further supplies are provided from the negative terminal of the battery. At the same time the P-type germanium near the junction loses holes, which is the same thing as saying that it acquires extra electrons. These electrons attract holes from the germanium which is nearer the connection to the positive terminal of the battery, with the result that the excess of electrons now appears at this point. These excess electrons finally find their way into the positive terminal of the battery. In other words, we have a flow of electric current through the two blocks of germanium which is caused by the potential of the applied battery. To keep ourselves thinking transistor-wise, we can say that the current in the N block consists of a movement of electrons, whilst the current in the P block consists of a movement of holes in the opposite direction. At the same time the current at the junction itself consists half of electrons and half of holes.

"I would like to emphasise the fact that it is the potential of the battery which initiates the current, because it enables the holes and electrons to overcome the barrier at the junction of the two blocks of germanium. If the battery potential is low, this barrier is only partially overcome, and the current flowing is small. If the voltage of the battery is high, the barrier may be almost completely overcome, and a disproportionately heavy current may flow. In other words, the resistance offered by the two blocks of germanium is non-linear and, if drawn as a curve, would look something like this (Fig. 3).

"Let's next see what occurs when we connect our battery to the two blocks of germanium the other way round (Fig. 4). If we were to do this we would find that the positive terminal of the battery would merely attract the electrons in the N-type germanium away from the junction, and that the negative terminal would similarly attract the holes in the P-type germanium. The result would be that negligible current would flow, since all the battery does is to assist the barrier at the junction in keeping the holes and electrons apart."

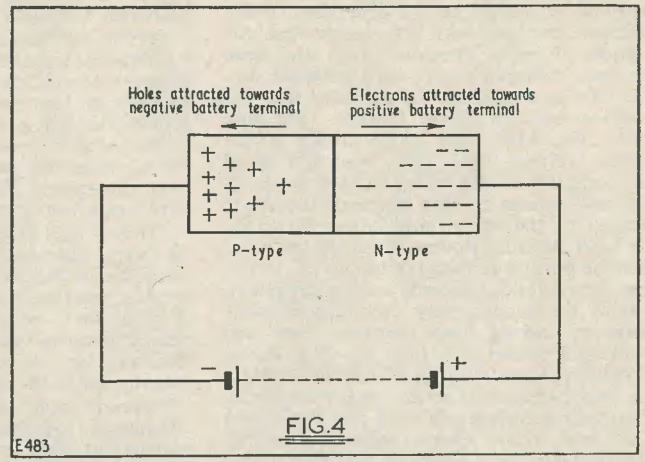


Fig. 4. *When the applied potential has the polarity illustrated in this diagram it assists the barrier in keeping holes and electrons apart. No current flows*

"To sum it up," commented Dick, breaking in at this point, "when we join a piece of P-type germanium to a piece of N-type germanium we have a device which passes current when a battery is connected to it one way round; and which passes no current—or proportionately very little current—when it is connected the other way round."

"That's exactly right," replied Smithy, "and because of this effect the device becomes nothing more nor less than a rectifier. We would, in fact, be perfectly truthful if we called it a junction germanium diode. Just so that we may continue to keep our terms correct I must now say that, when the applied polarity is such that the diode exhibits low resistance—or that it conducts—we refer to the *forward* current and to the *forward* resistance. If the applied polarity is changed round so that the diode offers very high resistance and negligible current flows, then we have the *reverse* current and the *reverse* resistance.

"Before finishing on this particular part of the discussion I should also add that it is possible to apply too high a potential to the diode either way. If too high a potential is applied when the diode is conducting the junction may burn up, simply because the forward current is too great. At the same time, if we apply too high a potential when the diode is conected up in the non-conducting manner we may strain the crystalline structure of the germanium so much that it breaks down, and both electrons and holes become released to cause a heavy *reverse* current to flow. The reverse potential which is just large enough to cause this effect is called the 'turnover' potential. When either of the two cases I have just described occurs, the diode is usually ruined.

Transistors

"We can now at long last commence to consider what happens in the transistor itself. To start ourselves off, I have sketched an N-P-N junction transistor here (Fig. 5), with no external circuit connected to it at all. The 'minus' signs in the emitter and collectors parts indicate that these are made of N-type germanium and that they have a number of wandering electrons inside them; whilst the 'plus' signs in the P-type base indicate the presence of wandering holes. As you can see, the transistor consists, in reality, of two germanium junction diodes with a common P-type block shared between them.

"The next step consists of connecting a battery, which I shall call 'battery A,' to the transistor like this (Fig. 6). As you will note, all I have done here is to apply to the diode formed by the base and collector a potential whose polarity is such that the diode is non-conducting. The result is that, as before, negligible current flows. If, however, I add a second battery, 'battery B,' between emitter and base (Fig. 7), so that a forward current flows in the particular diode formed by *these* two sections, quite a different thing happens throughout the transistor. As occurred with the conducting diode we considered earlier on, battery B causes holes from the base to pass through the junction barrier into the emitter section, and electrons from the emitter to pass through the barrier into the base section. If the base section is very thin, quite a number of the electrons from the emitter will continue on through it, passing right into the collector section. We already have a positive potential from the battery terminal connected to the other end of the collector section, with the result that the ingress of extra electrons from the base becomes balanced out by an equivalent outflux of electrons from the collector into the positive terminal of the battery. We now have, therefore, two paths along which electric current flows. We have first of all the complete circuit where battery B causes forward current to flow through the diode formed by the emitter and base. Secondly, we have electrons flowing from the collector into the positive terminal of battery A. Since this second lot of electrons are, in actual fact, lost by the emitter, their deficiency is made good by having fresh electrons leave the negative terminal of battery B. The second circuit we are considering, then, is supplied by the two batteries in series—you may notice that their polarities are such that their voltages add—from whose negative terminal electrons flow to the emitter, and into whose positive terminal a similar number of electrons flows from the collector.

"Just to make the idea of the two separate circuits more clear, let's have a look at another possible set-up (Fig. 8). In this arrangement we have battery B connected, as before, between emitter and base, and polarised such that a forward current flows in the diode which these two sections form. As occurred previously, some of the electrons entering the base pass right on through to the collector. Because of this influx of electrons into the collector, a similar quantity of electrons flows into the positive terminal of battery A. At the same time electrons flow from the negative terminal of battery A into the emitter to make good those it has lost to the collector. And that's the second circuit, with its associated current, in its entirety. We have one current flowing through battery B; and we have a second current flowing through battery A. The overall effect of this arrangement is pretty well the same as that given by the previous set-up (Fig. 7), but I think you may find it easier to visualise.

"And so we finally come to the amplifying action of the transistor. I told you it couldn't be done in a few sentences! You don't need much imagination to realise that, if the potential of battery B is increased, the flow of electrons and holes through the barrier between the emitter and base sections is going to increase also. Since the electrons entering the base from the emitter increases, the number passing through into the collector section must also become greater. The current flowing through the circuit energised by battery A will then also increase in consequence. In other words, an increase in emitter-base current causes an increase in collector current. If, similarly, we decrease the emitter-base current, the collector current decreases in sympathy.

"When the base section is made very thin it is possible for a very high proportion of the electrons leaving the emitter to carry straight on through into the collector, only a small proportion being needed to maintain the emitter-base current. Small changes in the emitter-base current may thereupon cause large changes in the collector current. We have, therefore, a basic amplifier."

"Phew," said Dick, as Smithy paused. "It all seems quite clear now. As you say, the operation of the transistor is quite a lot more complicated than that of the valve; although, as you also mentioned, this is probably mainly because you have to spend so long 'building up the background' before you actually get to the meat of the subject."

"You're right there," agreed Smithy. "Transistor operation is easy enough to understand once you've grasped the basic ideas of donor and acceptor atoms, and of wandering electrons and holes. Even in the description I've just given you, I'm afraid that the information about the structure of N and P type germanium is rather skimpy. Still, you've got to start somewhere, and what I've told you may perhaps be sufficiently intriguing to make you work backwards, as it were, by studying the atomic and crystalline structure of germanium in greater detail. At the same time I hope I've given you enough gen to enable you to visualise what goes on *inside* the transistor, and thereby more readily understand transistor circuits and design. By the way, the two types of transistor operation I've already shown you are typical of two standard modes of amplification. The first one (Fig. 7) is the basic circuit used for an earthed-base transistor amplifier, whilst the second (Fig. 8) is that for an earthed-emitter transistor amplifier. In both cases battery B represents a source of bias potential, and battery A a source of h.t.

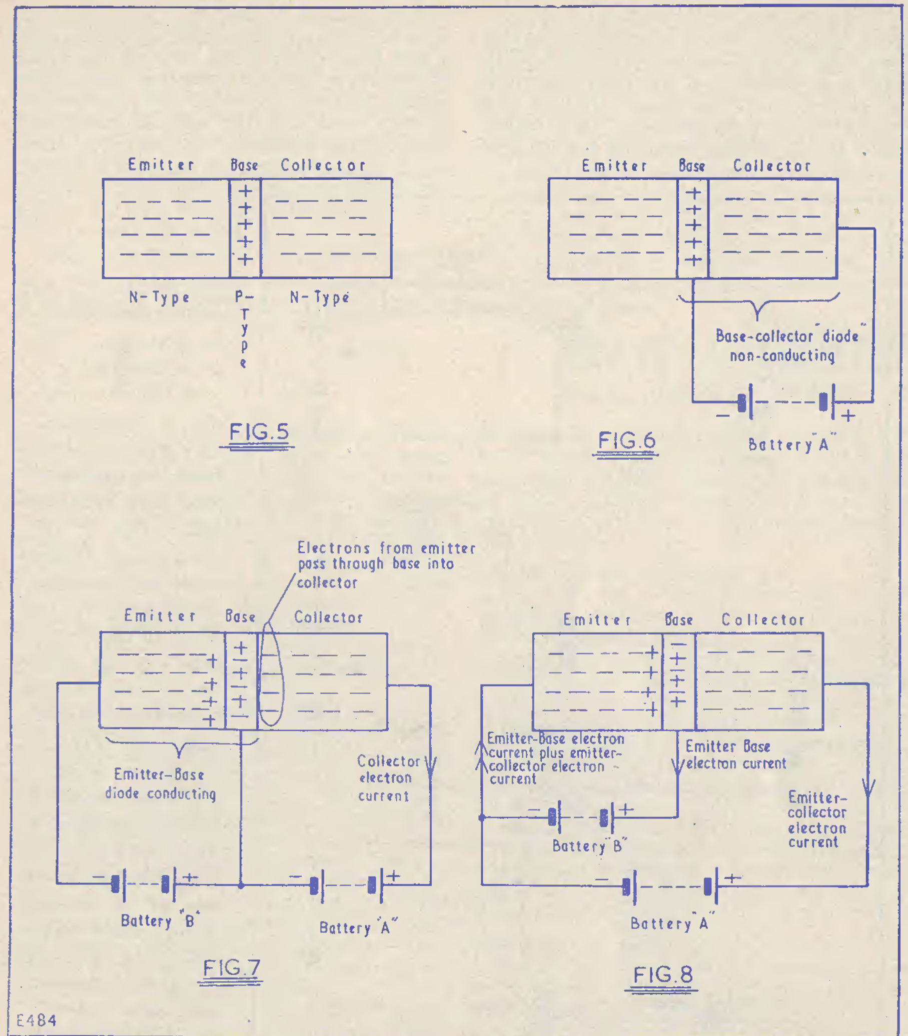


Fig. 5. An elementary N-P-N junction transistor. Fig. 6. Applying a potential between base and collector in the manner shown here, results in no (or negligible) current flow. Fig. 7. If a second battery, "B," is applied to base and emitter as shown, some of the electrons entering the base will pass on through into the collector. Fig. 8. A re-arrangement of Fig. 7 which may assist in visualising emitter-collector current as a separate entity

potential. If I redraw the circuits like this (Figs. 9 (*a*) and (*b*)) you will see the resemblance at once. You may note that I've also inserted an impedance, 'Z,' in series with the collector supply to form a 'load' and make the transistor fall in line with standard amplifying practice. Since, in the earthed-emitter amplifier (Fig. 9 (*b*)), the negative terminals of both batteries connect to the emitter we can dispense with one, if we wish, by using a circuit arrangement like this (Fig. 9 (*c*)) wherein a series resistor controls the emitter-base, or bias, current which flows."

"So far as I can see," commented Dick, "a useful statement would be given by saying that, to get a transistor to work, you have to apply a potential to emitter and base such that forward current flows through the diode given by these two sections. The h.t. supply is then applied in such a manner that the diode formed by the collector and base would normally be in the non-conducting state."

"That seems to tie it up fairly neatly," agreed Smithy. "And there is just one final point. Up to now I have only mentioned N-P-N junction transistors. However, this does not raise any difficulties, as the action in a P-N-P transistor is the same as that in an N-P-N type, with the exception that all the applied battery potentials are reversed in polarity, and that the roles of holes and electrons are reversed. In the P-N-P transistor it is *holes* which travel through the thin base section and, thence, into the collector."

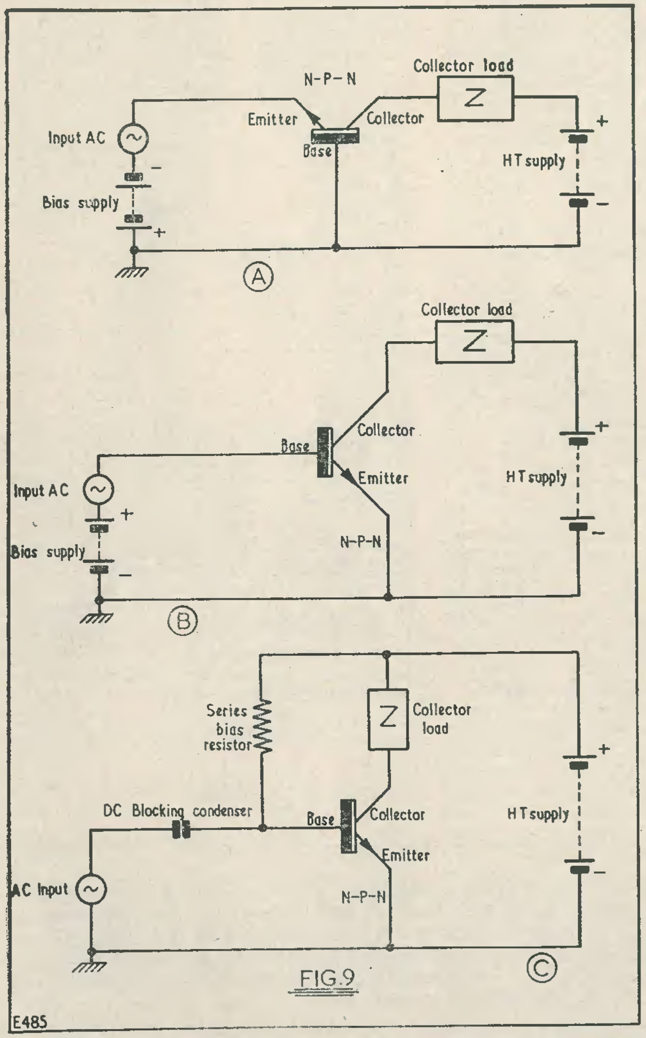


Fig. 9 (a). An earthed-base transistor amplifier. This is the same as Fig. 7, with the exception that a "generator," to represent signal input, and a collector load have been added. Fig. 9 (b). An earthed emitter transistor amplifier. Apart from the addition of the "generator" in the input circuit and the collector load this is the same as Fig. 8. Fig. 9 (c). An alternative version of (b), wherein we may dispense with the bias supply battery by the use of a suitably valued series resistor. The blocking condenser prevents the input generator from altering the d.c. potential existing between base and emitter

A Further Explanation

Smithy put his cigarette out in the ashtray at his side, and seemed surprised to note that he had already left several stubs there during the time that he had been speaking.

"I see," he remarked, "that I have once again let the time roll by whilst I have been nattering away to you. Anyway, it doesn't matter so much today, when things are quiet."

"No, I suppose not," agreed Dick, just a shade too solemnly, "and I must thank you for having also made me understand how a cathode ray tube works."

"How a cathode ray tube works?"

"Why, yes," said Dick. "I've never quite understood how the picture builds up on the screen. Now I can see that what happens is that holes leave the screen and travel back towards the negatively charged cathode. When holes pass through an aluminium backing they cause intense heat; which is why aluminised tubes give brighter pictures!"

Dick waited expectantly for a response from Smithy, but he was disappointed. For once, the Serviceman's feelings were rather too intense to be safely expressed in words.

AN EASILY SET-UP AND CALIBRATED VALVE VOLTMETER

by A. A. TUCKER

Although there are excellent valve voltmeters on the market, the writer decided that it would be interesting to design one which would be relatively cheap to make, be easy to set up and to calibrate, and at the same time have a useful range and degree of sensitivity. A high degree of accuracy was not aimed at, but it is thought that the accuracy obtained should be sufficient for most amateur purposes.

Fig. 1 shows the basic design features of what is, in effect, a form of peak valve voltmeter.

The valve is an indirectly heated a.f. power amplifier, which is biased by the potential developed across R_4 to operate at the point of cut-off, indicated by a sensitive meter in the anode circuit. A resistor, R_2, is also included in the anode circuit, primarily to form an a.c. filter in conjunction with C_1, but also to act as a guard for the meter. Here it may be noted that an ordinary good grade voltmeter set to a suitable range may be inserted between the terminals shown, thus avoiding the expense of another meter. The resistor R_1 completes the bias circuit whilst maintaining a high input resistance.

The h.t. supply must be smooth, quiet, constant and isolated—in a d.c. sense—from earth and the mains.

When a steady voltage is applied to the test terminals, the meter will indicate a flow of anode current. The purpose of R_5 is to enable a variable and known voltage to be applied in opposition to the measured voltage. When both are equal, the anode current will have been restored to zero. By providing a linear scale around the potentiometer spindle, the unknown voltage may be read off directly. In the case of alternating voltage measurement, peak values are indicated and, to correct to r.m.s. values in the case of sinusoidal waveforms, the scale reading must be divided by $\sqrt{2}$. The resistor R_5 determines the range of the instrument. In the diagram (Fig. 1), R_5 is shown as $2k\Omega$, and when 10mA passes through it 20V will be developed across it, therefore giving a range of 0–20V. Other values for R_5 and the current through it may be chosen to obtain a desired range.

Setting Up and Calibration

Turn R_5 to "Zero Volts" and R_4 to maximum resistance. Switch on h.t., when the meter should show zero anode current. Reduce the resistance of R_4 until current begins to flow, then increase again until current reaches zero—the valve is now at the cut-off point. Next adjust R_3 until 10mA flows through R_5—a suitable meter will have to be inserted in series at the h.t.– end to indicate this. Then re-set R_4 to restore the cut-off point.

Repeat this procedure until both adjustments are simultaneously correct. Hereafter, it will only be necessary to set the cut-off bias before use by a slight adjustment of R_4, whilst R_5 is at "Zero."

Increasing the Range

Fig. 2 shows how the instrument may be given a more comprehensive range on four scales, i.e. 0–200V by means of switch S_1 in the $\times 10$ position and S_2 in the $\times 1$ position; 0–20V, S_1 at $\times 1$ and S_2 at $\times 1$; 0–4V, S_1 at $\times 1$ and S_2 at $\div 5$; 0–1V, S_1 at $\times 1$ and S_2 at $\div 20$.

Sensitivity and Accuracy

The sensitivity of the voltmeter is influenced by the sensitivity of the meter movement and the g_m of the valve.

Assuming that the current through R_5 has been truly measured, the accuracy of the meter depends only on the accuracy of the resistors used and upon the accurate division of the potentiometer scale—this only applies except when high radio frequencies are involved. At these frequencies it is the practice to employ a diode rectifying probe in front of the test terminals.

Construction

Details of construction are hardly necessary for such a simple circuit, but the following points should be borne in mind.

