THE Radio Constructor

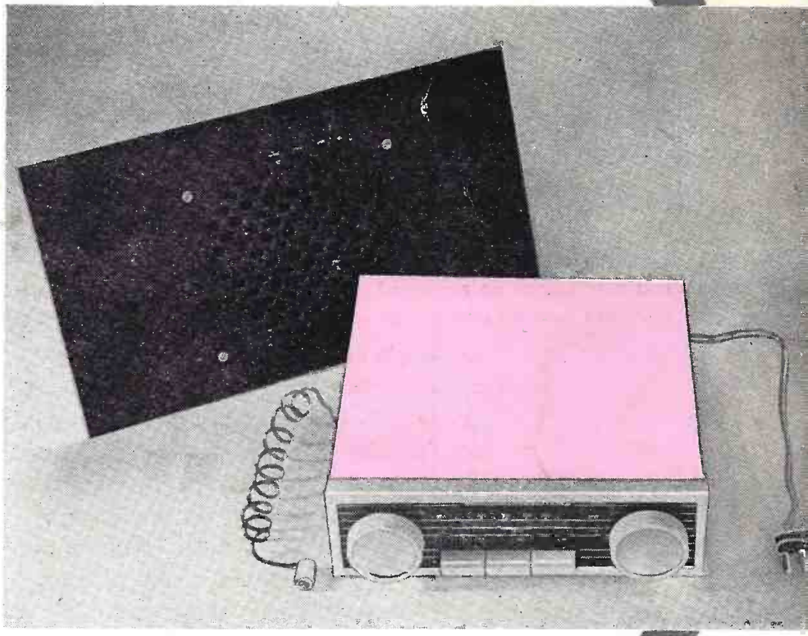
RADIO
TELEVISION
AUDIO
ELECTRONICS

VOLUME 15 NUMBER 12
A DATA PUBLICATION
PRICE TWO SHILLINGS

July 1962

"Highwayman" Transistorised Car Radio

● Experimental Remote Control with Capacitive "Memory" ● 2-Valve Stereo Amplifier ● Transistorised Single Sideband Transmitter ● The Nomotron ● Test Instruments Need Testing ● Certification of High Fidelity Amplifiers



Announcing —

the NEW EDDYSTONE '940'

H.F. COMMUNICATIONS RECEIVER

This new Eddystone receiver has been produced for the Professional and serious Amateur. It has a large number of attractive features that will be highly appreciated in operational working including:

★ Single conversion superhet covering 480 kc/s to 30 Mc/s in 5 switched bands
★ 2 R.F. stages and 2 I.F. stages including phased crystal filter
★ 1st R.F. is of cascode type resulting in excellent noise and cross modulation figures
★ Precision gear drive, flywheel loaded, and an adequate degree of mechanical bandspread
★ High selectivity and excellent signal-to-noise ratio
★ A high degree of frequency stability
★ Suitable for C.W., A.M., SSB reception
★ Push-pull output stage with excellent quality of reproduction
★ Modern styling in two-tone grey finish, with the alternative of rack mounting fittings suitable for 19in rack

Suitable for operation from 110/125 and 200/250 volts, 40/60 cycle with built-in power and stabiliser

£125

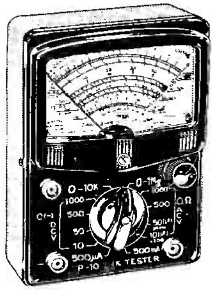
STRATTON & CO. LTD · BIRMINGHAM 31 · ENGLAND

SUPERB COMMUNICATION RECEIVERS

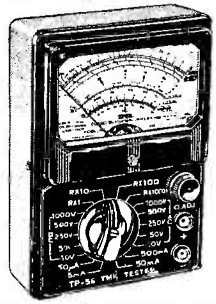
AMERICAN AR88D RECEIVERS. Fresh release of these renowned sets. 14 valves, 6 wavebands, covering 500 kc/s–32 Mc/s. Incorporate every possible refinement and have internal A.C. mains pack for nominal 115/230V. Thoroughly reconditioned, immaculate in appearance, and in perfect working order. ONLY **£35** (add carriage 30/- and 50/- deposit on returnable transit case). S.A.E. brings illustrated leaflet.

MARCONI CR. 100/8 COMMUNICATIONS RECEIVER. Covers 60 kc/s to 30 Mc/s. Complete with all valves, maker's instruction manual, and internal A.C. power unit for 200/250 volts. BRAND NEW IN ORIGINAL TRANSIT CASES. Aerial tested before despatch. ONLY **£35** (carr. etc., 40/-). S.A.E. for full details.

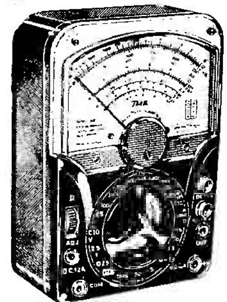
TEST METERS FOR EVERY PURPOSE & POCKET



2,000 O.P.V. MODEL TP-10. Reads A.C. and D.C. volts up to 1,000; D.C. Current to 500mA; resistance to 1 Meg; Capacitance to 1µF; Decibels from —20 to +36; Output jack for Audio Measurements. Size 3½" x 5" x 1½".
£3.19.6



20,000 O.P.V. MODEL TP-5S. Reads Voltage up to 1,000; D.C. at 20,000 ohms per volt and A.C. at 10,000 o.p.v.; D.C. Current to 500mA; Resistance to 10 Meg.; Capacitance to 0.1µF; Decibels from -20 to +36. Size 3½" x 5¼" 1¾".
£5.19.6



30,000 O.P.V. MODEL 500. Volts to 1,000: D.C. at 30,000 o.p.v., A.C. at 20,000; 12 Amps D.C. Current; 60 Meg. Resistance; —20 to +56 Decibels; Internal buzzer short circuit warning. Size 3$\frac{5}{16}$" x 6$\frac{5}{16}$" x 2¼".
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All new stock, with leads, prods & internal batteries. 6 mths. guar. backed by full service facilities. Details S.A.E.

AMPLIFIER TYPE A1413. Ex-R.A.F. For normal A.C. mains use. 5Z4 rectification with 6V6 output. Input and output jack sockets, gain control, fully fused. 600 ohms output transformer, easily changed for 3 ohms type. Standard rack mounting size 19" x 7" x 6". Used, good condition. ONLY **59/6** (carriage, etc., 10/6).