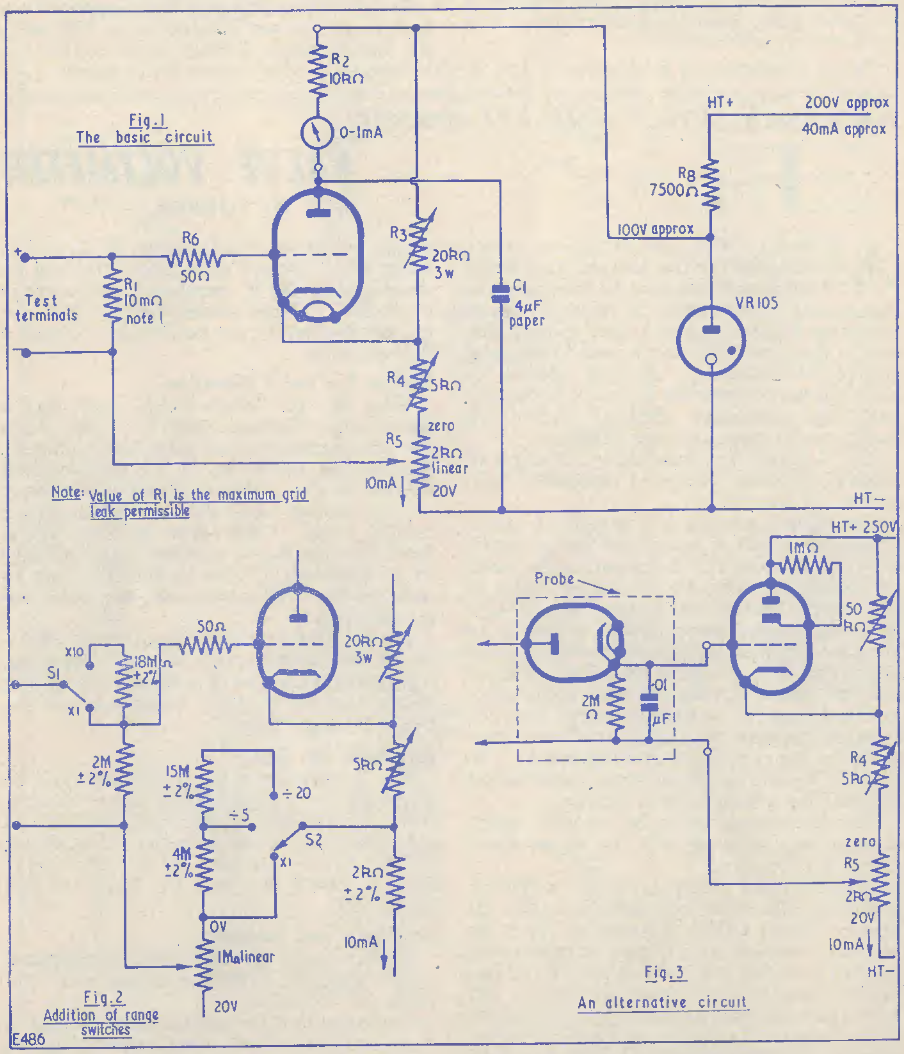
1. Avoid unwanted pick up by making use of adequate screening.

2. Keep grid wiring short.

3. If an external power supply is used, screen the supply leads connecting the two units.

Another Suggested Circuit

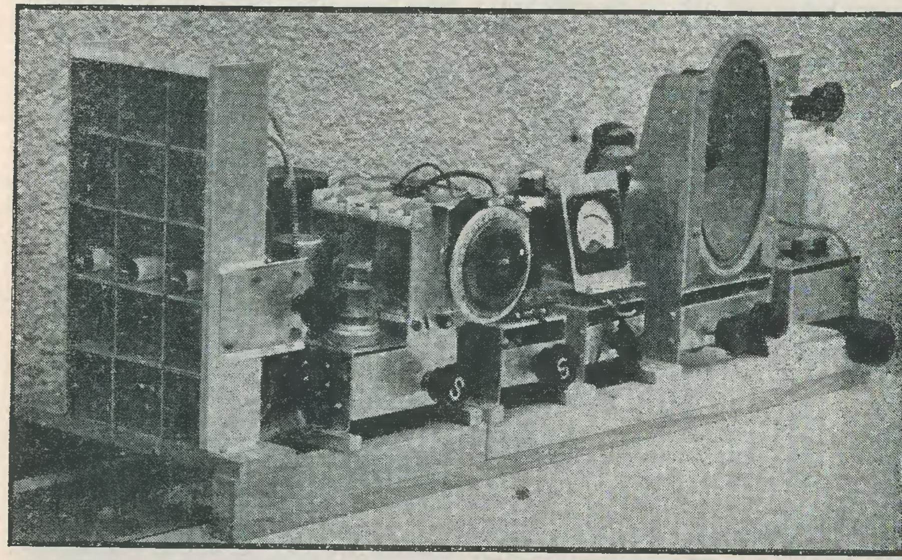
A variation on the same theme is to combine the function of the valve and the meter by using a magic eye indicator, as shown in Fig. 3. The bias developed across R_4 in this circuit is adjusted to close the angle of target illumination to 0° under zero input conditions. When a voltage is applied to the input, the screen illumination will open. R_5 is then adjusted to close the shadow to zero angle again, and the voltage is read off the scale in the same way as in the previous circuit. A rectifying probe is again necessary for alternating voltage measurements.



Radio Miscellany

THE RECENT DISCUSSION IN THIS COLUMN regarding the unimaginative sameness of most modern receivers brings a letter from Mr. J. E. Fogg of Whitburn, Co. Durham. His individual ideas have found expression in an interesting composite receiver allowing scope for immediate experiment and, at the same time, providing for easy modification to bring it into line with his subsequent needs. His receiver comprises six main parts, each of which can be easily handled and brought to the stage of maximum efficiency.

The detector stage is from the circuit of the *Quality Tuner* (June 1955), but instead of a magic eye an 0–10 milliammeter is inserted in the second i.f. anode lead. The i.f. amplifier itself is an exact duplicate in valves and design of the *Clipper* (April 1955). The coils are Osmor, which J.E.F. praises highly for neatness and efficiency, and the tuning circuit is again from the *Quality Tuner*, and is made mostly from components culled from an R.F.26 Unit. The l.f. circuitry is that of the "*Micro-amp*" (September 1955), and the power supply is from the *Globemaster* (December 1954).



Reader J. E. Fogg's Receiver

A photograph illustrating how he has put his ideas into practical form appears on this page. Sections of various receivers taken from *The Radio Constructor* descriptions have been adapted or modified to suit both the gear in hand or to conform to his personal conception.

Additions already on schedule are the noise limiter from the *Voyager* (January 1954), the *Electronic Selectivity Filter* (April 1954), and a b.f.o. using an acorn valve.

J.E.F.'s approach to his individualist set serves as an excellent pattern for the keen constructor with a taste for experiment. Each stage of the receiver can be brought to perfection, while at the same time a lot of practical knowledge is acquired. Nor need it be expensive. In his particular case only the coils, mains transformer and speaker were new—virtually everything else is ex-W.D. To my mind this is amateur radio at its best. Every receiver consists of a number of minor circuits each doing its separate job. There is no surer way of learning to evaluate each stage when it is met in the multi-stage receiver design to which a keen interest in radio inevitably leads.

Mr. L. Sergent (Newton-Le-Willows—no small town this, you southerners: pop. just under 22,000), although no old-timer himself, is greatly interested in the types of gear used in the early days of the century. He also sent along Part 16 of *Harmsworth Wireless Encyclopædia*, which he recently acquired. This came out in 1923 in about 30 fortnightly parts. Here we find apparatus of the period in all its glory, with a four R-type valve set appearing on the cover, which with 'phones, horn-type loudspeaker, and rotating table aerial looks for all the world like a

CENTRE TAP *talks about* *Items of General Interest*

The Golden West

Many of the readers who appeal for assistance in the way of data or special components through the medium of "Can Anyone Help" later write of their gratitude and pleasure at finding so much good fellowship among constructors. It has been noticeable recently that quite a goodly proportion of these letters especially mention the West of England as the most fruitful source of response. I recall, only a few months back, Mr. Gilbert Davey (of Kenton) mentioning that all the best specimens of early type valves came from that part of the world. He jokingly asked whether people down there hang on to their sets much longer, or are they more cautious in dumping their former "good servants" in the dustbin?

The fact that help in other directions also appears to be readily forthcoming from enthusiasts in the western counties seems to suggest that they are generally more friendly and have a stronger sense of the fellow-hobbyist spirit than elsewhere. It would be interesting to know if this is general, or whether it has just happened in the few particular cases that have come to my notice.

Days of Yore

My recent paragraphs about long-service hobbyists brought in quite a number of interesting letters. No new records are claimed, so it appears that the veterans already mentioned must be considered the most senior. A few readers found themselves reminded of early apparatus built by fathers and uncles. Perhaps it is well now and again to ponder on things that are fast becoming forgotten. Our up-to-the-minute sets will look just as laughably absurd to coming generations.

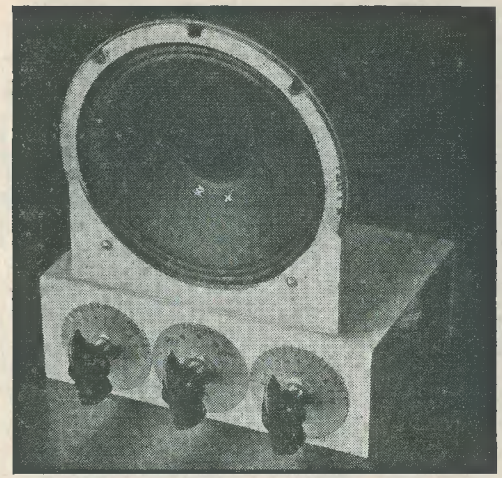
section of a small power station. Unit construction was the thing in those days. Tuning unit, detector unit and each amplifying stage were built in their own separate wooden boxes, each fitted with a row of lacquered brass terminals. These were connected to the corresponding terminals of the next unit, and all the best constructors used stout brass strips with slotted holes to connect their many units together.

Stand-by

This particular part also contains an article on how to build a "3-valve Neutodyne Receiver on Prof. Hazeltine's Principle," complete with a three-fold photogravure plate. I remember such receivers well. One didn't operate them—one manipulated them. After a few minutes of adjusting everything with the most delicate care (remember, too, each valve had its own rheostat), a signal of reasonably satisfactory level could be obtained. Holding one's breath one tried cautiously to move back, but before one got a full pace, something happened. While standing over it, it behaved itself (more or less), but however cautiously the attempt to withdraw was made, it immediately "spilled over." This meant the most horrible shrieks emanated from the loudspeaker trumpet, and all the young children within a radius of 100 yards ran screaming to their mothers. Wiseacres told us it was due to the capacity of our bodies in proximity to the set. Hence we "earthed" ourselves with a flexible wire, but it made no difference. We knew better. It wasn't body capacity. It was sheer temperament!

(*continued on page 117*)

the 'THREE-DEE' 3 transistor receiver



Described by
JAMES S. KENT

THE DEMAND AMONG THE HOME constructor fraternity for transistor receiver designs continues unabated, with the result that numerous prototypes are being built and the resultant end products placed on the market for purchase by the hobbyist. The present design, about to be described, is available in complete kit form from Radio Experimental Products Ltd. and other advertisers.

The "Three-Dee" transistor receiver has been primarily designed to meet the need for an economical local station set. It is ideal for caravan installation, as a bedside receiver, the workshop or as a second domestic radio. In the prototype shown herewith, the speaker is mounted on the chassis by means of a small piece of aluminium cut and shaped to suit the speaker—an Elac 5in type. Normally, the kit is not supplied with this type of speaker mounting, it being a very simple matter for the average constructor to make this mounting. The speaker output is taken to a socket panel on the rear of the chassis, thus allowing the speaker to be mounted in the required position according to the cabinet, or other enclosure, chosen by the individual constructor.

Whilst surplus transistors were used throughout in the original model, the quality of output may be somewhat improved by fitting a Mullard type OC72 transistor in the output stage.

With the "Three-Dee," an aerial and earth system is necessary; the length of aerial largely depends on local station reception. Where signals are inclined to overload the receiver, a series aerial condenser of between 100 and 500pF may be fitted. Where a short aerial is used, a similar value condenser may be fitted between the two green tags of the respective aerial coils.

Component List

R_1	220kΩ ¼ watt
R_2	100kΩ ¼ watt
R_3	6.8kΩ ¼ watt
R_4	10kΩ ¼ watt
R_5	47kΩ ¼ watt
C_1	500pF variable, mica dielectric
C_2	500pF variable, mica dielectric
C_3	2μF, electrolytic, 150V wkg.
C_4	2μF, electrolytic, 150V wkg.
C_5	2μF, electrolytic, 150V wkg.
C_6	100μF, electrolytic, 25V wkg.

Speaker, Elac 5in, 3Ω
Transistors, Red Spot type
Type DRR2 coils, Repanco Ltd.
Socket Panels (2)
Crystal Diode
7½V battery
Chassis, Repanco Ltd.
Yaxley switch, 3-pole, 3-way
Tag Board, 8-way
Output Transformer, type TT5, Repanco Ltd.
3 Dial plates, Repanco Ltd.
Battery plug

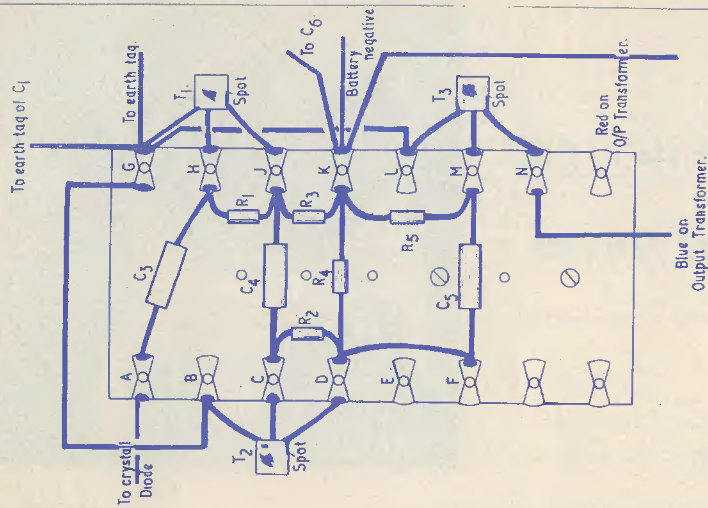


FIG. 1B.
WIRING DIAGRAM OF "THREE-DEE" TAG BOARD.

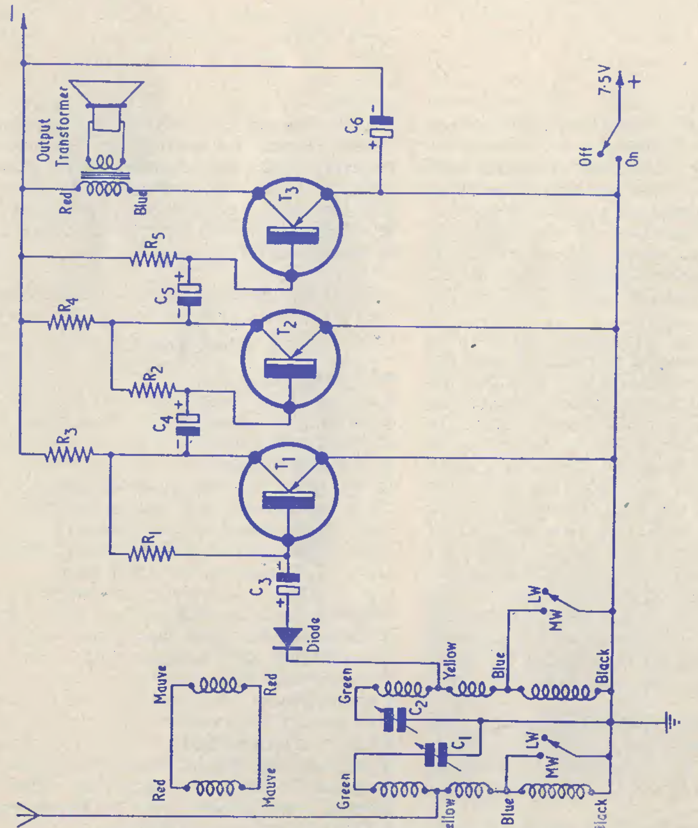
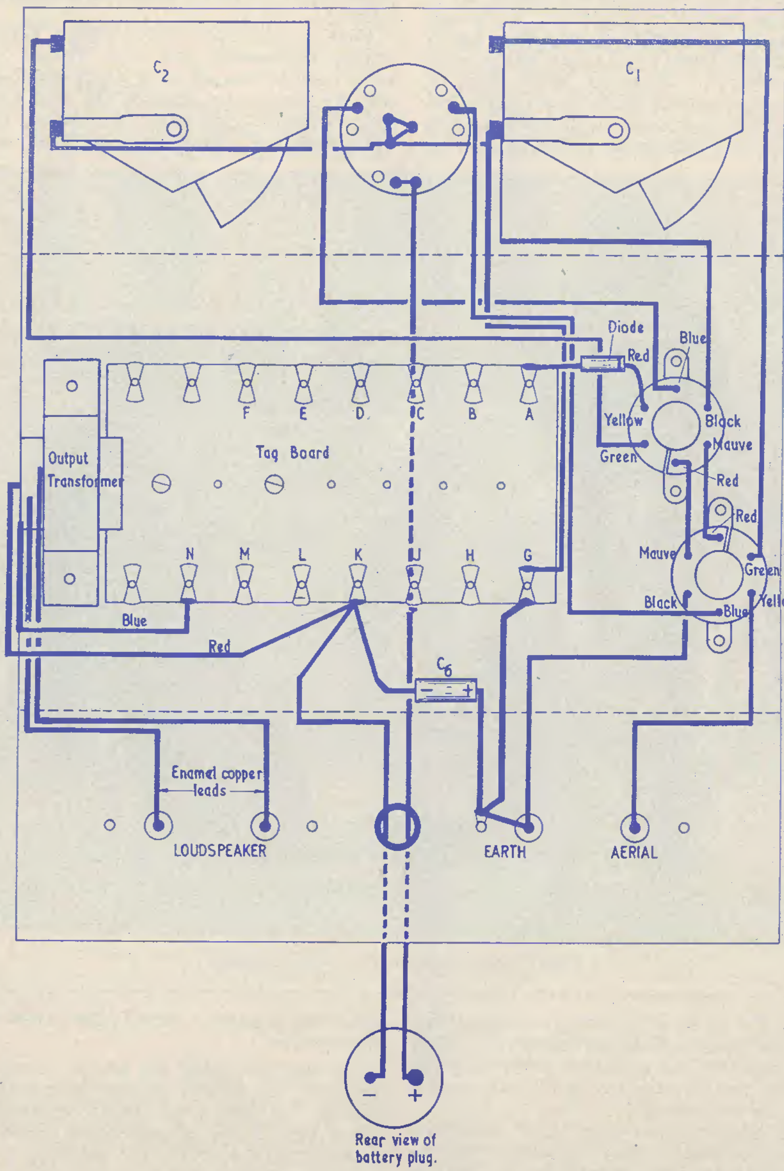


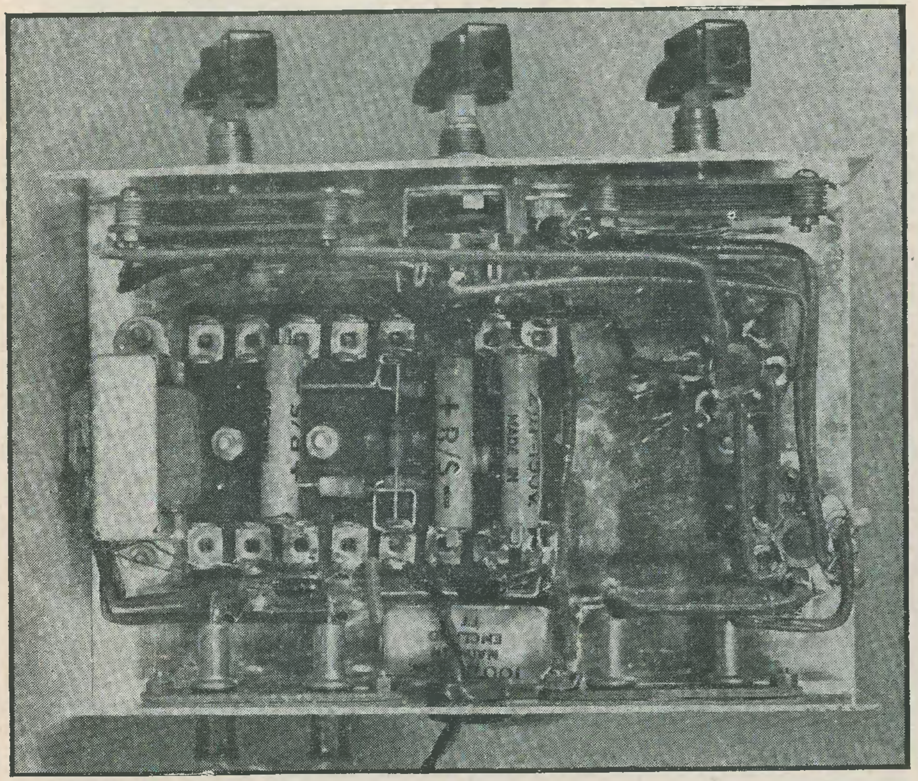
FIG. 1A.
"THREE-DEE" THEORETICAL CIRCUIT.



"THREE-DEE" WIRING DIAGRAM.

Circuit

This is shown in Fig. 1(*a*), from which it will be seen that it comprises a bandpass tuned crystal diode as the detector followed by a three stage transistor amplifier. It will be noted that each coil of the bandpass circuit is independently tuned by a single 500pF variable condenser. This has been done in preference to the more conventional method of utilising a two-gang component, both in order to achieve the maximum sensitivity and to obtain the greatest selectivity without the need for using additional trimmers. Both Long and Medium waves are covered by the receiver, the wavechange switch also acting as the on/off control.



Under chassis view—see wiring diagram

The output from the three transistor cascade amplifier, each working in the earthed emitter mode, is sufficient to effectively drive the 3 ohm speaker via the transistor output transformer type TT5.

Assembly Instructions

These are quite simple and, if carefully followed, no difficulty should be encountered even by the beginner. It should be noted here that the tag board is wired up before mounting into position on the underside of the chassis—the wiring process being described later.

First, mount both of the 500pF variable tuning condensers and the Yaxley type switch on the chassis front drop, not forgetting to place into position the dial plates before finally tightening the fixing nuts. Note from the photograph the positions of these components. Next fit the knobs on to the spindles.

Having completed the above, mount into position, by means of the 6BA nuts and screws, the two type DRR2 coils—noting from Fig. 2 the alignment of these with reference to the slots in the tag rings.

Fit the socket panels on the rear of the chassis with 6BA nuts and screws; that on the left-hand side, looking at the rear of the receiver, being the aerial/earth connections, and the other being the speaker output sockets. A solder tag should be fitted under the nut nearest the external earth connection (see Fig. 2). Place into position the ½in rubber grommet in the hole between the socket panels.

This completes the assembly instructions—the output transformer being fitted later with the tag board.

Wiring the Receiver

Carry out the wiring as shown in Fig. 2 to those components which have already been fitted. It is best here to commence with the wavechange switch and follow with the variable condenser wiring. Leave the leads to A, K, G and N to be fitted later, when the tag board is mounted. Having done this, solder into position the crystal diode—the red end of which should be soldered to the yellow tag of the coil. Careful attention to Fig. 2 will ensure that no errors are made with reference to the above.

Having carried out the wiring so far, continue by wiring up the tag board as shown in Fig. 1. This is self-explanatory and no further instructions are, therefore, required. Great care must be observed when soldering the transistors; the wire ends should be held with pliers between the actual transistor body and the point of soldering—the pliers thereby forming a heat shunt and thus avoiding damage to the transistors themselves.

Fit the tag board to the chassis with the four 4BA nuts and the 2 screws, using the extra 2 nuts to space the tag board away from the underside of the chassis deck. Fit these screws into the last and the third holes from the unused tags on the tag board (see Fig. 1).

With the above completed, next wire in the previously missed leads A, K, and G to the appropriate tags on the tag board. Solder into position C_6 from point K on the tag board to the earthed solder tag, taking care that the positive end of this condenser is connected to the earth side.

The next step is to fit the output transformer to the chassis by means of two 6BA nuts and screws; note from Fig. 2 the orientation of this component. Solder the red lead of the transformer to point K of the tag board and the blue lead to point N. Next solder the output leads of the transformer to the speaker output strip terminals. The black lead of the output transformer is not used in this circuit, and it should, therefore, be left disconnected and preferably be taped in order to avoid contact with the chassis, etc.

This completes the wiring of the receiver circuit. The next step is to connect the speaker, aerial and earth and the battery, and to try out the receiver on either the Medium or Long wave bands.

It will be found that this receiver will work very well with an external "throw-out" aerial, but the addition of a good earth connection will result in greatly increased signal strength. The length of the aerial will largely depend on the actual location of the individual constructor but, generally speaking, some six to eight feet should suffice in the majority of cases.

Can Anyone Help?

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

M. Keogh, Willowbeck, Planetree Road, Hale, Cheshire, asks if any reader can supply data concerning the ex-Govt. Wireless Set No. 17, Mk. 2, in particular relating to its operation on the Amateur bands.

* * *

C. E. Rees, 83 Mirador Crescent, Upton Lea, Slough, Bucks., would like to obtain data or circuits for the Wayfarer "Major" and the American Wards Airline Radio No. 14BR-684A.

* * *

W. A. Collin, 42 Pellatt Road, East Dulwich, London, S.E.22, wishes to obtain circuits and details of conversion of the U.S.A. Command Receiver type BC.455B to make it suitable for use as a car radio on MW.

* * *

J. Sangewood, 187 Brettell Lane, Stourbridge, Staffs, would like to borrow, if possible, the circuit and data on the BC.624A Receiver.

A. R. Haggarty, 55 Finsbury Park Road, London, N.4, would like particulars of the Service type Signal Generator/Wavemeter G.73, and would like to purchase any service data regarding this equipment.

* * *

Wayne Wheeler, KL7DR, Box 903, Anchorage, Alaska, wishes to obtain details of the "ZL Special" 135° Beam Antenna. These were given in the *Short Wave Magazine*, July 1950 issue, but this is now unobtainable from the publishers.

* * *

L. C. Lucas, 36 Lindfield Road, Ealing, London, W.5, would like to borrow or purchase data and circuits relating to the R.A.P. "Transatlantic" 5-valve LW, MW, 2-SW receiver and the Ferguson 372A LW, MW, SW and FM receiver. He can lend full data for the Philco A537 and the Regentone Multi 99.

(*continued on page* 115)

SIMPLIFIED LOW-DISTORTION DETECTOR

by D. E. PASFIELD, *Ass. Brit. I.R.E.*

THIS CIRCUIT MAY BE OF INTEREST TO readers who are in a reasonably good service area for medium and long wave reception, as it can be built cheaply and is an excellent introduction to hi-fi. The circuit to be described is simplicity itself and uses the minimum of components.

It is basically an r.f. stage followed by a diode detector directly coupled to a cathode follower. The qualities of the diode and infinite impedance detectors are well known, both with their advantages and disadvantages, and will not be enlarged on here. Let it be said that this circuit combines both the advantages and considerably less of the disadvantages.

The excellent performance is due primarily to two facts:

1. The diode load for normal a.m. carrier frequencies is essentially resistive, and the effects of excessive shunting capacity is eliminated.
2. As coupling to the cathode follower is direct, there are no biasing current effects as developed in a normal diode circuit using condensers.

The distortion figures, which can be seen from the graph, are 0.3% at 400 cycles and 0.8% at 4 kc/s at 100% modulation.

The r.f. stage for preference is a 6BW7. This valve was designed originally for t.v. circuits and has a very high input impedance, and considerable damping can be used with still useful gain. A 12AT7 is used for the next two stages, one half strapped as a diode, the other half as a cathode follower. Obviously, these are not critical and any similar type of diode and triode can be used.

It must be stressed that in all circuits of this type strict attention must be paid to adequate screening, otherwise the circuit will not be stable.

As to the performance of the circuit, this can be assessed from the following comments.

The writer lives in Daventry within one mile of 11 high power short-wave transmitters, one radar station, one aircraft beacon (within the medium-wave band) and several national grid systems!

The aerial used is 70ft long, 36ft high at one end and 8ft at the other, and the Home, Light and Third programmes are received even during darkness with quality and absence of noise which could even be the envy of f.m.

In spite of the strong local r.f. field, no cross modulation or other effects have been noticed; in fact, any short-wave signals tend to favour the feedback circuits of the l.f. amplifiers.

This is a thing which the writer also has to contend with, and l.f. screening has to be of a very high order also.

All listening has been done on a Williamson amplifier with a Wharfedale three-speaker system, and the absence of background noise between items is quite remarkable for a.m. signals.

It must be remembered that the writer is about 40 miles from Droitwich for Light and Home programmes.

The unit is also used for high quality tape recordings and the results are such that the writer no longer feels he ought to buy commercial records.

Component List

R_1, R_2	Between 50kΩ and 100kΩ according to available signal strength. Adjustment made under operating conditions
R_3	15kΩ ½ watt
R_4	250Ω ½ watt
R_5	4.7kΩ ½ watt
R_6	250kΩ ½ watt
R_7	15kΩ ½ watt
R_8	10kΩ ½ watt
R_9	1.0MΩ ½ watt
C_1	500pF, 2-gang
C_2	0.1μF, 350V
C_3	0.1μF, 350V
C_4	0.1μF, 350V
C_5	8μF, 450V
C_6	100pF
C_7	0.1μF, 350V

Coils: Weymouth iron cored
Switch: 4-pole 2-way
Valves: Brimar 6BW7, 12AT7

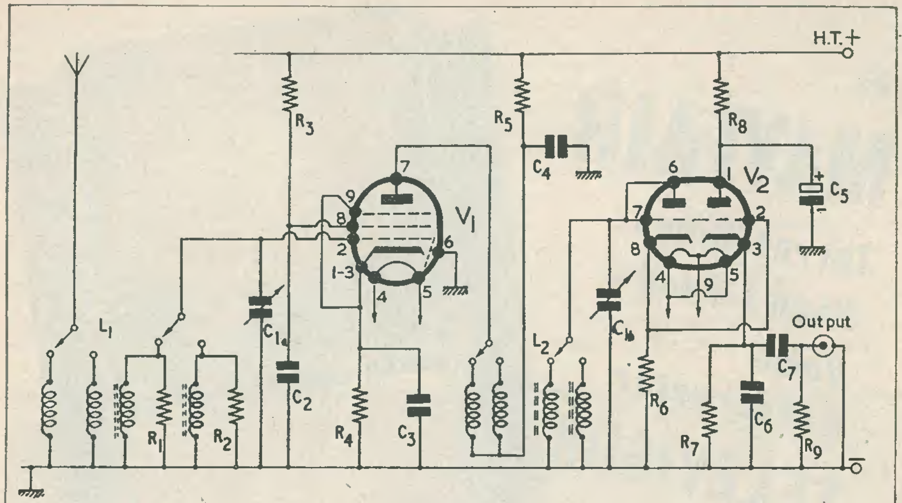


FIG 1

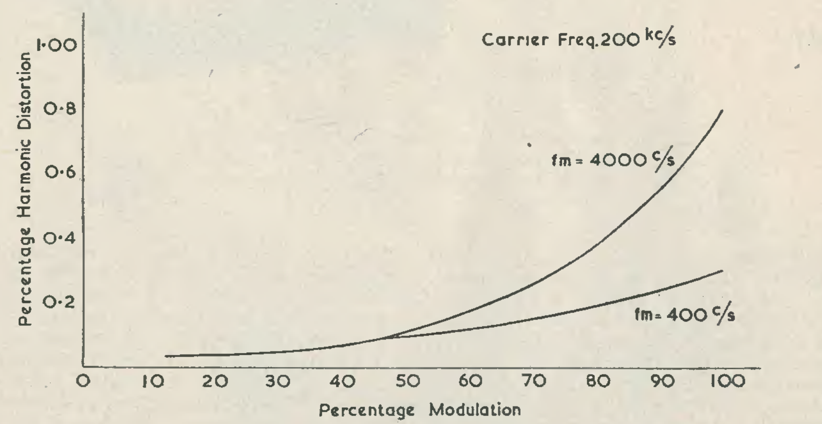


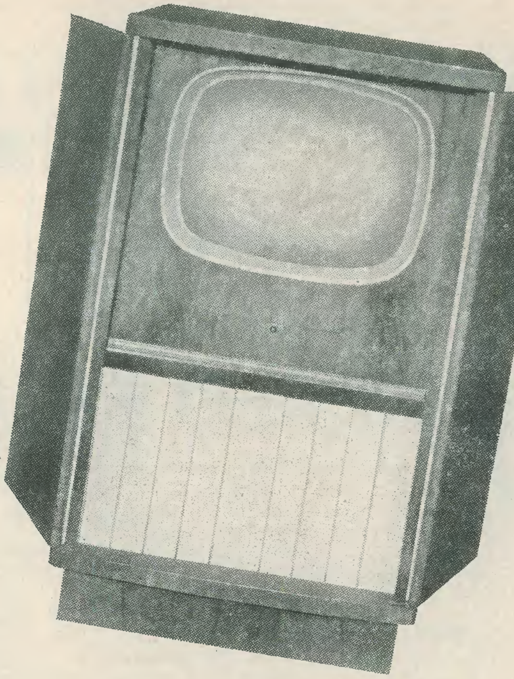
FIG. 2

M.451

The

MAYFAIR

Turret Tuned Band 1-Band 3 Home Constructor TELEVISOR



PART I

by S. WELBURN

Our popular contributor on television topics, S. Welburn, returns to introduce a receiver designed expressly for the home-constructor

READERS MAY RECALL THAT, JUST BEFORE the writer finished his previous series of articles on the subject of television, he stated on several occasions that there was a dearth in television receivers designed for the home-constructor. Since the time when his comments appeared in this magazine, he has had much evidence to show that there is, nevertheless, a very considerable *demand* for an amateur-built televisor, and he has adjusted his line of thinking in consequence.

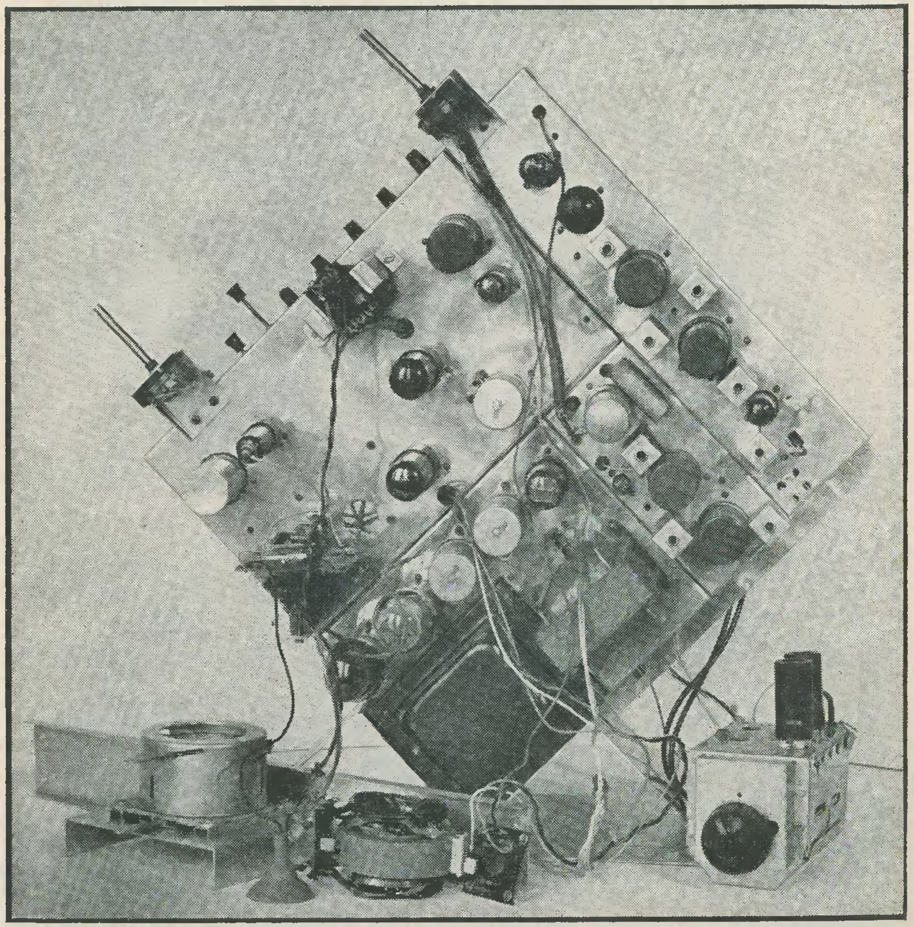
Unfortunately, the business of presenting a home-constructor televisor is not so easy as it may at first sight appear. A large number of difficulties have to be overcome, and it is symptomatic of the present television scene that the question of circuit design constitutes one of the *lesser* obstacles.

Home-Constructor Receivers

Before proceeding further it might be worth-while studying, from a basic common-sense angle, the several factors which affect home-constructor t.v. receivers. First of all, it is obviously very desirable that a home-constructor design must be capable of being built at a cost which is not excessive. Although much pleasure and pride may be obtained from the efficient working of a piece of equipment which has been built completely at home, it would be uneconomic for the amateur to embark on the construction of such equipment if its overall price were markedly higher than that of a commercially produced equivalent. The days of relatively expensive commercial televisors are now over, and complete sets are being offered at prices which are extremely competitive when compared with home-built receivers. Some of the amateur designs which appeared a number of years ago, although capable of good results from a technical point of view, are unattractive these days purely from financial considerations. It is true that these receivers can still be built without too great an outlay by those constructors who have many of the parts, such as resistors, condensers, valve-holders, etc., already on hand, but this state of affairs is not general. It follows from the above that, for an amateur design to be successful and worthwhile, it *must* be economic from the cost point of view.

A second point, and one which is equally important, is concerned with the availability of components. As the television trade stands at present, commercial receiver manufacture is proceeding at a considerable rate, and many makers of television components are fully occupied in feeding their output to the assured market which this manufacture entails. Some of the component makers who supply to home-constructor markets may not be fully prepared to embark on the manufacture of television components, where they have not done this before. A safe statement would be given in this context by saying that the manufacture of television components normally involves working to very tight specifications, and that it requires a considerable amount of know-how, plus expenditure on factory and test equipment, if it is to be fully satisfactory. We therefore have the case where the supply of television components designed specifically for a particular home-constructor application may be limited to the rather small number of firms who have established themselves in this field, and who have not dropped out in the last five years or so.

Also under the heading of availability of components comes the question of component distribution to retailers. As will be apparent from the paragraphs which follow, not only this but the preceding points have been taken up with regard to the "Mayfair" televisor.



Top view of the Mayfair Televisor, showing the various chassis assembled together in one easily serviced unit

The Mayfair

The Mayfair receiver is a televisor which, as well as providing efficient reception and a picture of excellent definition, also meets the requirements just dealt with. As can be gathered from the advertisers' announcements in this issue, the cost of construction is very competitive when compared with commercial receivers. The design of the set is based very largely on the Premier "Design I" televisor, and Premier components are specified in the parts lists where these are particularly applicable to the Mayfair circuitry. *It must be emphasised that all components for the Mayfair are available to the general trade and may accordingly be purchased where advertised.* An innovation is a turret tuner, this being available as a complete item fitted with coils for whatever channels in Band I and Band III are required by the purchaser. Normally, one Band I and three Band III channels are supplied according to locality. The turret tuner is *not* made up by the constructor. Instead, it is obtained as a completely built and aligned unit which has been set up on factory test equipment to the appropriate frequencies. It is worth pointing out that the turret tuner is, basically, exactly the same model as is used in many commercial receivers, and that worries about oscillator drift and frequency response can, in consequence, be forgotten.