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12 VOLT AMERICAN DYNAMOTORS. Deliver 220 volts at 100mA. Size 5½" x 3½" diameter. Ideal for running Electric Shaver, etc., from car battery. ONLY **32/6** (post 2/6).

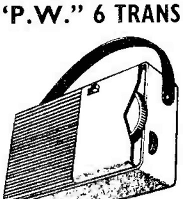
B.C. 221 FREQUENCY METERS. The famous American crystal controlled, portable frequency measuring standard. Coverage 125 kc/s–20 Mc/s. With original calibration book. Perfect order. Illustrated details on request. ONLY **£16.**

PCR COMMUNICATION RECEIVERS

Manufactured by **Pye and Philips.** One of the Army's most versatile and sensitive sets. RF stage and 2 of IF, using 6 British I.O. type valves. Large 180 degrees. Illuminated and Calibrated Dial. Flywheel tuning with locking device. Aerial trimmer. Tone and volume controls. Band switch from panel jacks for speaker or phones. In black metal case, size 17" L x 8" H x 10" D. Model PCR covers 6–18 Mc/s, 200–550 metres and 850–2,000 metres and has internal 5" speaker. REME reconditioned as new. **£6.19.6. Model PCR2** has similar L & M waveband coverage. Short wave 6–22 Mc/s, but no speaker. Used but excellent condition, **£5.19.6.** Every receiver aerial tested before despatch. Add 10/6 carr. all models. Designed to operate from bulky EXTERNAL power supply, but any set can be fitted with BRAND NEW COMPONENTS INTERNAL PACK for 200/250V a.c. at extra cost of **£2.**

S.A.E. FOR ILLUSTRATED LEAFLET

"P.W." 6 TRANSISTOR PERSONAL RECEIVER

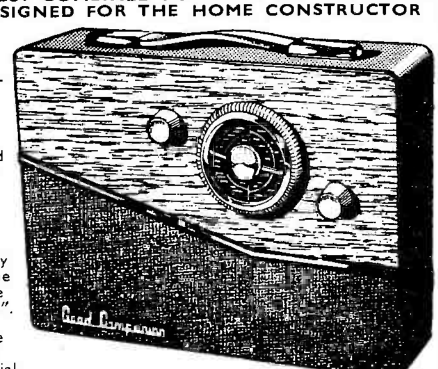


Designed by the technical staff of *Practical Wireless*: easy to build, using printed circuit and 1st grade Matched Transistors and Diode. Full Medium and Long Wave coverage to internal speakers. All parts sold separately (new components only) enabling you to buy as required, and full detailed price list will be sent on request. Constructional details 1/6. Newly designed OSMOR Cabinet and reduced price. TOTAL COST INCLUDING BATTERY AND CABINET NOW **£8.10.0.** S.A.E. for 7 transistor version.

THE "GOOD COMPANION" Mk. II

Using transfilters, the latest manufacturing technique to save alignment difficulty.

THE FINEST COMBINED PORTABLE and CAR RADIO YET DESIGNED FOR THE HOME CONSTRUCTOR



★ 750mW output.

★ 6 transistors and 2 diodes.

★ Full Medium and Long Wave coverage.

★ Quality speaker.

★ Brilliantly styled 2-tone cabinet, size 11" x 8" x 3".

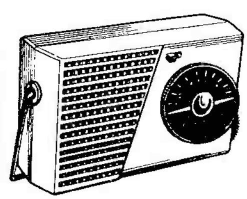
★ Very fine tuning with calibrated dial.

★ Latest printed circuit. ★ Internal high gain aerial with car aerial socket. Easy to follow construction data (available separately 3/6). All parts sold separately and full illustrated details will be sent on request.

Total Cost **£9.19.6**

With alternative luxury cabinet using 7" x 4" speaker, **£10.19.6.** Either type, plus 5/- post and ins. (Battery 3/6 extra.)

"POCKET 4" TRANSISTOR RECEIVER



Uses miniature speaker, proper tuning condenser, and volume control. Built-in aerial makes unit efficient and portable. Ideal for the beginner. Full medium wave coverage. All components and case for only **42/6** (p. & p. 2/6). Ten-page constructional book free with parts or separately 1/6. S.A.E. for parts price list.

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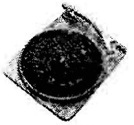
"GLOUCESTER"

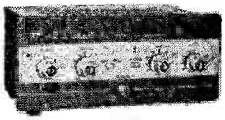
Our four equipment cabinets meet a wide variety of tastes and requirements: the "CHEPSTOW" was designed for those who have little floor space, the contemporary "MALVERN" for the Tape and Gram. enthusiast, and the "GLOUCESTER" Mk. I and II for those with traditional tastes. All parts are pre-cut and drilled for easy assembly, and left "in the white".
Prices from **£11.12.6** to **£18.10.0**

TRANSCRIPTION RECORD PLAYER (STEREO). Manufactured by Goldring-Lenco. This 4-speed unit is fitted with a G60 pick-up arm. Infinitely variable speed adjustment from $33\frac{1}{3}$ to 80 r.p.m. Fixed speed of 16 r.p.m. Its balanced turntable ($3\frac{3}{4}$ lb) reduces rumble, wow and flutter to very low level. The unique lowering device fitted provides absolutely safe means of placing pick-up on record **£19.12.6**



GL-58

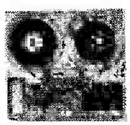
6W STEREO AMPLIFIER, Model S-33. 3 watts per channel, 0.3% distortion at 2.5 w/chnl., 20dB N.F.B. Inputs for Radio (or Tape) and Gram., Stereo or Monaural, ganged controls. Sensitivity 100mV. **£12.8.6**



S-33

AT LOWEST PRICES

TRUVOX D83 & D84 TAPE DECKS. High quality mono/stereo tape decks.
D83, 2 track, for highest fidelity. **£31.10.0**
D84 (identical presentation), 4-track, for most economical use of tape. **£29.8.0**



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COLLARO "STUDIO" TAPE DECK. The finest buy in its price range. Operating speeds: $1\frac{7}{8}$, $3\frac{3}{4}$ and $7\frac{1}{2}$ i.p.s. Two tracks. "Wow" and "flutter" not greater than 0.15% at $7\frac{1}{2}$ i.p.s. Long Term Speed Stability better than 0.5%. **£17.10.0**

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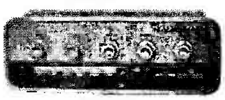
TAPE RECORDING AND REPLAY HI-FI AMPLIFIER

Mono model TA-1M, Stereo model TA-1S. For use with most tape decks. Thermometer type recording indicators, press-button speed compensation and input selection, 3-position bias level and printed circuit construction.

TA-1S

TA-1M	£18. 2.6
TA-1M & Collaro STUDIO	£30.10.0
TA-1M & TRUVOX D83 ...	£47. 2.6
TA-1M & TRUVOX D84 ...	£45. 5.0
TA-1S	£23. 6.0
TA-1S & STUDIO	£35.14.0
TA-1S & TRUVOX D83 ...	£52. 6.0
TA-1S & TRUVOX D84 ...	£50. 9.6

STEREO CONTROL UNIT, Model USC-1. Push-button selection, accurately matched ganged controls to ±1dB. Negative feedback, rumble and variable low-pass filters. Printed circuit boards. **£18.18.6**



USC-1

FINEST ELECTRONIC KITS IN THE WORLD

VALVE VOLTMETER. Model V-7A 7 voltage ranges d.c. volts to 1,500 a.c. to 1,500 r.m.s. and 4,000 peak to peak. Resistance 0.1Ω to 1,000MΩ with internal battery. D.C. input impedance 11mΩ. dB measurement has centre-zero scale. Complete with test prods, lead and standardising battery. **£13.0.0**

V-7A

MULTIMETER. Model MM-1U. Ranges 0–1.5V to 1,500V A.C. and D.C.; 150μA to 15A D.C.; 0.2Ω to 20MΩ. $4\frac{1}{2}$" 50μA meter. **£11.18.6**

MM-1U

R.F. SIGNAL GENERATOR. Model RF-1U. Up to 100 Mc/s fundamental and 200 Mc/s on harmonics and up to 100mV output on all bands. **£11.18.0**

AUDIO WATTMETER. Model AW-1U. Up to 25W continuous, 50W intermittent. **£14.14.0**

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AUDIO SINE-SQUARE WAVE GENERATOR. Model AO-1U. Covers 20 c/s to 150 kc/s and square waves to 50 kc/s in four ranges. Maximum output 10V, distortion less than 1%. **£12.18.6**

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HI-FI SPEAKER SYSTEM. Model SSU-1. Ducted-port bass reflex cabinet "in the white". Twin speakers. With legs **£11.15.0.** **£10.14.0**

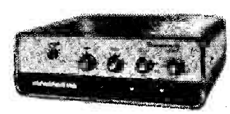
SSU-1

HEATHKIT ELECTRONIC WORKSHOP, Model EW-1. This educational kit will teach and amuse your children. It can make 21 exciting experiments including transistor radios, burglar alarm, radio or TV silencer, intercom., etc. **£7.18.0**

UJR-1

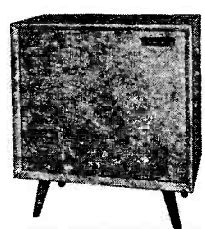
JUNIOR TRANSISTOR RADIO, Model UJR-1. Single transistor set. Excellent introduction to radio. An instructive present. **£2.13.6**

HI-FI STEREO AMPLIFIER, Model S-99. 18W output. Ganged controls. Stereo/mono gram., radio and tape recorder inputs. Push-button selection. Printed circuit construction. **£26.19.0**



S-99

THE "COTSWOLD". This is an acoustically designed enclosure 26" x 23" x $15\frac{1}{2}$" housing a 12" bass speaker with 2" speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 32–20,000 c/s. Capable of doing justice to the finest programme source, its polar distribution makes it ideal for really Hi-Fi Stereo. Delivered complete with speakers, cross-over unit, level control, Tygan grille cloth, etc. All parts pre-cut and drilled for ease of assembly and left "in the white" for finish to personal taste. **£21.19.0**



THE "COTSWOLD"

All prices include free delivery U.K.—Deferred terms available over £10

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FULL DETAILS OF MODEL(S) ....

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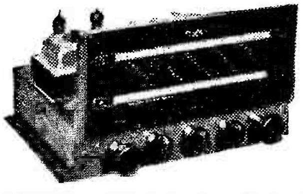
WORLD'S LARGEST-SELLING ELECTRONIC KITS

ARMSTRONG AF 208 AM/FM RADIOGRAM CHASSIS



★ Full VHF Band (87–108 Mc/s.) and Medium Band, 187–570M. ★ 7 Valves ★ 5 Watts Output ★ 15dB Negative Feedback ★ Separate wide range Bass and Treble Controls ★ 2 Compensated Pick-up Inputs ★ Frequency Response 30–22,000 c.p.s. ★2dB ★ Tape Record and Playback Facilities ★ Continental Reception of Good Programme Value ★ For 3, 7½ and 15 ohm speakers. Send S.A.E. for leaflet.

Price **£22.18.0** Carr. Free

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

Acos Hi-Fi Pick-up for LP. and/or 78, 7", 10" and 12" records. Silent motor, heavy turntable, auto stop. Completely assembled on base plate. **£6.5.0** post free

SINGLE PLAYER BARGAIN

Ready built complete with B.S.R. TU9 4-speed Gram Pick-up unit. Handsome portable case. 3-watt amplifier with 2 valves and speaker.

Our Price £8. 19. 6.

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DK96, DF96, DAF96, DL96 8/- each or 29/6 set.
1R5, 1T4, 1S5, 3S4 or 3V4 Set of four 19/6

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1/350v.	2/-
2/350v.	2/3
4/450v.	2/3
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16/450v.	3/-
32/450v.	3/9
25/25v.	1/9
50/25v.	2/-
50/50v.	2/-

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50/350v.	5/6
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8+16/450v.	3/9
16+16/450v.	4/3
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16/450v.	5/-
32/350v.	4/-
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5,000/6v.	5/-
32+32/350v.	5/-
32+32/450v.	6/-
32+32+32/350v.	7/-
50+50/350v.	7/-
64+120/350v.	11/6
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QUALITY 2-STAGE HI-FI AMPLIFIER

A.C. only, 200–250V Valves ECL82 and EZ80. 3 watt quality output. Mullard tone circuits, bass boost, treble and volume controls. Separate engraved front-panel with de-luxe finish. Heavy duty output transformer 3 ohm. Shrouded mains transformer. Stove enamelled chassis size 6in. x 5in. x 3in. **Bargain price £4.10.0.** Circuit supplied.