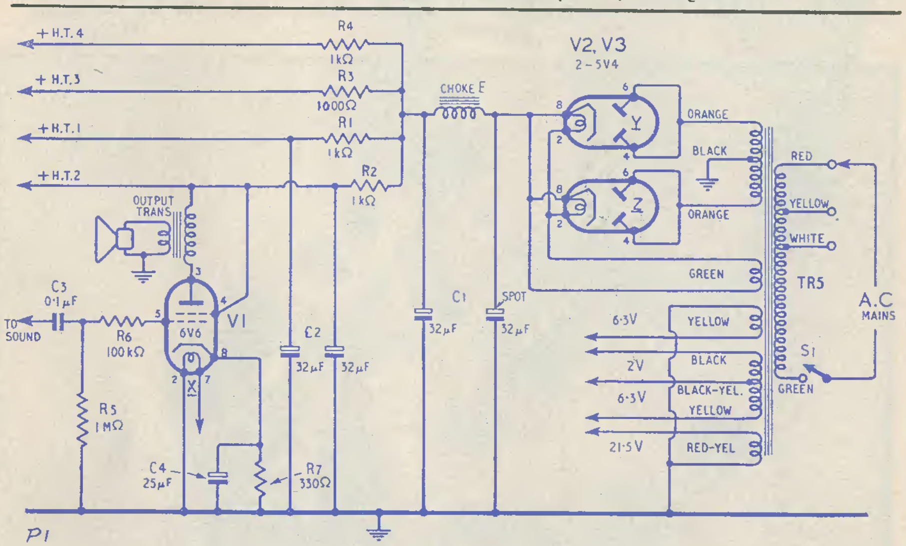


Fig. 1. The circuit of the power pack and sound output stage

Resistors
R1, R2 1kΩ, 4 watt, wirewound
R3 1kΩ, 12 watt, wirewound
R4 1kΩ, 1 watt
R5 1MΩ, ½ watt
R6 100kΩ, ½ watt
R7 330Ω, 1 watt

Condensers
C1, C2 32 + 32µF, 350V wkg., electrolytic. With clips for vertical mounting
C3 0.1µF, 350V wkg., paper
C4 25µF, 25V wkg.

Valves
V1 6V6
V2, V3 5V4

Transformers and Choke
1 mains transformer type TV5 (Premier Radio)
1 sound output transformer (Mayfair type) (Premier Radio)
1 smoothing choke (Mayfair type) (Premier Radio)

Chassis and Chassis Components
1 power unit chassis, fully punched (Premier Radio)
3 valveholders, international octal
1 voltage selector panel (Premier Radio)
3 5-way tag-strips (end tag earthed)
1 3-way tag-strip (end tag earthed)
1 2-way tag-strip

Miscellaneous
2 grommets
1 yd 2mm sleeving
1 yd tinned copper connecting wire (22 s.w.g.)
Mains lead and inter-chassis P.V.C. covered wire.*
Nuts, bolts, solder tags, etc.
* The mains lead and P.V.C. covered wire are employed at a later stage.

The Mayfair receiver is, itself, a superhet and employs comprehensive vision and sound i.f. circuits. The coils for these are pre-aligned, with the result that, so long as reasonable care is employed in following the specified layout, no test equipment is needed to bring the receiver into working order after completion. The vision i.f. is 16 Mc/s, and the sound i.f. is 19.5 Mc/s.

The timebase section employs blocking oscillators both in frame and line circuits. the circuitry to obviate cross-talk between line and frame coils.

The power pack is generously designed and employs components which are more than adequate for the job they have to carry out. Of particular importance is the fact that a mains transformer with isolated h.t. and l.t. secondaries is included. This component ensures that the chassis is completely isolated from the mains supply, and that the risks of shock associated with the con-

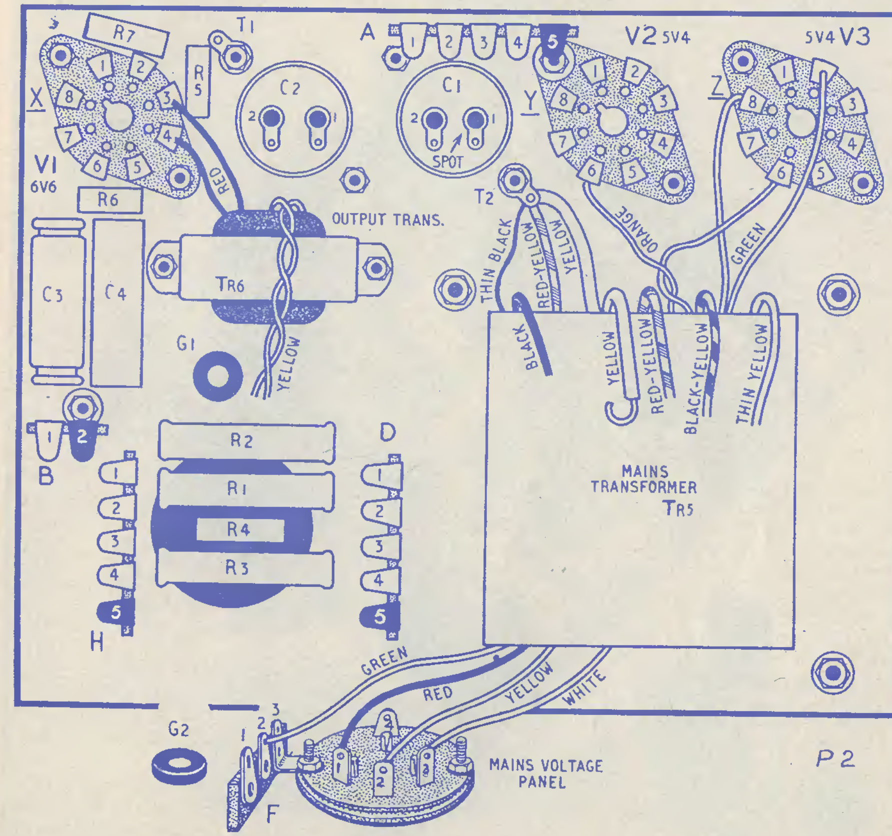
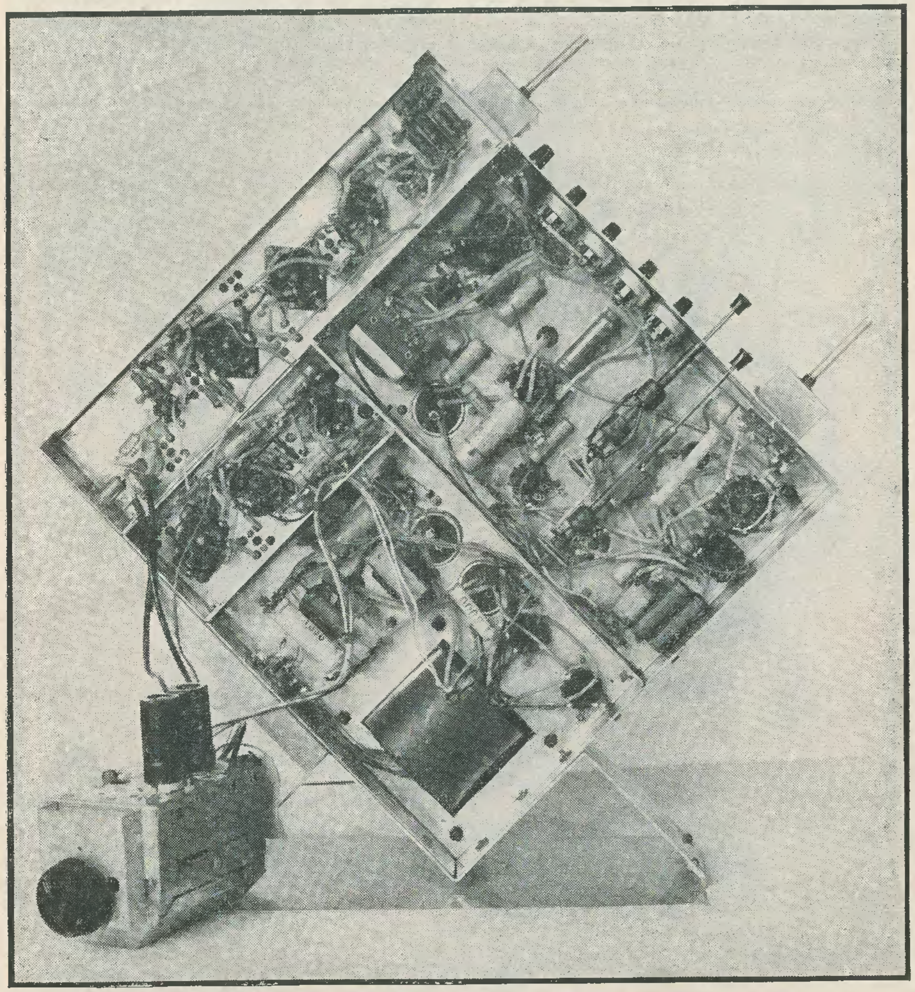


Fig. 2. Layout of the power pack unit below the chassis

Linearity controls are provided for both these circuits, in addition to the requisite height and width controls. A reliable and well-proven line output transformer is employed in the timebase unit, and this provides an e.h.t. voltage suitable for any modern 14 or 17in 70 degree cathode ray tube. The deflector yoke is similarly reliable in design and performance, and care has been taken in ventional a.c./d.c. type of receiver are entirely eliminated.

The complete receiver is built up in units, these being comprised of the following: the power pack chassis, including the audio output stage; the vision i.f. strip with the video output stage; the sound i.f. strip; the timebase chassis; and the turret tuner. Apart from the turret tuner all these sections bolt together to form the complete chassis shown in the photographs which accompany this article. The turret tuner is connected to the main chassis by flexible leads and is intended for mounting in the televisor cabinet. The various items of metalwork which make up the receiver are, incidentally, available in turers' lists, are also available via ex-Government sources. Thus, EF50's are employed in both the sound and vision i.f. strips where no advantage would be gained, performance-wise, from the use of B7G or B9A equivalents. In the same manner, octal-based valves are used elsewhere in



Another view of the Mayfair Televisor assembly, showing the "bottom" or reverse side

finished form ready for immediate assembly.

As has just been mentioned, the Mayfair design ensures that the requirements of low building cost and adequate component availability are met. Further economies within the design itself are effected by the use of valves which, whilst still current in manufac-

positions where they provide just as good results as would be given by smaller types. For a number of circuit applications the use of B7G and B9A affords almost the only advantage of saving of space, this being more applicable to commercial costing than to that of home-constructor equipment. It is very interesting to note, incidentally, that in current American television design octal-based valves, such as the 6SN7, are in very frequent use, despite the availability of B7G or B9A equivalents.

Constructional Articles

Due to the large amount of space needed, it would be impracticable to attempt to describe the construction of the complete Mayfair receiver in one single article. Each section of the set will, therefore, be described separately in succeeding issues; this procedure commencing this month with the power pack chassis. Individual articles will include the parts lists applicable to the section being described. It is possible that special prices will be available to readers who purchase the complete Mayfair kit, in which case it might be advisable to order this in advance of the articles. Also, arrangements may be made with advertisers where some of the components required are already on hand.

The Power Pack

The first part of the receiver which is to be described is the unit containing the power pack and sound output stage. The circuit of the power pack unit is given in Fig. 1 and, as may be seen, this diagram clearly demonstrates the fact that complete isolation from the mains is provided by the power transformer. This transformer has several heater secondaries, as well as a centre-tapped h.t. secondary. Rectification is provided by two 5V4's, these feeding into a filter circuit employing a heavy choke and large-value filter condensers. A number of separate h.t. lines are taken from the main h.t. supply, these feeding the various parts of the receiver circuit.

Also included in the power pack unit is the sound output stage. This consists of a single 6V6 output valve with its associated circuitry, and there is little here which requires further comment.

The layout of the power pack unit is illustrated in Figs. 2 and 3, these showing the positions taken up by the various components employed. It will be noted that some of the tags on the tag-strips are shown black. These tags are those which support the associated tag-strip and which are in consequence at chassis potential. For obvious reasons it is most important to ensure that only those tags are bolted to the chassis. It may also be noted that all the components shown in Figs. 2 and 3 are designated either with their circuit reference or with a separate letter or number reference. Thus, the two grommets on the chassis are marked G_1 and G_2, whilst the tag-strips are identified by different letters. This method of indication enables full wiring instructions to be given without any risk of ambiguity.

Step-by-Step Instructions

The assembly of the power pack and output stage should be carried out in the following manner.

Mount the three valveholders and tag-strip A, one fixing bolt securing one end of this tag-strip and one end of valveholder Y. The valveholders are bolted to the underside of the chassis. Next mount the mains voltage panel and tag-strip F, both these components sharing a common mounting bolt. Fit the two grommets G_1 and G_2, these being followed by the output transformer TR_6 and the 2-way tag-strip E. Tag-strip E is *above* the chassis and is secured by one of the bolts mounting the output transformer.

Choke E, above the chassis, comes next, and three of its mounting bolts also secure 5-way tag-strips D and H, and 2-way tag-strip B, below the chassis. Fit, with the aid of their clips, the two electrolytic condensers C_1 and C_2 mounting at the same time the two earth tags T_1 and T_2. T_1 is mounted under one of the bolts securing C_2, and T_2 under one of the bolts securing C_1. Make certain that the "spot" tag of C_1 takes up the position shown in Fig. 2. Finally, mount the mains transformer.

Wiring up may now be started. Care should be taken during wiring to ensure that all joints are well made and reliable. The first component to be connected up is the mains transformer. One of the thick yellow leads from this transformer should be taken to chassis tag T_2, the second thick yellow lead being bent back across the transformer as shown in Fig. 2. Also taken from the transformer to chassis tag T_2 are one thin black flexible (as opposed to solid) lead, and one red/yellow lead. All three leads should now be soldered at T_2. It may be found that the two thick yellow leads just mentioned need to be cleaned before soldering, and it may be found advisable to initially tin their ends. The yellow lead bent back over the transformer acts as an anchor for heater leads which will be added later.

We have already connected one red/yellow lead to chassis tag T_2. The second red/yellow lead is now connected to tag 1 of tag-strip A. Next, connect one green lead from the transformer to pin 8 of valveholder Z, and the second green lead to pin 2 of the same valveholder. Connect one orange lead to pin 6 of valveholder Y and the other orange lead to pin 6 of valveholder Z. Connect the black solid lead from the transformer to tag 4 of tag-strip A, the black/yellow lead to tag 3 of tag-strip A, and the thin yellow lead to tag 2 of tag-strip A.

Next make the following transformer primary connections. The green lead from the transformer connects to tag 2 of tag-strip F. Proceeding to the mains voltage panel, the red lead from the transformer connects to tag 1 of this panel, the yellow lead to tag 2, and the white lead to tag 3.

The mains transformer is now wired up, and the next component to tackle is the output transformer. One red lead from this component connects to tag 3, and the other to tag 4, of valveholder X. The two yellow leads from the output transformer travel above the chassis through grommet G_1 to tag-strip E, where one lead connects to tag 1 and the other to tag 2.

The output transformer is followed by the smoothing choke. Both leads from the tags negative end to tag 2 of tag-strip B. Connect resistor R_1 between tag 2 of tag-strip H and tag 2 of tag-strip D; R_2 between tag 1 of tag-strip H and tag 1 of tag-strip D; R_3 between tag 4 of tag-strip H and tag 4 of tag-strip D; and R_4 between tag 3 of tag-strip H and tag 3 of tag-strip D. This clears up the larger resistors. Next fit R_5 between pins 2 and 6 of valveholder X; R_6 between pins 6 and 5 of valveholder X; and R_7 between pins 8 and 2 of valveholder X. All the components are now fitted and all that remains is the wiring between tags.

Wiring should be carried out in the following manner. Connect together pins 1 and 2 of valveholder X and the chassis tag T_1. Connect together pins 6 and 4 of valveholder Y. Connect together pins 6 and 4 of

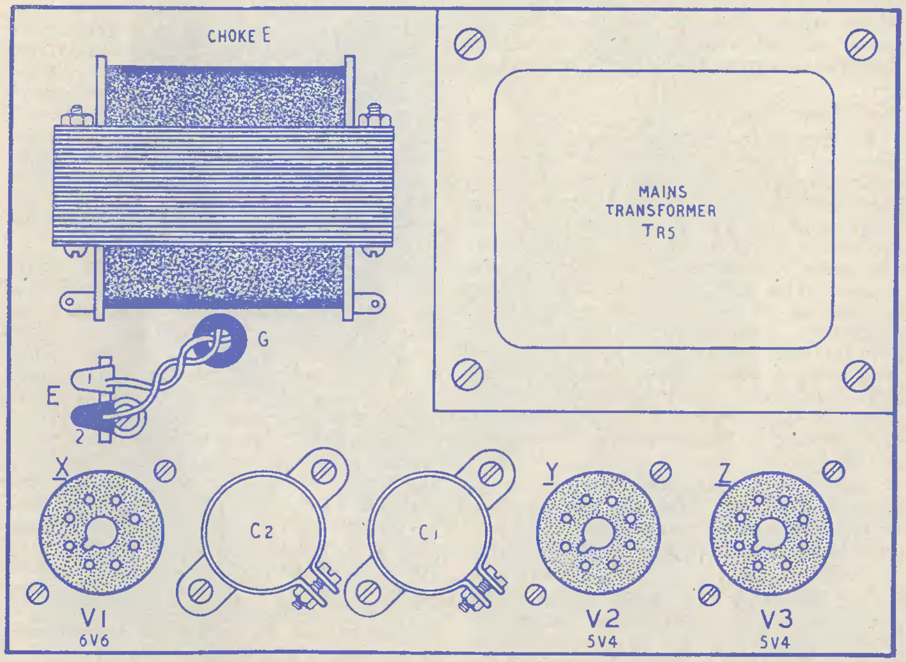


Fig. 3. Above-chassis layout of the power pack

of this choke travel through grommet G_1, one lead connecting to tag 1, and the other to tag 2, of condenser C_1.

The smaller components come next. When wired, these should take up the positions shown in Fig. 2. First of all, connect condenser C_3 between tag 1 of tag-strip B and pin 6 of valveholder X. Connect the positive end of C_4 to pin 8 of valveholder X, and its valveholder Z. Connect pin 2 of valveholder Z to pin 2 of valveholder Y. Connect together pin 8 of valveholder Z, pin 8 of valveholder Y, and tag 1 (spot) of condenser C_1. Connect tag 2 of condenser C_1 to tags 1, 2, 3 and 4 of tag-strip D. Connect tag 1 of condenser C_2 to tag 2 of tag-strip H. Connect together tag 2 of condenser C_2, pin 4 of valveholder X, and tag 1 of tag-strip H.

Finally, connect pin 7 of valveholder X to the thick yellow wire from the mains transformer which was bent back earlier.

Apart from one extra resistor, which will be added when the turret tuner is wired in, the power pack unit is now complete.

Next Month

In next month's issue the assembly of the Mayfair television receiver will be taken one stage further. The writer will continue to employ the same wiring instruction technique as he has used this month, since he feels that step-by-step instructions of this type are of especial value to the beginner, insofar that each stage in the wiring may be ticked off as it is completed. He might add that such a description may also be of assistance to the more experienced constructor who does not want to waste his time mentally transferring every connection from the theoretical circuit to the actual model he is building.

Technical Forum

Safety with AC/DC Grams

In the July issue we discussed certain of the major safety precautions which are necessary in domestic radio and television equipment to protect the user against accidental shock. It was seen that, if a receiver should have a "live" chassis—that is, one which is connected to one side of the mains supply—it is necessary to ensure that no part of it is accessible to the user. There are two reasons for this; firstly, it is possible to connect the mains plug in the socket in such a direction that the chassis is at the full mains voltage with respect to earth; and secondly, even if the plug should be reversed there may still exist a small voltage to earth which is capable of providing quite large current. Thus whichever way the mains plug is connected, it is not really safe to allow the chassis to be accessible. It should also be noted that even if the very desirable precaution is taken to ensure that the chassis is joined to the earthy side of the mains, it is not necessarily at earth potential, and can, in no circumstances, be connected directly to earth.