COMPLETE RADIO CHASSIS
£4.19.6 post free

4 Mullard valves, 5" speaker, frame aerial. 4 pre-set stations. 1 long, 3 med. wave.
Superhet Circuit.
Size 9" x 6" x 5½" high. Tested ready for use. 200/250V A.C.–D.C. Mains. **Brand New**

DE LUXE MODEL

As above but with illuminated dial. Fully tunable over medium wave 200–550 M and long wave 1,000–2,000 M.

Bargain Price £5.19.6

MAINS TRANSFORMERS
200/250 AC Post 2/- each

STANDARD 250–0–250, 80 mA., 6.3 v. tapped 4 v. 4 a., Rectifier 6.3 v. 1 a. tapped 5 v. 2 a. and 4 v. 2 a. 22/6
Ditto 350–0–350 ... ... 29/6
MINIATURE, 200 v. 20 mA., 6.3 v. 1 a. 10/6
MIDGET, 220 v. 45 mA., 6.3 v. 2 a. ... 15/6
SMALL, 220–0–220 v. 50 mA., 6.3 v. 2 a. 17/6
STANDARD, 250–0–250 65 mA., 6.3 v. 3.5 a. 17/6
HEATER TRANS., 6.3 v. 1½ a. ... 7/6
Ditto 6.3 v. 3 a. 10/6
Ditto 1.4, 2, 3, 4, 5, 6.3 v. 1½ a. 8/6
MULLARD "510" OSRAM "912", 300–0–300, 120 mA, 6.3 v. 4 a. c.t., 6.3 v. 2 a. tapped 5 v. 38/6
GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 a. 22/6
AUTO. TRANS. 150 w., 0, 10, 120, 200, 230, 250 v. 22/6
AUTO. TRANS. 500 w., 0, 115, 200, 230, 250 v. 82/6

O.P. TRANSFORMERS. Heavy duty 50 mA, **4/6.** Miniature 3V4, etc., **5/9.** Small, pentode, **4/6.** Multi-ratio push-pull, **7/6.** Multi-ratio push-pull 10 w., **15/6.** Goodmans heavy duty 10/20 w. 6K push-pull, **30/–**; Estone ultra-linear OT/ML 10 w. **45/–.**

L.F. CHOKES 15/10 H. 60/65 mA, **5/–**; 10 H. 85 mA, **10/6**; 10 H. 120 mA, **12/6**; 10 H. 150 mA, **14/–**

TELEVISION REPLACEMENTS
Line Output Transformers
from **45/-** each, NEW Stock
and other timebase components
Most makes available. S.A.E. with all enquiries

FULL WAVE BRIDGE CHARGER RECTIFIERS. 2, 6 or 12 v. 1½a., **8/9**; 2 a., **11/3**; 4 a., **17/6.** Free charger circuit.

CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v. 1½ a., **15/6**; 2 a., **17/6**; 4 a., **22/6.**

4 AMP. CAR BATTERY CHARGER with amp. meter Leads, Fuse Case, etc., for 6 v. or 12 v., **69/6.**

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Master Colour Code	1/6

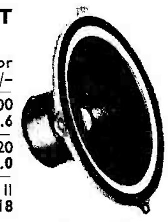
TINNED COPPER WIRE 16 to 22 swg. ¼ lb. **3/–**
COPPER ENAMEL WIRE ¼ lb. 16 to 22 s.w.g **2/9**, 24 to 30 s.w.g. **3/6**, 32 to 40 s.w.g. **4/6**

CRYSTAL MIKE INSERT 6/6
Precision engineered. Size only 1½" dia. x ⅜"

ACOS STICK MIKE 39-1 ... ... 35/–
T.S.L. DE LUXE STICK MIKE ... 25/–

SPEAKER FRET. Gold cloth, 17in. x 25in., **5/–**; 25in. x 35in., **10/-.** **TYGAN,** various colours, 52in. wide, from **10/–** ft.; 26in. wide from **5/–** ft. Samples S.A.E. Expanding Metal, Gold, 12in. x 12in., **6/–**

BAKER SELHURST LOUDSPEAKERS



12" Baker 15W Stalwart 3 or 15Ω, 45–13.000 c.p.s. **90/–**

12" Stereo 12W, 35–16,000 c.p.s. Foam suspension **£6.17.6**

12" Baker Ultra Twelve, 20 c.p.s. to 25 kc/s **£17.10.0**

15" Auditorium, Bass Mk II 35W 20 c.p.s. to 12 kc/s. **£18**

LOUDSPEAKERS P.M. 3 OHM. 2½in. 3in. 4in.-19/6; 5in. Rola, **17/6**; 7in. x 4in., **18/6**; 4in. Hi-Fi Tweeter, **25/–**; 8in. Plessey, **19/6**; 6½in. Goodmans, **18/6**; 10in. R.A., **30/–**; 12in. Plessey, **30/–**; 10in. x 6in. E.M.I. **27/6**; E.M.I. 13½" x 8" 45/–; Stentorian HF1012 10in., **95/–**; HF1016, £8. 12 in. R.A. 15Ω45/-.

CRYSTAL DIODES. G.E.C., **2/–**; GEX34, **4/–**; OA81, OA70, **3/–**. Crystal Coils HAX, **3/–**. DRR2, **4/–**.

CRYSTAL SET BOOKLET 1/–.

H.R. HEADPHONES, 4,000 ohms, brand new, **15/–** pair. Low resistance phones, **7/6** pair, **SWITCH CLEANER FLUID,** squirt spout. **4/6** tin.

C.R.T. BOOSTER TRANSFORMERS

For Cathode Ray Tubes having heater cathode short circuit and for C.R. Tubes with falling emission, full instructions supplied.

TYPE A. LOW LEAKAGE WINDINGS. OPTIONAL 25% and 50% BOOST ON SECONDARY: 2 V. OR 4 V. OR 6.3 V. OR 10.3 V. OR 13.3 V. WITH MAINS PRIMARIES. 10/6.

TWIN GANG CONDENSERS. Transistor 208 pF and 176 pF, with trimmers and screen, **12/6** each; 365 pF, miniature, 1⅞in. x 1½in. x 1¾in., **10/–**; 500 pF standard with trimmers, **9/–**; midget, **7/6**; midget with trimmers, 9/–.

SHORT WAVE. Single 10pF, 25pF, 50pF, 75pF, 100 pF, 160 pF, **5/6** each.

TUNING AND REACTION CONDENSERS. 100 pF, 300 pF, 500 pF, **3/6** each, solid dielectric.

CONDENSERS. 0.001 mfd. 7kV T.C.C., **5/6**; ditto 20 kV., **9/6**; 0.1 mfd. 7 kV., **9/6**; 100 pF to 500 pF Micas, **6d.**; Tubular 500 v. 0.001 to 0.05, **9d.**; 0.1, **1/–**; 0.25, **1/6**; 0.1/350 v., **9d.**; 0.5/500 v., **1/9**; 0.01/2,000 v., **1/9**; 0.1/2,000 v., **3/6.**

CERAMIC CONDENSERS. 500 v. 0.3 pF to 0.01 mfd., **9d.** 0.1/30v., **1/3.**

SILVER MICA. 10% 5 pF to 500 pF, **1/–**; 600 pF to 3,000 pF, **1/3**; close tolerance (plus or minus 1 pF), 1.5 pF to 47 pF, **1/6**; ditto 1% 50 pF to 815 pF, **1/9**; 1,000 pF to 5,000 pF, **2/–.**

465 Kc/s. SIGNAL GENERATOR. Total cost **15/–**. Uses B.F.O. Unit ZA 30038 ready made. **POCKET SIZE** 2½in. x 4½in. x 1in. Slight modifications required, full instructions supplied. Battery 8/6 extra 69 v. + 1½ v. Details S.A.E.

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2 p. 2-way, or 2 p. 6-way, long spindle **3/6**
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Wavechange **"MAKITS".** Wafers available: 1 p. 12 wafer, 2 p. 6 wafer, **3** p. 4 wafer, 4 p. 3 wafer, 6 p. 2 wafer. 1 wafer, **8/6**; 2 wafer, **12/6**; 3 wafer, **16/–**. Additional wafers up to 14, **3/6** each extra.

TOGGLE SWITCHES, s.p., **2/–**; d.p., **3/6**; d.p.d.t., **4/–**. **Rotary Toggles,** s.p., **3/6**, d.p., **4/6.**

JACKS. English open-circuit **2/6**, closed-circuit **4/6**, Grundig-type 3-pin **1/3**

JACK-PLUGS. English **3/-**, Screened **4/–**, Grundig 3-pin **3/6.**

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Our written guarantee with every purchase. Buses 133 or 68 pass door. S.R. Stn. Selhur

VOLUME CONTROLS

Long spindles. Midget 5K ohms to 2 Meg.

No. sw.	D.P. Sw
3/-	4/6

Linear or Log Tracks.

80 ohm CABLE Coax

Semi-air spaced ¼in. Stranded core, 6d. yd. 40 yds. 17/6; 60 yds. 25/-

Fringe Quality, Air Spaced 1/- yd.

EXTENSION SPKR. CONTROL 10 Ohm 3/-.
TELESCOPIC CHROME AERIALS 13in. extending to 43in. 8/6 each.
RESISTORS. Preferred values. 10 ohms to 10 meg. ¼ w., 4d.; ½ w., 4d.; 1 w. 6d.; 1½ w. 8d.; 2 w. 1/-.
HIGH STABILITY. ½ w. 1%, 2/-. Preferred values. 10 ohms to 10 meg. Ditto 5%, 100 ohms to 5 meg. 9d.

WIRE-WOUND RESISTORS
25 ohms- 10,000 ohms

5 watt	1/3
10 watt	1/6
15 watt	2/-
12.5K to 50K 10 w	3/-

I.F. TRANSFORMERS 7/6 pair
465 kc/s Slug Tuning Miniature Can. 2in. x 1in. x 1in. High Q and good band width. Data sheet supplied.

WIRE-WOUND Pots. 3 WATT. Pre-set Min. TV Type. All values 10 ohms to 25K, 3/- ea.; 30K, 50K, 4/-. Carbon 30K to 2 meg., 3/-

WIRE-WOUND 4 WATT POTS. Long Spindle, Values, 50 ohms to 50K, 6/6; 100K, 7/6.

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COAXIAL PLUGS, 1/-. **PANEL SOCKETS,** 1/-
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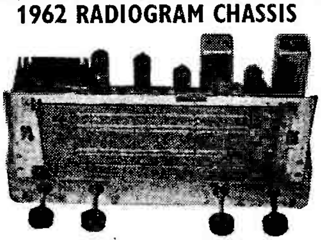
1962 RADIOGRAM CHASSIS



Three Wavebands
S.W. 16 m.–50 m.
M.W. 200 m.–500 m.
L.W. 800 m.–2,000 m.

Five Valves
Latest Mullard
ECH81, EF89, EBC81, EL84, EZ80

12-month Guarantee. A.C. 200-250V, 4-way switch. Short-Medium-Long-Gram. A.C.C. and Negative Feedback, 4.2 watts. Chassis 13½" x 5½" x 2¼". Glass dial size 10" x 4½", horizontal or vertical. Two Pilot Lamps. Four Knobs, Walnut or Ivory. Aligned and calibrated. Chassis isolated from mains.

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Matched Speakers 8" 17/6; 10" 25/–; 12" 30/–

BLACK CRACKLE PAINT. Air drying, 3/- tin.
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Tuneable channels 1 to 5. Gain 18 dB. ECC84 valve. Kit price 29/6 or 49/6 with power pack. Details 6d. (PCC84 valves if preferred.)
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MINIATURE CONTACT COOLED RECTIFIERS. 250 v. 50 mA, 7/6; 250 v. 60 mA, 8/6; 250 v. 85 mA. 9/6. 200 mA. 21/–; 300 mA. 27/6. Full Wave Bridge 250v. 75mA. 10/-. 120mA. 15/-.
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FERRITE ROD AERIALS. M.W., 8/9; M. & L., 12/6.
FERRITE ROD AERIALS. L & M. for transistor circuits, 10/- each. **FERRITE RODS** 8in. x ⅜in., 3/-. 8in x $\frac{5}{16}$in. 3/-. 6in. x ¼in., 3/-.