These features of a.c./d.c. technique raise certain difficulties when a universal radiogram is being designed. The reason for this will be apparent when it is remembered that in the standard a.c.-only model in which the chassis is isolated from the mains, the metal motor board carrying the turntable assembly is connected directly to the amplifier chassis, which is in turn often joined to an earth line. This renders the unit completely safe to touch and at the same time eliminates any possibility of hum. Now with the live chassis equipment no direct connection is permissible between record player and amplifier, and this can easily lead to a most prolific source of hum. One solution lies in the use of a record player in which the motor board and often also the turntable are made of a rigid plastic material. In this case a crystal pick-up is most desirable, and often essential if induction hum such as might occur with a magnetic unit is to be avoided. The pick-up is connected to the amplifier through two capacitors, one in each lead, each having a maximum d.c. working voltage in excess of 750V. There are players available in which the p.u. arm is entirely of plastic and the screened connecting cable completely inaccessible from the outside; with such units the use of isolating capacitors may be avoided in a permanent installation.

Should the player have a metallic motor board, ascertain whether or not it is connected either directly or indirectly to the outer screening of the pick-up lead. If there is no connection, the lowest hum level should be obtained by using the arrangement shown in Fig. 1. Here a separate earth return path is provided via C_1 for any interference signal induced on to the motor assembly. If the motor board were connected to the cable screen, capacitor C_2 would act as a common return impedance in the signal path and might easily lead to hum or excessive motor interference. These notes are not intended to deter the reader from making a.c./d.c. types of amplifiers, but to be forewarned of the possible causes of input hum is half the battle in either eliminating or avoiding it.

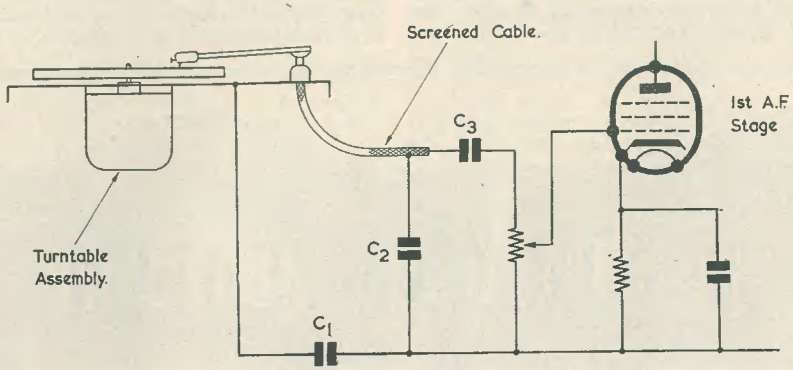


FIG.1.
Suggested Method of Connecting Pick-up to A.C/D.C. Type of Amplifier.
M445

Tape Deck Switching

In the June issue we published a suggested method of connecting up the switch assembly on the Collaro tape deck. As readers will know, the occasional error does occur—and the writer has to apologise for one in the diagram Fig. 1, p. 754 of the June issue. A lead is missing between the top right-hand contact on the switch assembly and the line marked L.S. (S_{1a}). Also, the two leads shown connected to the lower pair of contacts on the sixth set top row should be reversed. Several constructors have also suggested an improvement to the circuit, and we are passing this on as it may well interest other readers. When the deck is in the stand-by condition with all Record and Replay buttons up, there is no load on the amplifier. This may be simply avoided by connecting the bottom contact of the second set in the top row to the line marked "Dummy Load." To clarify these instructions we are reproducing the connections to the top row of switch contacts as they should be (Fig. 2). As an alternative, some constructors may wish to have the speaker connected in circuit when the stop bar is operated; this will enable the amplifier to function normally in this condition. This may be achieved by joining the lower contact of the second set to the L.S. line and not to the dummy load line. This alternative is shown as a dotted lead in the diagram.

Hum on Recorders

Whilst on the subjects of mains hum and tape recorders, it is opportune to mention one or two points which are worth bearing in mind when contemplating the construction of a portable recorder. It is inadvisable to consider a live chassis type of amplifier for use in a recorder, so in employing an isolated chassis it is permissible to connect the main assembly of the deck to the amplifier chassis. Hum bucking coils are often included in series with the Record/Replay heads to balance out any voltage induced into the heads by stray fields from the motors. These bucking coils are included in the decks, if necessary, by the makers. It will be realised from this that the heads are very sensitive to hum from stray a.c. fields, and certain precautions are necessary in the design and positioning of the power pack components. These points may be listed as follows:

(*a*) It is usually of advantage to construct the power pack on a separate sub-chassis and mount it as far from the tape heads as is possible. A little experimental work to find the best orientation of the mains transformer with respect to the heads normally makes possible some further reduction of hum.

(*b*) The stray field of a mains transformer is dependent partly on the size and type of core. In general, the smaller the core, the nearer it will be to magnetic saturation and

the greater will be the stray field. Hence, it is advisable to use a good quality product, having a core of reasonable dimensions.

(*c*) The h.t. supply must be adequately smoothed, but in a portable equipment this is best achieved by means of a resistance-capacity smoothing filter. Chokes normally are fitted with a gapped core to prevent magnetic saturation, and the presence of a gap can produce a very high extraneous field. If the choke is following a full wave rectifier, this field will have a large 100 c/s fundamental component which can be particularly troublesome to eliminate. It is usually easier to avoid setting up a magnetic field in an equipment rather than attempt to screen sensitive components from a field which already exists.

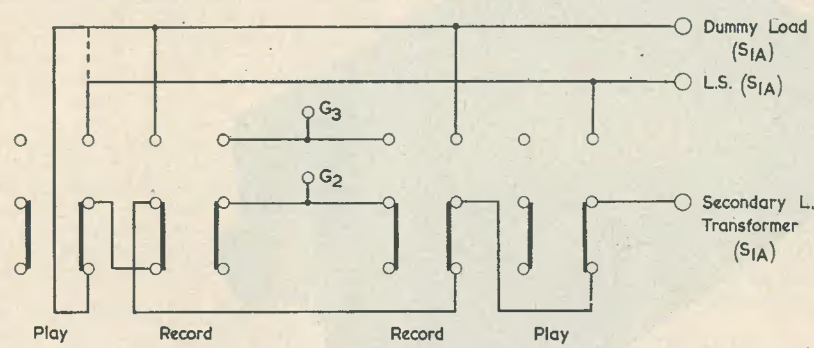


FIG. 2.
Amended Connections to Top Bank of Switch Contacts on Collaro Type Deck.
M446

Can Anyone Help?

(*continued from page* 103)

A. Burrows, 132 North Road, Bellshill, Lanarkshire, Scotland, wishes to obtain the service sheets for, or any data on, the Vidor model CN.247 5-valve receiver and the Alba model 462 5-valve receiver.

* * *

L. Keast, Royal Oak Cottage, Chainhurst, Marden, Kent, wonders if any reader can supply any information on the Signal Generator type W.1268, 30–86 Mc/s, ref. No. 10T67, XW530V/179.

* * *

E. Northcott, 60 Harwell Street, Plymouth, Devon, wishes to obtain information on the Service receiver type P.104, and will pay for any circuits or return if required.

* * *

A. J. B. Cutler, 22 Cox Lane, Chessington, Surrey, would like to buy or borrow any details, and especially the circuit, of the surplus C.R. Unit "Wavemonitor G87" design "H."

P. A. Russell, 133 Monks Park, Wembley, Middx., wishes to buy or borrow a service sheet for the Ultra 9in console televisor W.470 (London transmissions).

* * *

J. S. Bell, 7 Wascana Close, Anlaby Park Road South, Hull, Yorks., requires the circuit or service data for the True Vue televisor model A.33.

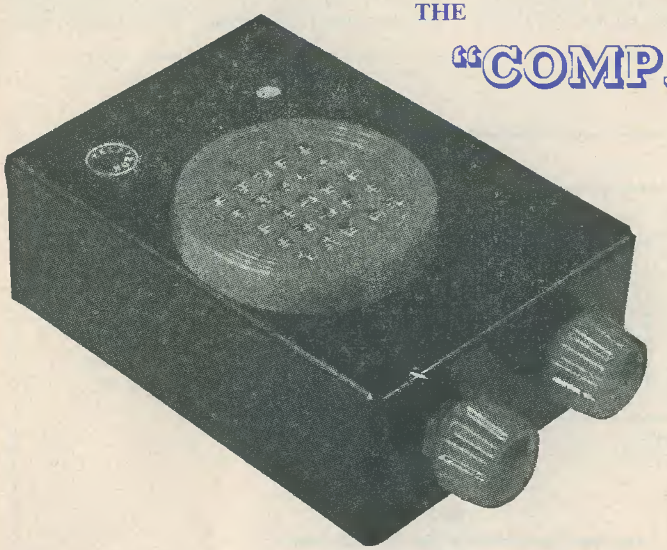
* * *

J. U. Cull, 6 Rising Brook, Stafford, wishes to obtain details of the linking connections for the Parmeko Universal Output Transformer, believed purchased just prior to the last war. The manufacturers are unable to help.

ERRATA—On p. 40, August issue, it was stated: "From the right-hand tag of the headphone strip . . . solder one end of both R_2 and R_3 . . ." This is incorrect; R_2 should be connected to the outer tag, and R_3 to the inner tag, to which the h.t.+ lead is also connected.

Further Notes on

THE "COMPANION"



REGENERATIVE TRANSISTOR '3' POCKET RECEIVER

by **R. A. LANGIS**

SINCE THE PUBLICATION OF CONSTRUCTIONAL and other information on the above receiver in our July issue, many enquiries have been received from intending constructors. Of these enquiries, some asked for further information on the final cabinet design, and others required details and additional information on the various allied uses of the receiver.

Dealing with the cabinet first, this is shown in the illustration, from which it will be seen that it largely follows the prototype design but differs in certain respects. Of these, the most striking is the attractive two-colour scheme, the cabinet itself being black with the speaker fret in a contrasting shade of red. The whole assembly itself is a very sturdy affair, the lid being fixed to the case by two strong metal hinges—these being moulded into the strengthened wall of the cabinet.

Regarding the allied uses, two of the most frequently asked questions were: "Can the receiver be used as a car radio," and "Can larger speakers be incorporated into the design?". The following endeavours to answer these queries, and deals with some additional points concerning the actual construction of the receiver.

The balanced armature reproducer is essentially a low impedance earphone which provides audio output similar to a small speaker. Where portability is of secondary importance, a larger moving coil speaker with a suitable matching transformer will provide improved performance. Class B push-pull output may be added, using TR_3 as a driver stage, but of course a larger cabinet and chassis would be required to house the resultant receiver.

The "Companion" receiver is not suitable for use as a car radio, although in some cases it will operate within a car, but with much reduced volume due to the shielding effect of the metal car body. Similar results will prevail when the receiver is used within a reinforced concrete building. Results achieved with the receiver will vary greatly depending on the actual location of the user with respect to the local transmitting station. Judicious use and careful adjustment of the feedback control R_2 will also greatly affect the results obtained at any given location. This control must be maintained just below the point of oscillation for best results and the loudest signal strength.

The layout of components, as shown in the drawing (Fig. 2) should be strictly adhered to, with neat and tidy wiring, angled and kept close to the chassis in order to both minimise r.f. instability and acoustic feedback. Haphazard "point to point" wiring will usually produce disappointing results.

Blue Spot or r.f. junction type transistors were specified for TR_1 in the original design, but either Red/Yellow Spot or the White Spot types are satisfactory as substitutes. Where either of these two latter types are used, however, L_2 may be omitted and C_3 should be reduced from 50pF to 20pF. In the case of TR_2, a Green/Yellow Spot type may be substituted for the specified Red Spot; for TR_3, a Green/Yellow Spot type may be used in place of the Brimar TS3 transistor.

The stated values for both R_5 (8.2kΩ) and R_6 (4.7kΩ) are optimum values but, due to the wide variation of transistor characteristics, these values should be adjusted so that the collector current of TR_2 is 0.5 to 1mA, and that of TR_3 some 3mA. A milliammeter connected in series with the collector of each transistor, and a 10kΩ variable wired temporarily in place of R_5 or R_6 will enable the correct value of resistor to be ascertained.

The three 1.5V cells are connected in series, with the "plus" end connected to the "earth" line. When correctly wired into circuit, with suitable values for both R_5 and R_6 having been chosen and fitted, a low level hiss from the reproducer will be heard upon switching on the receiver.

Where the hiss level is excessive, this would indicate a faulty junction in TR_1 which may have been caused through the application of excessive heat during the soldering operation.

In the absence of suitable test equipment, rough functional tests may be carried out by momentarily connecting a 1 or 2μF condenser across R_5, then across R_6. These connections should produce a loud "click" in the reproducer. Similar results should occur when R_4, C_4 are momentarily short circuited.

Dealing with the wiring of R_2 (see Fig. 2), care should be observed that the correct tags are wired into circuit as follows: Tag A (top tag) should be connected to R_3; Tag B (centre) to 2 of the FX25 tag ring and Tag C (nearest to chassis) to positive end of C_1.

Radio Miscellany *(continued from page 98)*

Help!

Also described is a Mercury Jet Interrupter, a Microphonic Amplifier and an Omnigraph. In case you have no idea what the latter might be, it was a device with a hand-driven notched wooden drum for practising Morse. The notches on the revolving disc operated a contact breaker to give the necessary dots and dashes. The faster you wound, the faster the Morse; all perfect copy, of course, at umpteen words per minute provided the notches had been carefully cut.

Our old friends the Oojah coils also appear. These are simply basket coils wound in and out of nails driven into a wooden core. Then the lot was steeped in boiling paraffin wax to hold the wiring together, as after cooling the nails and wooden core were removed. Their self-capacity was terrific, but they looked nice, had a pleasant smell, and it was good fun making them.

The *pièce de resistance* which really intrigued me was in the cover advertisement for Part 17. The Polar Blok System of building sets was to be described. That has got me completely foxed. I cannot remember the name, let alone how it was done. It is described as "an extremely ingenious patented method of building up receiving sets with ease and simplicity," etc.

That makes it my turn to appeal to "Can Anyone Help." WANTED URGENTLY by puzzled Radio Magazine Columnist. Full details of the Polar Blok System of Set Building—from friendly western county readers who don't want their postage money refunded.

Quid Pro Quo

An idea which may be of interest to many readers, at least those who also happen to be photographers, was recently noted whilst on holiday. The bottom of the carrying-case of a home constructed battery portable had been fitted with a bush to fit a camera telescopic tripod. When out picnicking, etc., the portable was kept clear of the ground (preserving the finish of the leatherette case), could be rotated to use the frame aerial to the best advantage, and could be set for any height to make for easy tuning adjustment or volume level, according to whether the user was seated on the grass or a camp stool.

There are many instances of electronics lending ideas to the photographer—here, at last, we borrow one in return!

A SENSITIVE SIGNAL TRACER

by P. YATES

THE TECHNIQUE OF SIGNAL TRACING, AS A means of swiftly diagnosing faults in t.v. and radio equipment, has always greatly interested the writer. Even the simplest form of tracer—a pair of 'phones with a 0.1μF capacitor in series with one lead—can be put to a large variety of uses, e.g. distortion tracing, checking pick-ups, hum location, etc.

A less obvious use is the tracing of faults in the sync separator and timebase circuits of t.v. receivers. In the absence of an oscilloscope the 'phones are invaluable. The frame sync is recognised as a 50 cycle hum, and the line-sync as a high-pitched whistle (10,125 c/s). Care must be taken to ensure that it really is the sync voltages being traced, and not the output due to the respective timebase oscillators themselves. To check this, the contrast-control should be turned to the minimum gain position, which means that there is no output from the sync separator, and the audible indications due to the sync voltages will disappear.

The addition of a crystal-diode in series with the capacitor and 'phones enables the tracer to be used for radio-frequency tracing as well. Here the need for greater sensitivity is quickly felt, as these voltages in the early stages of a receiver are usually of the order of millivolts only. To provide this increased sensitivity the more advanced tracer about to be described was constructed, and has proved very successful in actual use. It can be used for r.f. and a.f. tracing, and provides both visual and aural indications of the signal.

Referring to the block schematic diagram Fig. 1, it will be seen that the signals from the r.f. probe feed into the first r.f. amplifier stage, which uses a 6SJ7 type pentode valve. This stage is resistance-capacity coupled into the second r.f. amplifier, which uses a similar valve. The r.f. gain is controlled by means of a 25kΩ wire-wound potentiometer in the cathode circuit of these valves.

The amplified r.f. signal is then passed to the detector stage, which uses a 6U5G "magic-eye" valve. The triode section of this valve acts as a leaky-grid detector, demodulating the r.f. signal and passing it on as a.f. to the a.f. gain-control. A leaky-grid detector can be considered as a diode-detector followed by a stage of Class A amplification, thus this stage also provides useful amplification.

The "magic-eye" section of this valve is used as the Visual Indicator, and the "eye" will close progressively as the signal strength increases.

Following the path of the signal, it has now arrived at the a.f. gain-control, and from here it feeds into the grid of the 6V6 beam-tetrode type output valve, which operates the loudspeaker to give aural indication.

A full-wave rectifier type 5Z4 is used in the power unit, followed by a two-section smoothing circuit, thus ensuring a very low hum-level.

Each stage is decoupled from the h.t.+line by a large capacitor, to ensure good stability.

Components

In general all component values are shown on the circuit diagram, and any special features are referred to below.

Valves

These should preferably be of the metal type, as these provide their own screening. If the glass type are used, however, external screens must be used on the r.f. amplifiers.

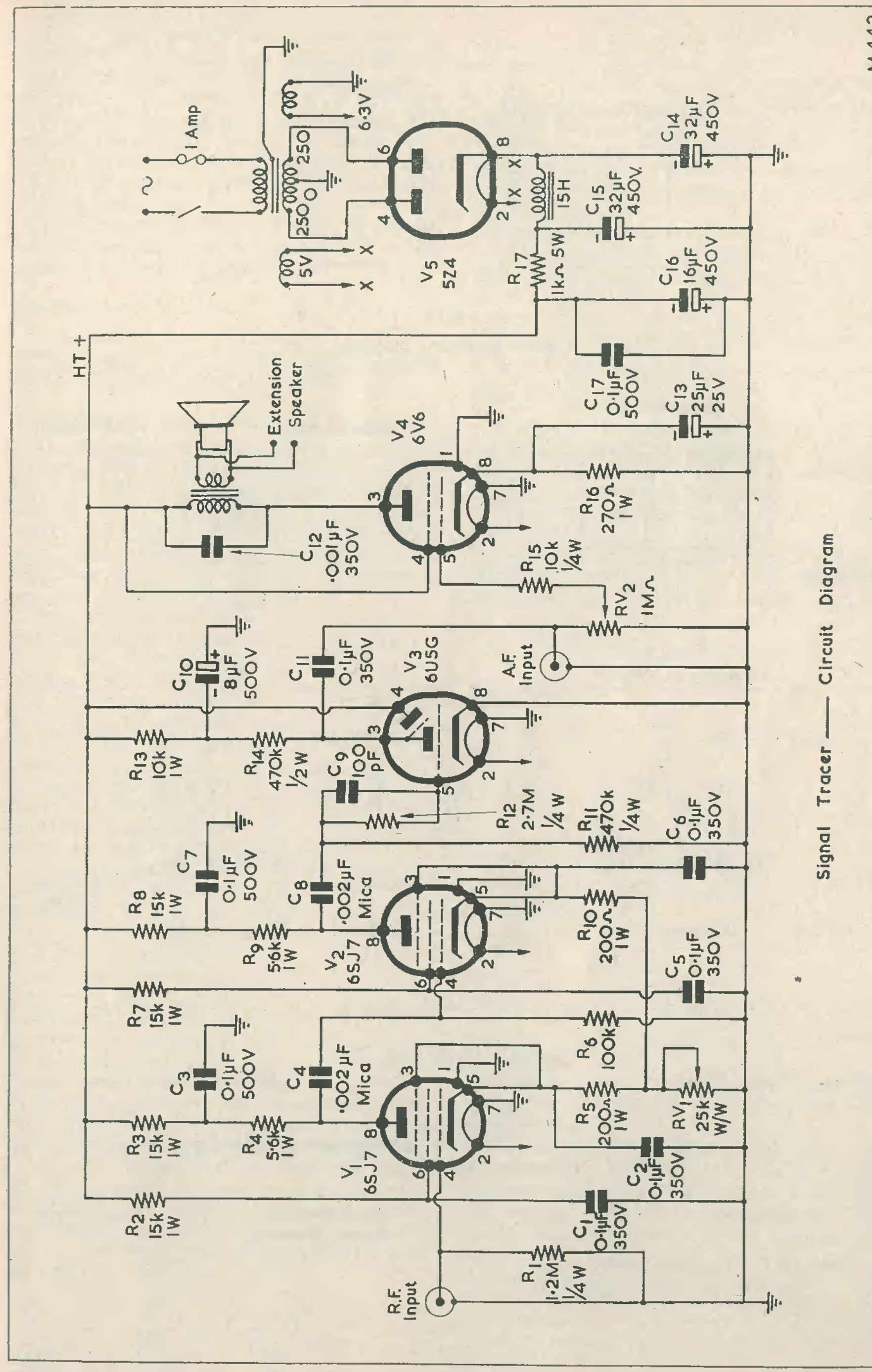
Resistors

The wattage rating shown on the circuit diagram are important, and should be adhered to; of course, there is no objection to using a ½ watt in a ¼ watt position if this is more convenient!