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H.F. CHOKES, 2/6. Osmor QC1 6/9.
T.R.F. COILS A/HF, 7/– pair; HAX, 3/–, DRR2, 4/–.
ALADDIN FORMERS and cores. ¼in. 8d., ⅜in. 10d.
0.3in. FORMERS 5937 or 8 and cans TV1 or 2, ½in. sq. x 2½in. or ⅜in. sq. x 1½in., 2/– with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6-1, 2/3.
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PRECISION Sub-miniature Iron. 200 or 240 v, 29/6:

4 TRANSISTOR PUSH-PULL AUDIO AMPLIFIER

Size 3 x 1¾ x ⅞

A ready built miniature push-pull amplifier with input and output transformers, 4 transistors. Ideal for use with record players, intercoms, etc. Complete with full instructions and circuit.

PRICE 52/6 9v Batt. 2/3. 2½" SPEAKER 15/–

MAINS DROPPERS. Midget. With adj. sliders. 0.3A, 1,000 ohms 5/–; 0.2A 1,200 ohms, 5/–; 0.1A 2,000 ohms. 5/–.
LINE CORD. 0.3 A 60 ohms per foot, 0.2 A 100 ohms per foot, 2-way, 1/– per foot; 3-way 1/– per foot.
MIKE TRANS. 50:1, 3/9.
P.V.C. CONN. WIRE, 8 colours, 2d. yd.
SLEEVING, 1 or 2 mm, 2d.; 4 mm, 3d.; 6 mm, 5d. yd.

AMERICAN "BRAND FIVE" PLASTIC RECORDING TAPE

			Spare Plastic Reels	
Double Play	7" reel, 2,400 ft.	60/–		
	5" reel, 1,200 ft.	37/6		
Long Play	7" reel, 1,800 ft.	35/–	3"	1/6
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	5" reel, 900 ft.	18/6	5"	2/–
Standard	7" reel, 1,200 ft.	25/–	5¾"	2/–
	5" reel, 600 ft.	16/–	7"	2/6

"Instant" Bulk Tape Eraser and Head Defluxer, 200/250V A.C. 27/6. Leaflet S.A.E.

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The cutter consists of four parts: a die, a punch, an Allen screw and key.
½" 14/6, ⅝" 14/9, ¾" 15/6, ⅞" 15/9, 1" 17/6, 1⅛" 17/6, 1⅜" 20/–, 1½" 20/6, 1¾" 22/6, 2" 34/3, 2$\frac{3}{32}$" 37/9, 2½" 44/3, 1" square 31/6, $\frac{11}{16}$" square 28/–.

"REGENT" 4 VALVE
"96" RANGE VALVES

Kit Price
£6.6.0
carr. 4/–

PRINTED CIRCUIT BATTERY PORTABLE KIT

Medium and long wave. 7 x 4 in. Speaker. Printed Circuit. Components clearly identified with assembly instructions. Ferrite Aerial. Rexine covered cabinet. Size 12 in. x 8 in. x 4 in. Batteries used B126 (L5512) and AD35 (L5040), 10/9 extra. Instructons 9d. (free with kit).

MONARCH RECORD PLAYER

BUILD IT YOURSELF using 4-SPEED BSR MONARCH AUTOCHANGER READY BUILT 3W AMPLIFIER, HANDSOME PORTABLE CASE. HIGH FLUX LOUDSPEAKER. FULL INSTRUCTIONS

Total Price
Carr. and ins. 5/– **£12.10.0**

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Amplifier player cabinets with cut boards. 63/–. 2-valve amplifier and 6½ speaker for above, ready mounted on baffle, 12in. x 7in., 3in. deep, *Wired and tested ready for use.* **£4.15.0.**

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D239, 4.5:1 Driver, ⅝in. x ½in. x ½in., 10/–.
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DEAF AID EARPIECE Xtal or magnetic 7/6.

WEYRAD
COILS AND TRANSFORMERS FOR A 2-WAVE TRANSISTOR SUPERHET WITH PRINTED CIRCUIT AND FERRITE ROD AERIAL

Long and Medium Wave Aerial—RA2W. On 6in. rod, $\frac{7}{16}$in. diameter, 208 pF. tuning, 12/6. Oscillator Coil P50/1AC. Medium wave. For 176 pF. tuning, 5/4. Car aerial coil 1/-. 1st and 2nd I.F. Transformer—P50/2CC. 470 kc/s, $\frac{11}{16}$in. diameter by ⅞in. high, 5/7. 3rd I.F. Transformer—P50/3CC, to feed diode detector, 6/–. 24-Fixed resistors 10/6. Driver Transformer—LFDT2, 1$\frac{3}{16}$in. x ⅞in. x 1½ in., 9/6. 16-Fixed condensers 21/–. Printed Circuit—PCA1. Size 2¾in. x 8¼in. Ready drilled and printed with component positions, 9/6. Jackson 00 gang 12/6. 35 ohm Speakers, 7in. x 4in., 25/–, 3½in., 19/6. Wavechange Swtch 3/6. Volume Control 4/6. Set of 6 Mullard Transistors and diode, 42/6. These components are approved by transistor makers and performance is guaranteed. Constructor's Booklet with full details, 2/–.

NEW MULLARD TRANSISTORS

Audio OC71	...	6/–	R.F. OC44	...	8/9
OC72	...	7/6	OC45	...	8/6

Sub-miniature Electrolytics (15 V). 1 mfd. 2 mfd., 4 mfd., 5 mfd., 8 mfd., 16 mfd., 25 mfd., 30 mfd., 50 mfd., 100 mfd., 2/6.
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B.B.C. 2 Transistor. M.W. and L.W. Radio Kit, 22/6. Earpiece, 7/6. Battery 2/3.

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First-class components to make a 6-transistor 2-waveband superhet chassis. Ideal for portable or table radio. All parts including BVA transistors ferrite aerial, printed circuit, 8⅛in. x 2¾in., but EXCLUDING speaker and cabinet. Simple instructions, 1/6 (Free with kit). 35 ohm 7in. x 4in. Speaker 25/– extra. **£4.5.0**

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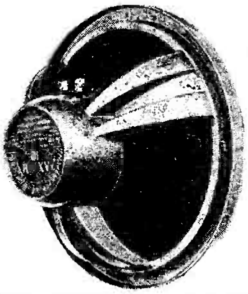

TWO NEW GOODMANS SPEAKERS

AXIETTE 8"

6 watts 15 ohms die-cast chassis with latest FEROBA 11 high-flux magnet. Price now **£5.4.6.** post 1/6.

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10 watts 15 ohms 10" die-cast chassis with new FEROBA 11 high-flux magnet. Price now **£5.16.8** post 1/6.

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Have you tried CEIBALINE? This is the new super sound-absorbent material with self-adhesive backing designed for internal lining the inside surfaces of loudspeaker enclosures. Easily cut to shape with scissors. PRICE **2/6 sq. ft.** Please add 1/6 postage to order.

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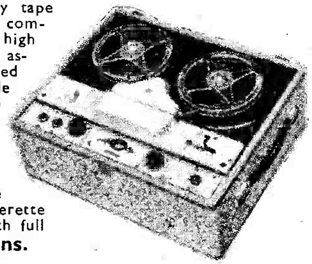

It is easy to build a quality tape recorder with one of these completely trouble-free kits. The high quality amplifiers are already assembled and wired on to printed circuit boards, and a few simple tools are all that is required to build. Send 3d. stamp for fully illustrated leaflet.

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Four-track BSR deck complete with amplifier, two-tone leatherette covered case and speaker with full instructions. PRICE **24 gns.**

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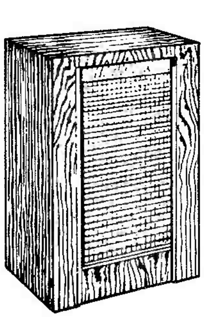
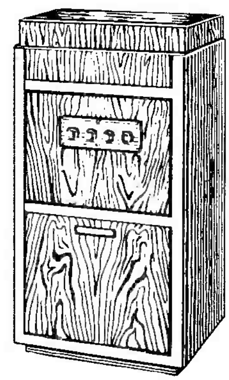
RECORDAKIT "C" Two-track 3-speed Collaro Studio tape deck complete with high quality amplifier, two-tone leatherette covered case and hi-fi 9" x 5" speaker with full instructions. PRICE **£29.18.0**

SPEAKER AND EQUIPMENT CABINETS



WB STENTORIAN CABINETS. We stock the full range of these beautifully made and finished cabinets including the new contemporary "Prelude" models. Fully illustrated leaflet will be sent on receipt of 3d. stamp. These cabinets are supplied packed flat and can be completely assembled in a few minutes with only a screwdriver.



BASS REFLEX CONSOLE

Designed to provide the utmost quality from any 10" or 12" unit with provision for tweeter if desired. Size 32" x 22" x 16". Finished in polished walnut and complete with speaker covering.
PRICE **£10.10.0**
part carriage **3/6**

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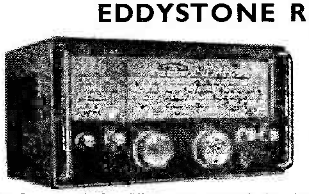
Accommodates most makes of tape deck or record player, amplifier, pre-amp. and tuner. Also provides ample storage space in compartment at bottom for tape or records. Motor board and front panel are blank ready for cutting. Size 33" x 20" x 16". Finished in polished walnut.
PRICE **£12.12.0**
part carriage **3/6**

ALSO IN STOCK. Prelude Bass reflex console **12 gns.** Prelude Hi-Fi equipment cabinet **14 gns.** Prelude Bass reflex corner console **11 gns.** Prelude Hi-Fi table equipment cabinet **10 gns.** (Legs 30/– extra.) Senior Bass reflex corner console **12 gns.** Junior Bass reflex corner console **10 gns.** Also CABINETS by HEATHKITS and RECORD HOUSING.

WE ARE ACTUAL STOCKISTS FOR
HEATHKITS
SOME MODELS NOW ON DEMONSTRATION

EDDYSTONE RECEIVERS



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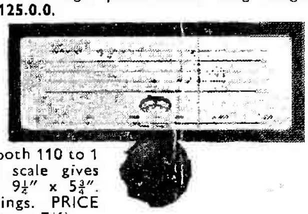
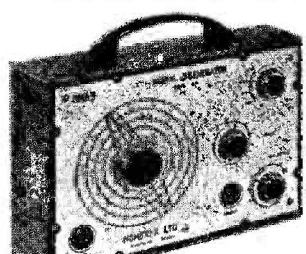
MODEL 940. The last word in high performance long range receivers. 13 valves. PRICE **£125.0.0.**

898 SLOW MOTION DIAL



Without doubt the finest dial assembly available. Essential for really high grade receivers. Tuners, test gear, transmitters, etc. Precision cut Swiss gears give velvet smooth 110 to 1 reduction drive and vernier scale gives exact logging positions. Size $9\frac{1}{2}$" x $5\frac{3}{4}$". Complete with knob and fittings. PRICE **£3.11.4** post **1/6** (Overseas post **7/6**)

NOMBREX SIGNAL GENERATOR



Completely portable transistor signal generator covering 200 kc/s to 220 Mc/s in 8 ranges. Built to highest standards with quality components and the best value in test equipment in the world. Accuracy on all ranges better than 2%. R.F. output modulated or unmodulated. Audio output of 1 kc/s. Weighs under 2lb. Size only $6\frac{1}{2}$" x $4\frac{1}{2}$". An essential instrument for all engineers and constructors. PRICE **£7.12.0** complete with battery. Post and packing **3/6**

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166 pages
600 illustrations
5000 items
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JULY 1962

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CONTRIBUTIONS on constructional matters are invited, especially when they describe the construction of particular items of equipment. Articles should be written on one side of the sheet only and should preferably be typewritten, diagrams being on separate sheets. Whether hand-written or typewritten, lines should be double spaced. Diagrams need not be large or perfectly drawn, as our draughtsmen will redraw in most cases, but all relevant information should be included. Photographs should be clear and accompanied by negatives. Details of topical ideas and techniques are also welcomed and, if the contributor so wishes, will be re-written by our staff into article form. All contributions must be accompanied by a stamped addressed envelope for reply or return, and should bear the sender's name and address. Payment is made for all material published.

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

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

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

CORRESPONDENCE should be addressed to the Editor, Advertising Manager, Subscription Manager or the Publishers, as appropriate.