All resistors can be 20% tolerance, except R_4 and R_9, which should be 5%. RV_1, the 25kΩ r.f. gain control, must be wire-wound, as it has to carry the combined cathode currents of V_1 and V_2. The a.f. gain-control RV_2 should preferably have a logarithmic law, but a linear one would be acceptable.

Capacitors

C_4 and C_8 must be of the mica type (or non-inductive paper). The working voltages are shown on the circuit diagram and are specified to give a good safety factor.



Signal Tracer — Circuit Diagram

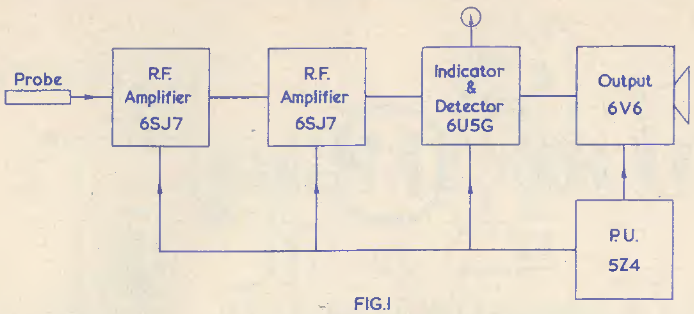


FIG.1
Block Schematic Diagram.

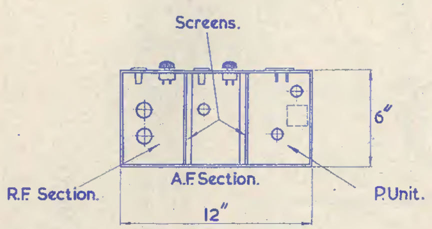


FIG.2.
Underside of Chassis.

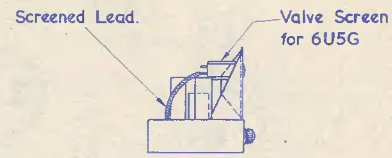


FIG.3.

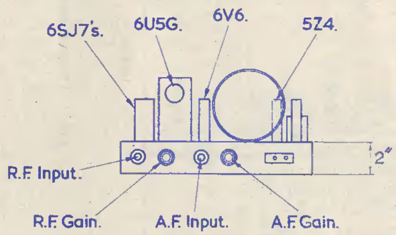


FIG.4.

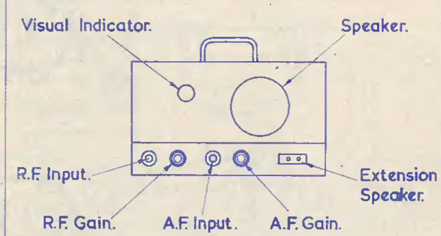
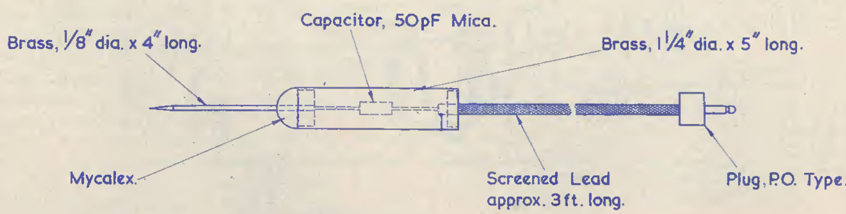


FIG.5.



Note. A.F. Probe is similar to R.F. Probe but with Capacitor increased to 0·05μF.

FIG.6.
R.F. Probe.

M443

Transformers and Chokes

The mains transformer should have a 250–0–250 volt secondary winding, and be capable of delivering at least 60mA d.c. The secondary windings are 5V at 1 amp and 6.3V at 3 amps. It should preferably also have an electrostatic screen.

The smoothing choke should be between 10 and 20 henrys, and be capable of carrying at least 60mA d.c.

The output transformer should, of course, be of a suitable ratio to match a 6V6 to the speaker, and is a standard type.

Loudspeaker

This is a 5in p.m. Elac unit, with a 3-ohm speech coil; however, any good quality speaker of similar type can be used.

Constructional Details—Chassis Layout

The chassis used was one which happened to be at hand, the dimensions being 12in × 6in × 2in, and this appears to be the smallest size on which the components can be conveniently arranged. It is housed in a metal case—again conveniently available—which measures 12½in × 8in × 7in and so makes a compact portable unit (Fig. 5).

The wiring layout is not particularly critical and any convenient chassis could be used, provided the following precautions in the interests of stability are undertaken.

The underside of the chassis is divided into three compartments by metal screens (Fig. 2). The r.f. components are contained in the first section, the a.f. in the middle, and the power unit parts in the third. The connections to the base of the 6U5G "magic-eye," which is mounted horizontally on a bracket above the chassis, are made via a screened lead (Fig. 3). This general layout should be adhered to as it prevents pick-up between stages working at different frequencies.

Individual leads in the r.f. sections should be kept as short as possible, especially grid leads, and a colour code for wiring facilitates the tracing of any particular lead in the event of a fault developing. The particular code used by the writer is as follows:

Anode:	Blue
Grids:	Green
H.T.+:	Red
Earth	Black
Heaters:	Brown
Cathodes:	Yellow
Screens:	Orange
Misc.:	White, Grey, Violet

The valve connections are shown numbered on the circuit diagram, and resistors and capacitors were wired directly across them; however, a perhaps neater construction could be made by using tagboards, provided leads are kept short.

The speaker is fixed to the chassis by means of a 16-gauge mild-steel right-angled bracket attached by one of the magnet retaining bolts at the rear. The front circumference is recessed into the chassis by ¼in and secured through the bottom-fixing hole to the chassis by a 4-BA bolt.

Probe Construction (*Fig.* 6)

The physical construction of both r.f. and a.f. probes is identical, the only difference being in the size of the capacitor used; 50pF for the r.f. and 0.05μF for the a.f. one.

The bodies are made from 1¼in diam. brass tube, with Mycalex plugs at either end. The front plug is drilled to give a tight push fit to the needle itself, a 4in piece of tapered ⅛in brass rod. The rear plug is drilled to accommodate the insulated screened lead, the screening of which is bonded to the brass housing.

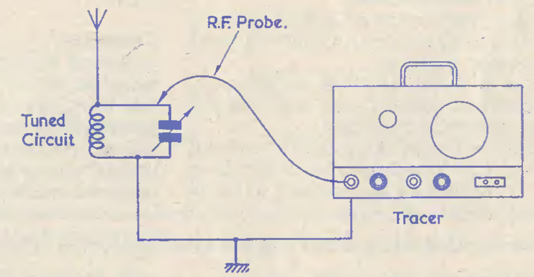


FIG.7

M444

The screened-lead need not be more than approximately 3ft long or shorter if required, and terminates at the other end in a P.O. type two-contact plug. P.O. type jacks are used in the chassis to receive them, labelled R.F. Input and A.F. Input on Fig. 4.

The brass housings effectively screen the pick-up capacitors from hand-capacity and external fields, and it is only when the needle itself is touched that a healthy "burp" is heard from the loudspeaker!

Operation of Tracer

A general view of the unit is shown in Fig. 4. Some notes on the operational use might be useful.

The technique of signal tracing is rapidly mastered and soon becomes second nature, and in many cases cuts servicing time considerably.

The sensitivity of the tracer is such that the signal can be traced from aerial input right through to the speaker—this with an input from a picture-rail aerial. So in the case of a "dead" receiver—after a visual check has ascertained that all heaters are O.K. and a meter check has indicated the presence of h.t.—tune the receiver to a strong local signal; or inject a signal (modulated r.f.) if a signal-generator is available.

Then with r.f. jack plugged in, and r.f. and a.f. gain controls at maximum, place the tip of the probe on the Ae socket; the signal will be heard, and the "eye" will partially close. Next, place the probe on the frequency-changer grid, and if the signal is again indicated, proceed to the frequency-changer anode. Here the signal should be louder, and the "eye" should close more. In this way, working backwards to the speaker, all r.f. and i.f. stages can be checked; if the signal ceases at a certain point, then the fault obviously lies between that point and the point where the signal was last indicated.

For tracing faults in the a.f. section, the a.f. probe is used, and the r.f. gain control turned to the minimum position.

In general it is best to work with the a.f. gain at maximum always, and with the r.f. gain at the minimum possible.

The visual indicator is particularly useful in checking the local-oscillator stage in a superhet. Frequently it is necessary to know if the oscillator is, in fact, oscillating. This can be checked by placing the r.f. probe tip on the anode of the local-oscillator when, if all is O.K., the "eye" should close or partially close. There will be no audible indication, as, of course, the oscillator is generating unmodulated c.w.

Distortion Tracing

The point of entry of distortion can be swiftly located by working back from the detector anode, a task which can be very tedious by any other means.

Checking Bypass Capacitors

If, when the respective probe is placed on a bypass condenser, a signal is heard, then obviously the condenser is no longer by-passing, and should be replaced! Cases of instability due to this cause are quickly located.

Pick-ups may be checked by placing the a.f. probe tip on the live lead, with the a.f. gain at maximum; in the case of a low-impedance type, connection must be made to the secondary of the matching transformer.

Many more uses will soon present themselves to the user, and when the unit is not in use as a tracer, it can be used as a Monitor receiver. To do this, connect a tuned circuit as shown in Fig. 7 and tune to the desired signal.

Conclusion

Several further facilities have been envisaged but not yet incorporated. These include the bringing-out of the power-unit supply potentials to pins on the front-panel; and the use of a multi-match output transformer with connections also brought out. This would further increase the versatility of the unit.

Sixpence-in-the-Slot Shaving at the National Radio and Televison Show

28 August–7 September, 1957

There will be no need for either visitors or exhibitors' staff to suffer a "five o'clock shadow" at the forthcoming National Radio and Television Exhibition at Earls Court. The Management's consideration of this problem has prompted them to instal slot machine shavers in a number of their cloakrooms. For sixpence these will give five minutes' use, and they are automatically disinfected at the end of each shave.

On a hectic day-trip to London, many an out-of-town radio dealer, fitting a session at the Exhibition into a tightly packed schedule, will appreciate this opportunity of a quick shave before leaving Earls Court for other engagements. Radio enthusiasts, rushing straight from business to the exhibition in the evening, will also enjoy this chance of grooming before making their tour of inspection.

Such are the facilities afforded by the "Auto Shaver" produced by Partwest Ltd., of 50 Mount Street, London, W.1. The "Auto Shaver" is now available to an infinite variety of industrial, commercial and social organisations.

RIGHT—*From the Start*

Part 18

GAINS AND LOSSES

by **A. P. BLACKBURN**

EVERY ART, SCIENCE OR WHAT-HAVE-YOU has its technical language and its jargon. Radio, not the least of these, is liberally peppered with terms, many of them having no existence whatever in everyday speech.

Many become "household words," like frequency modulation, for example, or television. Others, however, remain elusive, usually because they are not directly connected with improvement in sales. Such a one is "decibel." The hi-fi enthusiasts will need no help in this matter, I am sure, as their life revolves around such things as "db's of bass lift" and "the response is 3 db down at 20 kc/s," and so on. Indeed, the decibel (db) is particularly useful when dealing with changes from one state to another as, I hope, we shall see later.

Levels

We will start by postulating a system of circuits, get in a tangle with them, and then see if there is an easy way out. Fig. 1 shows three attenuators connected in cascade. The first reduces the input power by half, the next reduces the output of the first by 10 times, and the last reduces the remaining power by half again. Now the output power may be calculated as follows. At the points BB the power will be $\frac{1}{2}P_i$. The next attenuator reduces this 10 times, so at CC the power will be $\frac{1}{2} \times 1/10$ P_i and, therefore, the output power after attenuator No. 3 will be

$$\tfrac{1}{2} \times 1/10 \times \tfrac{1}{2}P_i = 1/40\ P_i.$$

In other words, the attenuations have merely been multiplied together and the input power multiplied by the result to give the output power. This admittedly is not particularly difficult, but as systems become more complicated, it becomes clumsy.

Now another way of multiplying numbers together is to take the logarithm of these numbers and merely add them together. Say, for example, our attenuators had reduced the powers by 1/2.37, 1/10.4 and 1/3.21 instead of the easy numbers we assumed, multiplying these numbers would be a little clumsier than before, and to resort to logs would be one way out. We could say, then, that the powers may be expressed as follows:

$$\log \tfrac{1}{2} + \log 1/10 + \log \tfrac{1}{2} = \log A,$$

where A is the total attenuation from input to output. If we now multiply all these terms by 10 we get

$$10 \log \tfrac{1}{2} + 10 \log 1/10 + 10 \log \tfrac{1}{2} = 10 \log A \quad (1)$$

Now call each of these terms A_1, A_2, A_3 and A_4, and we may write $A_1 + A_2 + A_3 = A_4$ (2)

In simple language we may add the attenuations of each attenuator providing we take their logs and are satisfied with the total attenuation being given as the log of the true attenuation, i.e. $\log A = A_4$. You will probabably say at this point, "this seems to be just complicating the issue. After all, multiplication is simple enough." That is certainly true of this simple case, but if you will bear with it a little longer I hope to show that it is justified generally.

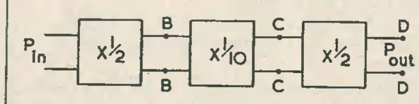


FIG. 1

M447

You will notice that the quantity behind the log is always a ratio, 1 : 2, 1 : 10, etc., and it represents the ratio of power into the attenuator to power out. We can say, therefore, that A_1, A_2, etc., can be written

$$10 \log \frac{P_1}{P_2} \ldots\ldots (3),$$

where P_1 and P_2 are the output and input powers respectively. At last we have arrived at the db. It is defined by (3) above.

$$\text{i.e. db} = 10 \log \frac{P_1}{P_2} \ldots\ldots (4)$$

So reverting again to (2) we see that all the A's are actually attenuation in these new units, decibels.

In other words, the decibel may be defined as "10 times the logarithm of the ratio of two power levels." Applying this to Fig. 1 we get

$\log 0.5 = -0.3$; $\log 1/10 = -1$.

Therefore, $10 \log \frac{1}{2} = -3$db and $10 \log 1/10 = -10$ db. The total attenuation of the three attenuators is therefore $(-3)+(-10)+(-3) = -16$ db.

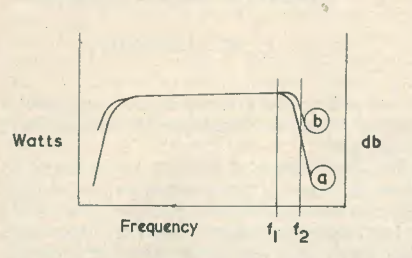


FIG. 2 M448

Signs

There is one feature in the above answer, the negative sign, that has not been explained. The simple answer is that negative signs mean attenuation (or losses) and positive signs gains.

To illustrate this we will work out a case for an amplifier. If the input were 1 watt and the output 10 watts, the ratio is 10 to 1. The gain in db is therefore

Gain db $= 10 \log 10/1 = 10$ db.

The sign is positive, showing that it is a gain.

Input and output power is all very well in its way, but very often we are interested in voltage or current. An ordinary voltage amplifier, for example, does not involve us in power at all. How may the gain of the amplifier be expressed in db?

We know that power $= E^2/R$. If we put this into the definition of the db as in (4) we get

$$\text{db} = 10 \log \frac{E_1{}^2/R}{E_2{}^2/R}$$

where E_1 and E_2 are the input and output voltages.

A theorem of logarithms enables us to write this as

$$\text{db} = 20 \log \frac{E_1}{E_2} \quad \ldots\ldots (5)$$

Therefore an amplifier which has an input of 0.001 volt and an output of 1 volt has a gain of 1,000 times, and in db,

Gain $= 20 \log 1{,}000 = 60$ db.

Here is one of the advantages of the db. The numbers involved are smaller. A gain of a million times is merely 120 db.

There is one thing to notice about expression (5), and that is that it was derived from (4), which involves powers. The derivation of (5) assumed that the input and output resistances were equal, of value R in that case.

This must be strictly observed; an amplifier with an input resistance of 1MΩ and an output resistance of 1kΩ cannot have its *voltage* gain stated in db.

Cause and Effect

So far only two justifications have been given for the use of the decibel, and these are that smaller numbers may be used and gains and losses in a system may be added rather than multiplied. Another and far more important reason is that in some cases the db gives a more truthful representation of the state of affairs than any other method.

Most human perceptions are logarithmic in their effect. This means that the effect observed does not appear to vary in the same way as the cause. For example, a loudspeaker producing 1 watt will not sound twice as loud when the volume is increased to 2 watts.

But if, say, 5 watts produced an apparent loudness of twice that at 1 watt, then changing the level to 25 watts would only sound twice as loud again, and 125 watts twice as loud again. Now this is particularly awkward when plotting frequency response curves. A typical curve is shown in Fig. 2. This is plotted directly in watts and frequency. But it has already been said that a change in power of n watts does not produce an effect in our ear of n times the loudness, so the curve of Fig. 2 will not tell us what the change in loudness is between f_1 and f_2. If, however, we plot decibels against frequency, we will obtain curve b, which will give a more accurate idea of the change in loudness from frequency f_1 to f_2.

Another more striking example of the same thing is shown in Fig. 3. An amplifier has been tested at two gain settings, shown by curves 1 and 2. When plotted gain against frequency, as in 3(*a*), the shapes of the curves look quite different—the lower gain curve looks as though it might have a better frequency response than the higher gain one. In fact, the 3 db "down" points, i.e. those frequencies where the gain has dropped to −3 db relative to the middle frequency gain, are the same for both curves.

Plotting the same curves on a db-against-frequency basis produces Fig. 3(*b*). The curves are exactly the same shape for both gain settings. This is certainly far less misleading than Fig. 3(*a*).

Relative Levels

You will notice that the db has always referred to a condition of change. The ratio between two levels at input and output of an amplifier or attenuator, or the two levels of output at two frequencies, etc. The db is a measure of change. It would be meaningless to say: "My radio has an output of 50 db." One could only ask, "20 db more (or less) than what?"

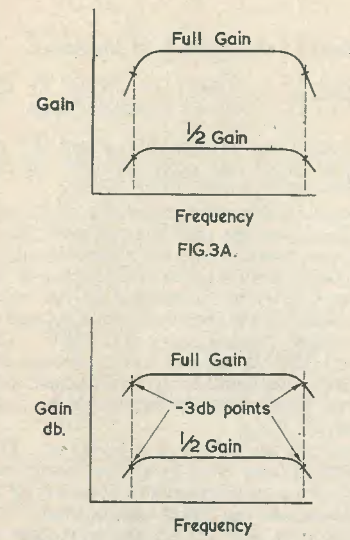


FIG.3B. M449

Such a statement can only be made if it is understood what level is taken as standard. If 50mW were taken, quite arbitrarily, as a standard of power output, then it could be said that the output of a receiver were 20 db, relative to 50mW. There have been a number of standard levels, one, for example, at 1mW in Europe and another of 6mW in America.

An expression that is always cropping up is, "the response is 3 db down at 10 kc/s." The reason for picking 3 db is that this number represents half power.

i.e. db $= 10 \log \frac{1}{2} = -3$ db (power).

(Note the minus sign representing a loss.)

This is a power ratio, however. As a voltage ratio 3 db is $1 : \sqrt{2}$.

i.e. db $= 20 \log \frac{1}{2} = -3$ db (voltage).

In other words, the power will have dropped to half its normal value at 10 kc/s, the voltage to $\frac{1}{2} = 0.707$ of its normal value at 10 kc/s.

This 3 db criterion is used when talking of tuned circuits. The Q of the circuit is often defined as (see Fig. 4):

$$Q = \frac{f_o}{f_2 - f_1}$$

Now f_2 and f_1 are the frequencies where the voltage across the circuit has dropped to 0.707 of its peak value (i.e. dead on tune) at f_o. These points, as may be seen, are also the points where the available power across the circuit has dropped to half its peak value, and are often called the "half power points." Either way, these points are the −3 db points.

The −6 db points are also shown in Fig. 4. These are of no particular significance in relation to tuned circuits, but it is worth remembering that −6 db represents half voltage and quarter power.

Historical

Early on in this article, in expression (1) to be precise, a mysterious 10 appeared, and was not explained at the time.

It appears that in telephone work at the beginning of the century, a "transmission unit" was evolved for expressing the performance of a telephone line in terms of a standard line. Later the "bel" appeared, and was subsequently divided by ten to become the decibel. The name "bel" is derived from Alexander Graham Bell, the inventor. It should be remembered that the decibel uses logarithms to the base 10. Another unit is the "Neper." This uses "natural" logarithms to the base 2.718, or *e* as it is usually designated.

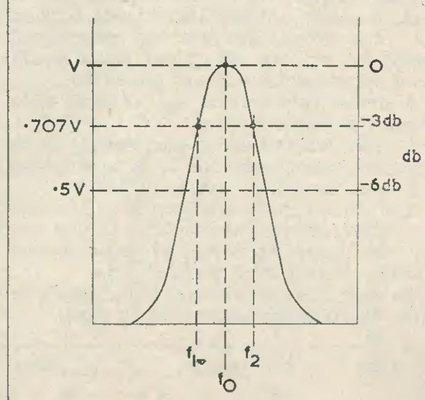


FIG. 4 M450

The rather arbitrary nature of the decibel, the introduction of logarithms, etc., does not detract from its usefulness. It is brought about to some extent by the somewhat arbitrary nature of human perceptions.

DESIGN CHARTS FOR CONSTRUCTORS

No. 17 TRIODE STAGE GAIN

by HUGH GUY

When the triode valve is used as an amplifier the voltage gain provided by the stage, defined as the output a.c. voltage per input a.c. volt, is given by the well-known formula:

$$G = \frac{\mu . R_L}{R_a + R_L}$$

where μ is the amplification factor of the valve R_a is the anode impedance of the valve in kΩ and R_L is the value of the anode load in kΩ.

Now for any given triode, working under specified conditions, the two valve parameters are constants and can usually be found quoted in valve data. The problem of determining stage gain then reduces to one of selecting the correct value of anode load R_L to give the correct gain. To do this the formula must be rearranged to give

$$R_L = \frac{G . R_a}{\mu - G}$$

Although this method yields a mathematically correct value for R_L, the required gain, if high, is rarely obtained in practice because the valve parameters are not maintained under the working conditions which result from the calculated value of anode load.

A deliberately chosen bad example soon brings this defect to light.

A resistance-coupled triode stage is to be designed to give a gain of 12 in an amplifier working from an h.t. supply of 350V.

The constructor's first step is to examine the contents of his valve boxes. In this case we will assume he finds two rather similar triodes—namely the 6J5 and a 6L5.

He then turns to his valve data, where he finds the following characteristics listed.

Type	*Heater*		*Anode*		*Bias*	R_a	μ	*Base*
	V	*A*	*V*	*mA*		*k*Ω		
6J5	6.3	0.3	250	9	−8	7.7	20	IO
6L5	6.0	0.15	250	8	−9	9.0	17	IO

Trying each valve in turn he calculates the value of R_L from formula.

For the 6J5 this would be solved as follows:

$$R_L = \frac{12 \times 7.7}{20 - 12} = 11.55\text{k}\Omega \text{ or } 12\text{k}\Omega \text{ to the nearest available value.}$$

For the 6L5 the anode load would be:

$$R_L = \frac{12 \times 9}{17 - 12} = 21.6\text{k}\Omega \text{ or } 22\text{k}\Omega \text{ to the nearest available value.}$$

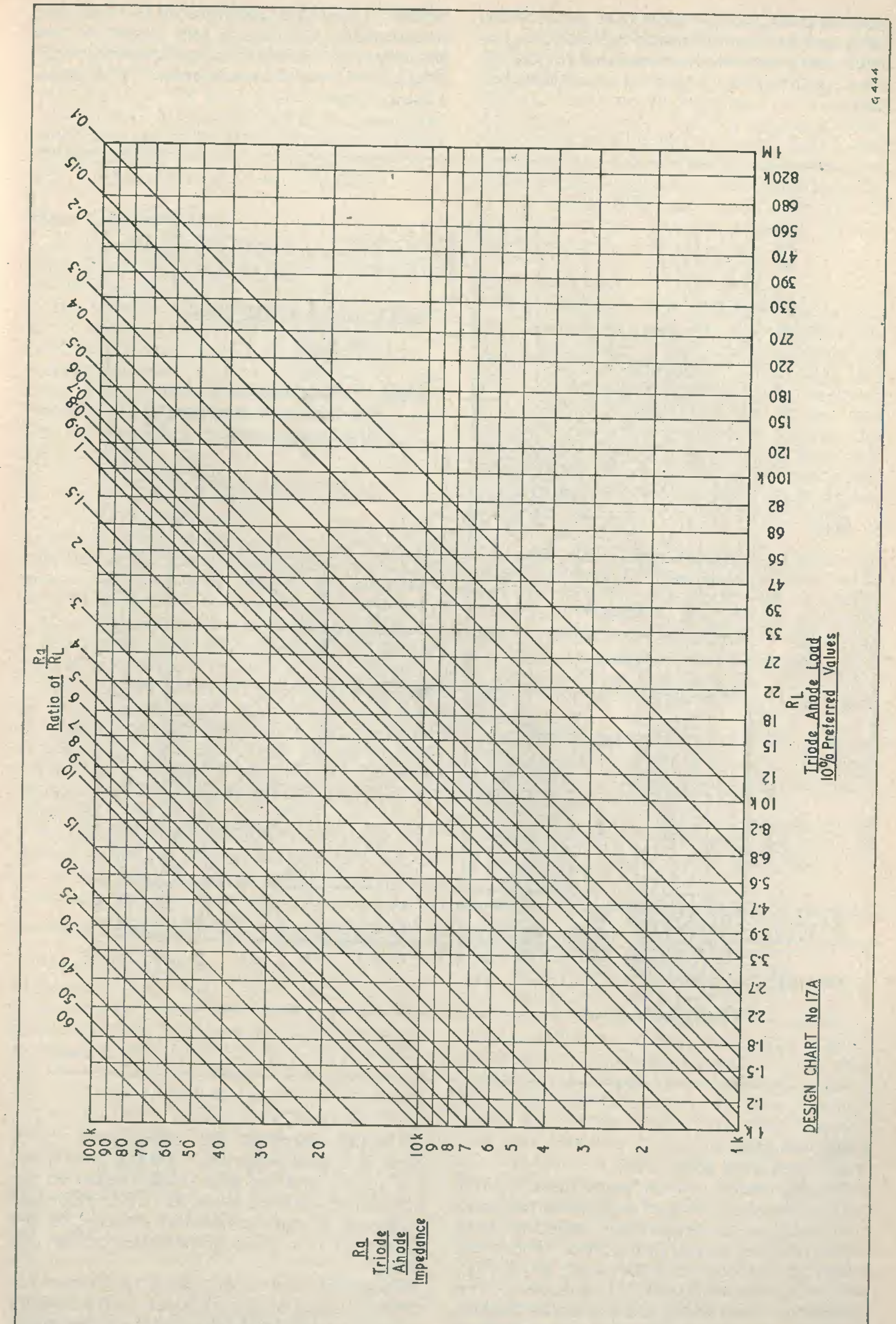
The conditions of operation must now be considered from the point of view of the effect they have on the circuit values.

Taking first the calculated value of the 6J5 anode load, we see that the required 9mA, which must flow through the valve and anode load to achieve an amplification factor of 20, produces a drop in the resistor of 108 volts, which, added to the specified anode voltage of 250V, makes the necessary h.t. 358V. The proposed 350V is not too low to change the valve parameters sufficiently in this case, and, therefore, the choice of a 6J5 would be quite satisfactory.

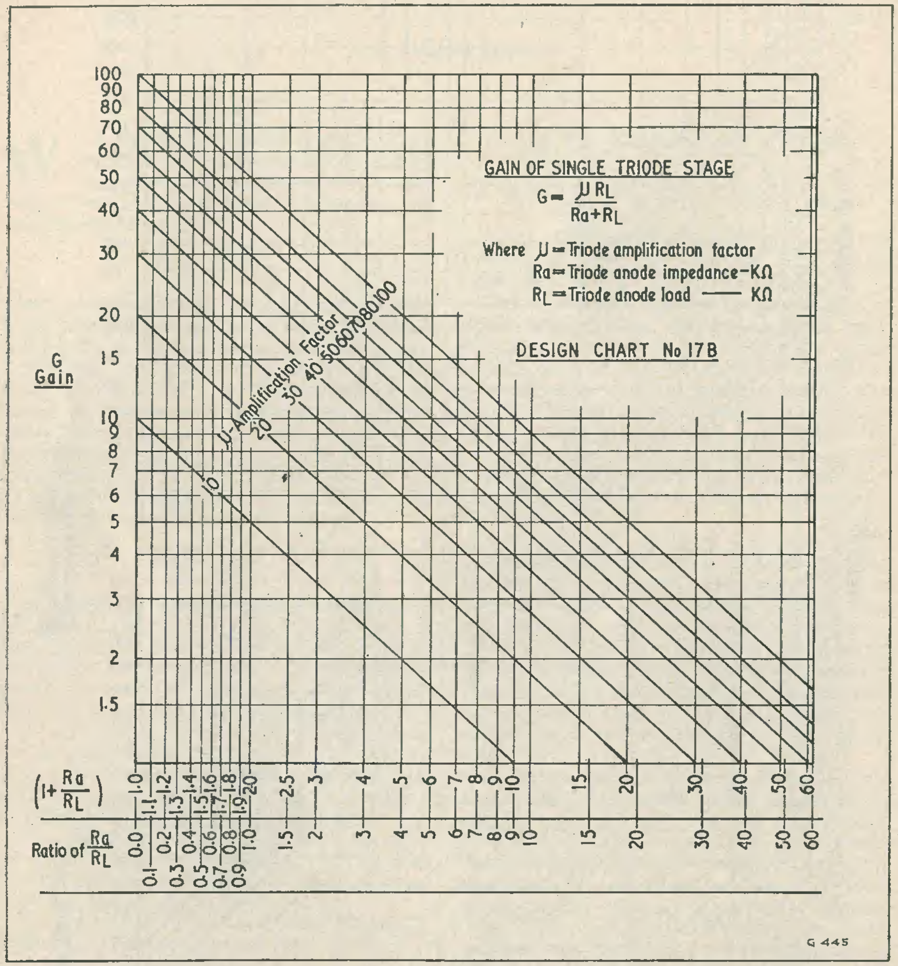
This is not true of the 6L5, however. This valve should draw 8mA for correct operation, but were it to do so, then 176 volts would be dropped across the 22kΩ anode load. For this condition, and for an anode voltage of 250V, the h.t. supply would have to be about 425 volts. In fact, to specify the true working conditions for the valve, the characteristic curves would have to be consulted for an accurate assessment of the performance of the stage.

Now this process of compromise is one that cannot be avoided in the design of an amplifier, and, in fact, it is only after quite a number of design attempts that the engineer becomes sufficiently experienced to know the limitations of his valves, and on this basis, which type to select for a particular application. The purpose of conducting the above exercise was twofold; both to demonstrate the steps involved, and to show that a certain amount of inevitable and tedious arithmetic arises.

The charts are, of course, designed to eliminate the latter process, and may be used



both to calculate the gain that a particular valve and load combination will give, and to determine the anode load required for known valve parameters to give a predetermined gain.



Using the Charts

A. *To Calculate Stage Gain.*

The R_a and R_L of the stage under review are first required. Chart A gives vertical and horizontal scales respectively covering most values likely to be met in practice. This chart must be used to find the ratio of R_a/R_L, which is accomplished as follows. The respective values of R_a and R_L are located on their scales on the chart and their intersection noted. Diagonal lines indicate the principal intersections, and where two values do not actually cross on one of the existing diagonals, the ratio value can be interpolated from those already there.

Having obtained the appropriate ratio, chart B is now consulted. To the ratio value 1 is added, and this new value located on the horizontal scale of chart B. (For reference purposes a scale calibrated directly in the ratio R_a/R_L is given immediately below this scale.)

Diagonal lines on this chart are marked for various values of amplification factor ranging from 10 to 100, and selecting the appropriate "μ" line for the chosen valve, the point of intersection of the "$(1+R_a/R_L)$" value and the "μ" value is referred back to the vertical "Gain" scale to give the value of stage gain resulting from the known parameters.

Like most detailed technical explanations, the process reads far more formidably than it appears in practice, and to clarify the procedure a design example is now detailed.

Stage Gain Example

What gain can be obtained using a 6J5 triode under the operating conditions specified previously, but with a 3.9kΩ anode load?

The previous operating conditions gave an anode impedance of 7.7kΩ, and hence using chart A the ratio R_a/R_L is approximately 2.

Referring now to chart B we add 1 to the ratio 2 to give 3 on the horizontal scale. Locating the diagonal "μ" line of 20 we see that horizontal and diagonal lines intersect at 6.6. The gain, therefore, of such a stage is 6.6. to an accuracy of better than 2%.

B. *To Calculate Anode Load Values*

In most practical cases the designer wishes to evaluate the anode load required for a specified gain, and to do this the above procedure is reversed. Again, an example is most helpful here.

What value of anode load must be used for a 6P5 triode (μ of 100, R_a 91kΩ) to give a gain of approximately 60?

Referring to chart B we see that a gain of 60 is obtained when the "μ" line of 100 intersects the horizontal scale reading $(1+R_a/R_L)$ of 1.65. This latter reading results from the ratio R_a/R_L of 0.65, which is promptly located among the diagonal lines of Chart A.

At the intersection of this ratio value and the value of R_a of 91kΩ, the required value of anode load will be found. Since no visible values exist for any of these quantities, the nearest obtainable anode load resistance to the interpolated values would be chosen. In this case it is a toss-up between 120kΩ and 150kΩ, the former giving a gain of 57 and the latter a gain of 62. The h.t. potential would have to be quite high to achieve such a gain in practice, and the constructor should verify that the typical operating conditions specified in the valve data are maintained in the practical circuit in the manner already indicated.

Point to Watch

The true gain of a triode under a.c. conditions should take into account the effect of the grid leak of the stage following the circuit under consideration. This grid leak effectively appears in parallel with the anode load, tending to reduce the real anode load, and hence lowering the gain. Though this effect does not modify the d.c. working conditions of the circuit, the reduction in the load to a.c. signals should be offset by an appropriate increase in the calculated value of anode load.

In the example considered above, for instance, if the following grid leak were 1MΩ, then the effective a.c. load with a 150kΩ anode load would be the resultant parallel value of 130kΩ approximately. Under this condition the gain becomes 59 instead of 62. If the following grid leak had been only 250kΩ, then the gain would have been reduced to 51.

As a rough general rule, the effect of the following grid leak can be ignored if the leak can be made ten times (or greater) the value of the anode load.

But take note of the manufacturer's ruling on the maximum grid leak for any given valve, particularly if the latter is an output stage.

RADIO COURSES

"The GRAFTON RADIO SOCIETY announce that they have again made arrangements with the Islington L.C.C. Men's Evening Institutes for official courses in the RADIO AMATEURS EXAMINATION and MORSE (both for beginners) to be held this winter at the Isledon School, Upper Hornsey Road, Holloway, London, N.7. The classes will meet on Mondays, commencing September 23rd, for the R.A.E. 7–9 p.m., followed by the Morse at 9–10 p.m., under the instruction of Messrs. S. H. Iles (G3BWQ) and L. Barber respectively. The fee is 20s. for one course, with an additional 2s. 6d. for the second. Application in the first instance should be made to the Hon. Secretary of the Grafton Radio Society, A. W. H. Wennell (G2CJN), 145 Uxendon Hill, Wembley Park, Middlesex, at once so that a place may be assured."

A course is being held during the coming autumn-winter Evening Classes at Doncaster Technical College, the instructor being Mr. J. B. Willmott, A.I.P.R.E. The course is purely an "interest" one, not being designed with any trade or professional examination in view, and it is mainly of a practical nature. Students are encouraged to bring along their own receivers, etc., home-built or otherwise, for alignment, servicing, etc.

Classes are held on Monday evenings. Full details and application form can be obtained on request from Mr. S. Edwards, Electrical Engineering Section, Doncaster Technical College.

A CIGAR BOX RADIO

by E. C. HARRIS

THE WHOLE RECEIVER, COMPLETE WITH batteries, was contained in a cigar box which previously held twenty Mannikin cigars. This box fits into most jacket pockets and is, therefore, very suitable for its purpose.

External controls have been selected so that they do not protrude more than is necessary for easy operation. The volume and on-off control are operated by one finger, and so is the sliding wavechange switch. The tuning trimmer has a knob which is only slightly larger in diameter than the depth of the box.

The circuit consists of a tuned crystal detector followed by a high-gain, three-valve amplifier. The signals are tuned by a Repanco Crystal Set Coil in parallel with a 250pF trimmer. Any reliable crystal can be used for rectification. The amplifier is built round three CK507AX deaf-aid pentodes, requiring 1.25 volts l.t. and 30 volts h.t. Control of filament current and volume is provided by a miniature 1MΩ pot. The output transformer is also of the miniature type, providing correct matching for the valve and earpiece.

The circuit is shown below; all resistors are ¼watt type. A minimum of components is used and the circuit is quite stable.

Construction

The main components, i.e. trimmer, coil, batteries and their clips, wavechange switch and volume control are mounted. The battery clips can be made from any springy metal, the writer using brass plates from a tuning condenser. The low tension positive terminal was made from the contact from a mains lamp-holder. The volume control is mounted by two woodscrews on the edge of the box, a suitable gap having been cut (see diagram).

The wavechange switch is mounted near the tuning components, to keep wiring short and direct.

The amplifier is built in a U-shape, curving round at the bottom so that all leads can be taken through the top of the box. The valves need not be mounted, but can be just held down at earthing points, etc., by their wires. They can be protected from microphony and damage by rolls of cotton wool contained in cellotape. The output transformer also needs no mounting, being held down by its wiring.

The valves have wire ends, and the electrodes are identified by numbering the wires from a red spot at one end, numbering 1 to 5, as shown in diagram.

After great trouble in identifying these leads, the writer found their connections stamped on the manufacturer's labels.

Results

For indoor use the set needed an earth and its 3ft rod aerial. An external aerial greatly improved volume to loudspeaker strength, the loudspeaker being five times as large as the receiver.

Outdoors, away from buildings, volume was quite adequate with the rod aerial and no earth. Volume increased slightly by connecting the earth clip to the framework of the writer's bicycle.

For listening on the bicycle, the writer devised a stethoscope arrangement with the miniature earpiece. A piece of rubber tubing from heavy cable was cut and a small hole made in its centre. This fitted the flange of the earpiece. Into both ends of this were fitted two lengths of tubing taken from the outer sheath of a length of co-axial cable. These were cut so that, when in the ears, the earpiece hung about two inches under the chin. The ends were covered by a single layer of soft foam rubber to make an airtight cavity and a comfortable fit. If the tubes tend to pull outwards they can be folded, tied and left in that position for a while.

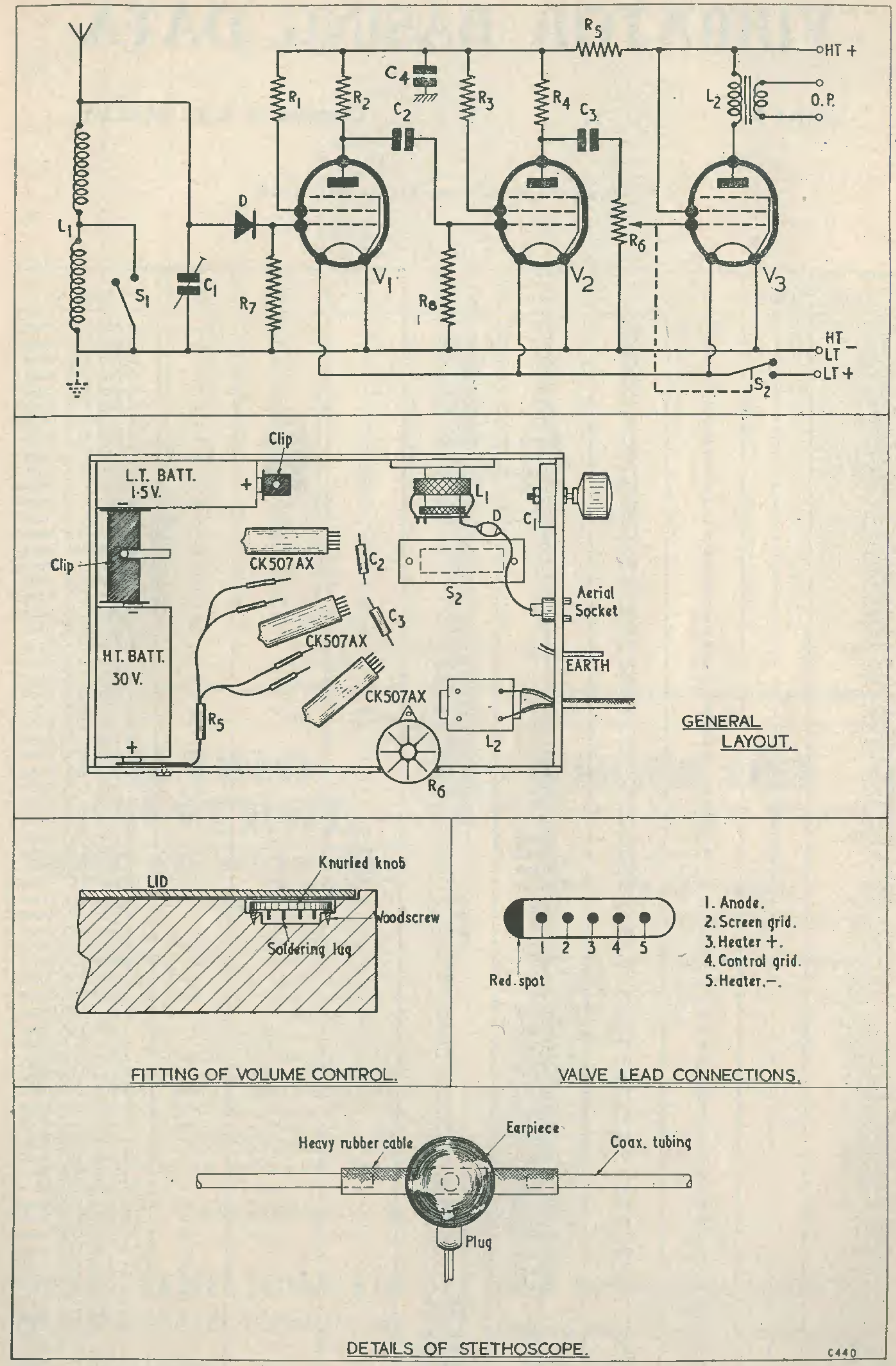
The writer's aerial was one of the elements of an indoor t.v. aerial. It had another rod inside it, and its extension increased volume and range considerably.

The knob for the trimmer was made from a large accumulator terminal. The screw was removed from the trimmer and replaced by one of the same thread, but selected so that when the trimmer was fully open the "spindle" extended for ⅛in out of the box. The knob was fixed by a lock-nut and solder.

The set is easy to build and very inexpensive. Its musical qualities can be improved by the addition of a 0.001μF condenser across the primary of the output transformer.

Components

C_1	250pF (trimmer)
C_2	0.002μF
C_3	0.002μF
C_4	0.1μF
R_1	10kΩ
R_2	500kΩ
R_3	10kΩ
R_4	500kΩ
R_5	10kΩ
R_6	1MΩ pot with switch.
R_7, R_8	2MΩ
S_1	Sliding switch
S_2	Filament switch on pot
D	Any reliable diode
L_1	Repanco Crystal Set Coil
L_2	Output transformer to match 30Ω
V_1, V_2, V_3	CK507 AX



VIBRATOR BASING DATA

PART 3

Compiled by E. G. BULLEY

For base connections and key see July issue

Type	Base	1	2	3	4	5	6	7	Remarks
V5770	1	Blank	P1	P2	R	—	—	—	4 pin UX base
5310	1	R	P1	P2	Blank	—	—	—	4 pin UX base
T15S	1	R	P1	P2	Blank	—	—	—	4 pin UX base
7239124	1	R	P1	P2	Blank	—	—	—	4 pin UX base
903M	1	R	P1	P2	Blank	—	—	—	4 pin UX base
454	1	R	P1	P2	Blank	—	—	—	4 pin UX base
V5641	1	R	P1	P2	Blank	—	—	—	4 pin UX base
5312	2	R	P1	Blank	Blank	P2	Blank	—	6 pin UX base
5052374	2	R	P1	Blank	Blank	P2	Blank	—	6 pin UX base
PJ14S	2	R	P1	Blank	Blank	P2	Blank	—	6 pin UX base
2991	2	R	P1	Blank	Blank	P2	Blank	—	6 pin UX base
5313	1	R	P1	P2	Blank	—	—	—	4 pin UX base
5052378	1	R	P1	P2	Blank	—	—	—	4 pin UX base
T12	1	R	P1	P2	Blank	—	—	—	4 pin UX base
5314	1	R	P1	P2	Blank	—	—	—	4 pin UX base
350	1	R	P1	P2	Blank	—	—	—	4 pin UX base
8543	1	R	P1	P2	Blank	—	—	—	4 pin UX base
2041	1	R	P1	P2	Blank	—	—	—	4 pin UX base
1100	1	R	P1	P2	Blank	—	—	—	4 pin UX base
400	1	R	P1	P2	Blank	—	—	—	4 pin UX base
NP490	1	R	P1	P2	Blank	—	—	—	4 pin UX base
5320	1	R	P1	P2	Blank	—	—	—	4 pin UX base
324B	1	R	P1	P2	Blank	—	—	—	4 pin UX base
5042703	1	R	P1	P2	Blank	—	—	—	4 pin UX base
2685	1	R	P1	P2	Blank	—	—	—	4 pin UX base
J15ST	1	R	P1	P2	Blank	—	—	—	4 pin UX base
505P	1	R	P1	P2	Blank	—	—	—	4 pin UX base
464	1	R	P1	P2	Blank	—	—	—	4 pin UX base
NP64	1	R	P1	P2	Blank	—	—	—	4 pin UX base
5321	1	R	P1	P2	Blank	—	—	—	4 pin UX base
902M	1	R	P1	P2	Blank	—	—	—	4 pin UX base
5323	1	R	P1	P2	Blank	—	—	—	4 pin UX base
5324P	2	P1	P1	Blank	P2	P2	R	—	6 pin UX base
337	2	P1	P1	Blank	P2	P2	R	—	6 pin UX base
J16	2	P1	P1	Blank	P2	P2	R	—	6 pin UX base
506P	2	P1	P1	Blank	P2	P2	R	—	6 pin UX base
5325P	1	R	P1	P2	Blank	—	—	—	4 pin UX base
5326P	1	R	P1	P2	Blank	—	—	—	4 pin UX base
5327P	1	R	P1	P2	Blank	—	—	—	4 pin UX base
5330	1	R	P1	P2	Blank	—	—	—	4 pin UX base
5331	1	Blank	P1	P2	R	—	—	—	4 pin UX base
294SW	1	Blank	P1	P2	R	—	—	—	4 pin UX base
ZW37216	1	Blank	P1	P2	R	—	—	—	4 pin UX base
5333	1	R	P1	Blank	P2	—	—	—	4 pin UX base
338	1	R	P1	Blank	P2	—	—	—	4 pin UX base
7237666	1	R	P1	Blank	P2	—	—	—	4 pin UX base
2689	1	R	P1	Blank	P2	—	—	—	4 pin UX base
J9S	1	R	P1	Blank	P2	—	—	—	4 pin UX base
860	1	R	P1	Blank	P2	—	—	—	4 pin UX base
5334	1	R	P1	Blank	P2	—	—	—	4 pin UX base
345	1	R	P1	Blank	P2	—	—	—	4 pin UX base
T9S	1	R	P1	Blank	P2	—	—	—	4 pin UX base
7238685	1	R	P1	Blank	P2	—	—	—	4 pin UX base
2088	1	R	P1	Blank	P2	—	—	—	4 pin UX base
PJ7	1	R	P1	Blank	P2	—	—	—	4 pin UX base
870	1	R	P1	Blank	P2	—	—	—	4 pin UX base
436	1	R	P1	Blank	P2	—	—	—	4 pin UX base
402	1	R	P1	Blank	P2	—	—	—	4 pin UX base
NP487	1	R	P1	Blank	P2	—	—	—	4 pin UX base
5335	1	R	P1	Blank	P2	—	—	—	4 pin UX base
5339	1	R	P1	Blank	P2	—	—	—	4 pin UX base
5340M	1	R	P1	P2	Blank	—	—	—	4 pin UX base
5341M	1	R	P1	P2	Blank	—	—	—	4 pin UX base
5342	1	R	P1	P2	Blank	—	—	—	4 pin UX base
5343M	1	R	P1	P2	Blank	—	—	—	4 pin UX base
TU3S	1	R	P1	P2	Blank	—	—	—	4 pin UX base
5052378	1	R	P1	P2	Blank	—	—	—	4 pin UX base
5365	2	R	P1	internally connected to pin 2	internally connected to pin 5	P2	internally connected to pin 1	—	6 pin UX base
5052374	2	R	P1	internally connected to pin 2	internally connected to pin 5	P2	internally connected to pin 1	—	6 pin UX base
PJ14S	2	R	P1	internally connected to pin 2	internally connected to pin 5	P2	internally connected to pin 1	—	6 pin UX base
452	2	R	P1	internally connected to pin 2	internally connected to pin 5	P2	internally connected to pin 1	—	6 pin UX base
5400	2	P1	S1	Blank	Blank	S2	P2	—	6 pin UX base
5404	2	P1	S1	R	Blank	S2	P2	—	6 pin UX base
540	2	P1	S1	R	Blank	S2	P2	—	6 pin UX base
T69	2	P1	S1	R	Blank	S2	P2	—	6 pin UX base
8637	2	P1	S1	R	Blank	S2	P2	—	6 pin UX base
PJ69	2	P1	S1	R	Blank	S2	P2	—	6 pin UX base
954	2	P1	S1	R	Blank	S2	P2	—	6 pin UX base
734	2	P1	S1	R	Blank	S2	P2	—	6 pin UX base
SP633	2	P1	S1	R	Blank	S2	P2	—	6 pin UX base
5406	3	P2	S1	R	S2	P1	—	—	5 pin UX base
525	3	P2	S1	R	S2	P1	—	—	5 pin UX base
T63	3	P2	S1	R	S2	P1	—	—	5 pin UX base
5053183	3	P2	S1	R	S2	P1	—	—	5 pin UX base
2687	3	P2	S1	R	S2	P1	—	—	5 pin UX base
PJ57	3	P2	S1	R	S2	P1	—	—	5 pin UX base
289Y	3	P2	S1	R	S2	P1	—	—	5 pin UX base
781	3	P2	S1	R	S2	P1	—	—	5 pin UX base
SP72	3	P2	S1	R	S2	P1	—	—	5 pin UX base
QD6	3	P2	S1	R	S2	P1	—	—	5 pin UX base
5409	3	S1	P1	R	P2	S2	—	—	5 pin UX base
520	3	S1	P1	R	P2	S2	—	—	5 pin UX base
T61	3	S1	P1	R	P2	S2	—	—	5 pin UX base
5053185	3	S1	P1	R	P2	S2	—	—	5 pin UX base

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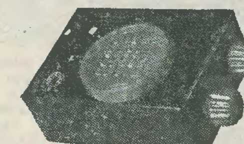
★  ★

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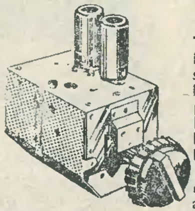

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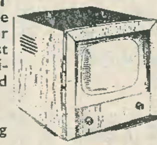

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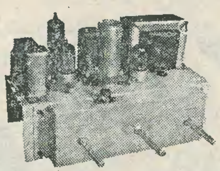

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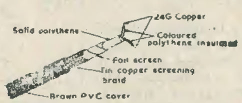

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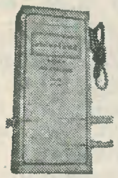

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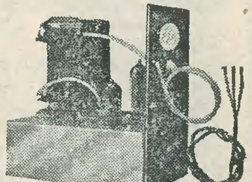

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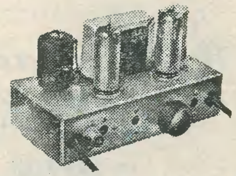

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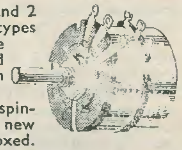

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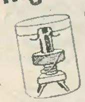

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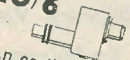

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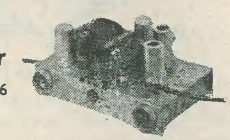

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EF40	12/6	PCL82	12/6	3Q4	9/–	50B5	10/–
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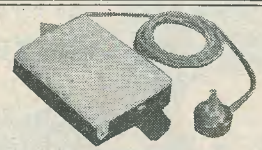

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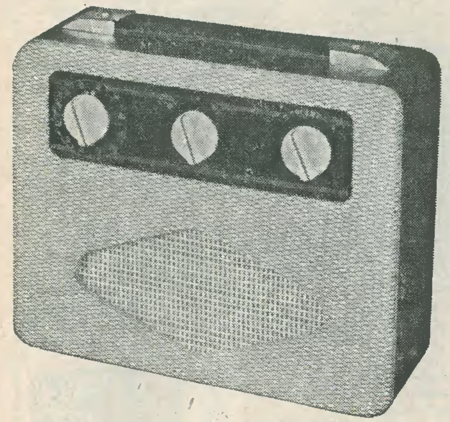

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As featured in August issue and described on page 28

"EAVESDROPPER"

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(No Aerial or Earth required)

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

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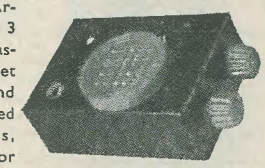

Total cost **89/6**

ALL PARTS SOLD SEPARATELY

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

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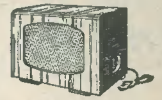

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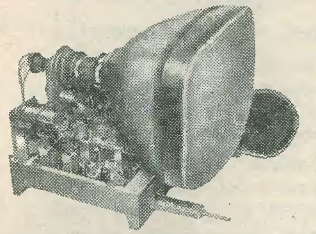

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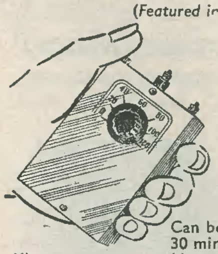
(Featured in June Issue)



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continued on page 143

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3Q5GT	9/6	6SQ7M	7/6	DF96	9/6	KT330	9/6
3Q4	8/6	6V6GT	8/6	DK96	9/6	PCC84	10/6
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5U4G	8/6	7B7	9/–	EABC80	10/–	PL83	10/6
5Y4G	6/6	7C5	9/–	EAF42	10/6	PCL83	12/6
6AC7M	5/–	7C6	9/–	EB34	2/6	PY80	9/6
6AG5	3/6	7S7	10/–	EB91	7/–	PY81	9/6
6AG7M	10/–	7Y4	8/6	EBC33	7/6	PY82	9/6
6AK5	5/–	12A6M	7/6	EBC41	10/6	R19	12/6
6AL5	7/–	12AT6	8/–	EBF80	10/–	SP61	3/–
6AM6	7/6	12AU6	9/–	EBF89	10/–	TT11	4/–
6AQ5	8/6	12AU7	8/6	ECC82	9/6	U25	12/6
6AT6	8/–	12AH8	12/6	ECC83	9/6	UAF42	10/6
6AU6	8/6	12BE6	8/6	ECC84	11/–	UBC41	10/6
6B8G	4/6	12C8M	7/6	ECC85	10/6	UBF89	10/6
6BA6	8/6	12J7GT	9/6	ECF80	13/6	UCC85	10/–
6BE6	7/6	12Q7GT	9/–	ECF82	11/6	UCH42	10/6
6BR7	11/6	12K7GT	9/–	ECH42	10/6	UF41	10/6
6C4	5/–	12SC7M	2/6	ECH81	10/–	UF89	10/6
6C5M	5/6	12SK7M	7/6	ECL80	10/–	UL41	10/6
6F6M	6/6	12SQ7M	8/6	EF36	4/–	UY41	8/–
6F8G	4/6	12SR7M	7/6	EF37A	8/6	UY85	10/–
6F13	12/6	35L6GT	9/6	EF39	5/–	UABC80	
6G6G	4/6	35Z4GT	8/6	EF41	10/6		10/6
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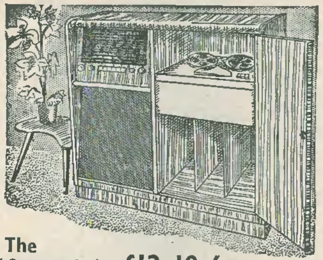

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3V4	8/6	6SS7	6/6	DL94	8/6	EL84	10/6
5U4G	8/6	6V6G	7/6	DL96	9/–	EL91	7/6
5Y4G	7/–	6V6GT	7/6	EA50	1/6	EY51	11/6
5Z4G	9/6	6X4	7/6	EB91	6/6	EZ35	8/–
6AG5	6/9	6X5GT	7/6	EBC41	9/6	EZ40	8/–
6AM6	8/6	12AT7	9/–	EBC33	8/6	KT33C	7/6
6AL5	6/6	12AU7	9/–	EBF80	10/–	KT66	11/6
6AT6	8/–	12AX7	9/–	ECC81	10/6	PCF82	11/–
6B8	7/6	12K8GT	10/6	ECC84	11/6	PL81	10/6
6B8G	7/6	12K7GT	8/6	ECF82	11/–	PL82	10/6
6BA6	8/6	12Q7GT	8/6	ECH81	10/6	PY81	10/6
6BE6	7/6	35Z4GT	8/6	ECH42	10/–	PCC84	11/6
6BR7	10/6	35L6GT	9/6	ECL80	10/6	U76	8/6
6BW6	8/6	807	6/9	EF36	7/6	UBC41	10/–
6G6G	4/9	5763	10/6	EF37A	14/6	UCH42	10/–
6J5G	5/6	DAF91	7/6	EF39	5/6	UF41	10/–
6J5GT	6/6	DAF96	9/–	EF41	10/–	UL41	10/–
6K7G	5/6	DF91	7/6	EF80	9/6	UY41	8/–
6K8G	9/6	DF96	9/–	EF85	10/6	W76	8/6
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SMALL ADVERTISEMENTS

continued from page 141

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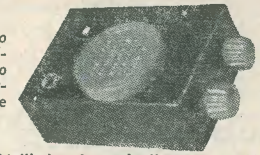

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