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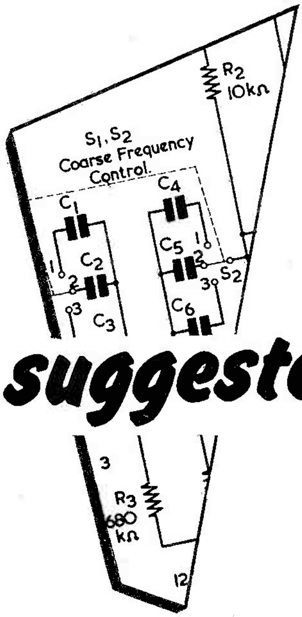

suggested circuits

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

No. 140 Experimental Remote Control with Capacitive "Memory"

In last month's issue, Suggested Circuits No. 139 dealt with control circuits employing light dependent resistors as sensing elements. It was pointed out that a typical L.D.R., the ORP12, is capable of operating a relay directly, and that an attractive application would consist of having one or more L.D.R.s mounted on the front of a television receiver each controlling its own relay. With suitable ancillary circuitry, the control of contrast, brilliance or volume could then be achieved by illuminating the appropriate L.D.R.s with a reasonably powerful torch from a distance of 6ft or so.

The writer has since experimented with circuits capable of translating the control signals from the L.D.R. relays into a form suitable for operating television receiver circuits. The results of these experiments are described in the present article, which discusses a device capable of remotely controlling brilliance and contrast (in receivers where contrast control is given by a varying voltage positive of chassis) by means of torch-illuminated L.D.R.s. Other applications for the device are quite feasible, but the present article refers only to that for television receivers.

It should be emphasised that the circuits discussed this month are of a definitely experimental nature and that they take advantage of characteristics in the "memory" component (a high-value electrolytic capacitor) which is not covered in the normal specifications for a component of this nature. This means that by no means all capacitors of the type employed by the writer could be guaranteed to work satisfactorily. Because of this point, the circuits described should be attempted only by the more experienced constructor who fully understands the principles involved. Also, the methods discussed for coupling the control circuit into a television receiver are illustrative only, and should be put into practice only by a constructor conversant with television functioning.

A "Memory"

Television contrast and brilliance controls employ potentiometers to enable continuously variable adjustments to be made. On the other hand, the only information available from an L.D.R.-controlled relay is either that it is "on" or that it is "off". The immediate problem in a torch-operated L.D.R. remote control system consists, therefore, of translating the information from the controlled relays into a continuously variable form.

A simple solution consists of employing two L.D.R.s and relays, these connecting to an electric motor such that, when one L.D.R. is illuminated the motor rotates in one direction, and when the other L.D.R. is illuminated the motor rotates in the reverse direction. When neither L.D.R. is illuminated the motor is at rest. The motor is then coupled, via a reduction gear, to the brilliance or contrast potentiometer. To operate the system, the appropriate L.D.R. is illuminated, the illumination ceasing when the motor has rotated the potentiometer to the desired new position. Despite its apparent clumsiness, a system of this nature is not at all unattractive, particularly when it is remembered that there are a considerable number of low-cost imported d.c. motors on the market at present which are quite capable of carrying out the job.* An arrangement of this type could also be used for volume control, or for the adjustment of any other potentiometer.

Another mechanical solution would be given by a step-by-step motor, this advancing the controlled potentiometer by one step each time the appropriate L.D.R. is illuminated. In this case the individual steps should preferably be small and the motor would need to be reversible. Such a system is not, at first sight, attractive.

The writer felt that an electronic means of controlling contrast or brilliance would be of interest. Two L.D.R.s and relays would be re-

* A typical motor capable of running from 1.5 or 3 volts is, for instance, available from M.R. Supplies Ltd., 68 New Oxford Street, London, W.C.1, at 5s. retail. See "Suggested Circuits No. 128. An Experimental Remote Control Servo System", *The Radio Constructor*, July 1961.

quired, as with the motor, these varying the condition of an electronic component which functioned as a "memory". In practice the component would be a capacitor, whereupon one L.D.R.-controlled relay could increase its charge, whilst the other would decrease its charge. When neither L.D.R. was illuminated the capacitor would retain the charge last imparted to it. The voltage across the plates of the capacitor could then be used to control the brilliance and contrast circuits of the television receiver.

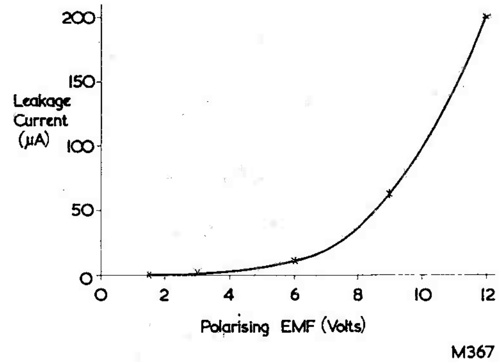

Fig. 1. Leakage current in the 2,000μF capacitor checked by the writer

The Capacitor

It was considered that the device employing the capacitor would only be of practical use if the capacitor could hold its charge within close limits over a period of an hour. This infers a large capacitance and a very large leakage resistance, especially when it is remembered that the time constant of a CR circuit (microfarads multiplied by megohms) defines the time taken for the voltage across the capacitor to drop to 37% of its initial value and that the slope of the discharge curve is greatest immediately after the applied charging voltage has been removed. The present application requires, over the period of an hour, a discharge in the capacitor much smaller than that represented by the time constant figure.

A polystyrene component would appear to be a good choice for the capacitor because of its very high leakage resistance. However, it was intended that the capacitor be employed in conjunction with normally available valves and other components, and leakage in the latter would still necessitate a high value in the capacitor. A polystyrene capacitor having the requisite high value would be very expensive, and it was decided to investigate an electrolytic component instead.

Fig. 1 illustrates the leakage current for varying values of applied e.m.f. for the capacitor employed by the writer. The capacitor was a Plessey component, type CE7036, and had a value of 2,000μF with a working voltage of 12. As it had been in store for a considerable time since manufacture, it was initially formed for an hour by connecting it to a 12 volt supply via a 10kΩ resistor. The readings for the curve of Fig. 1 were then taken.

At 12 volts applied e.m.f., leakage current was 200μA, this dropping to 60μA at 9 volts, and 10μA at 6 volts. Leakage current at 3 volts was less than 0.5μA and was negligibly small at 1.5 volts. A current of 0.5μA at 3 volts indicates a leakage resistance of 6MΩ and a consequent time constant (for 2,000μF) of 12,000 seconds. This was sufficiently encouraging for a more practical arrangement to be tried out.

The capacitor was connected up in the C_1 position of Fig. 2, its positive plate coupling to the grid of the cathode follower $V_{1(a)}$. The voltage on the cathode of $V_{1(a)}$ is applied to the grid of $V_{1(b)}$ via R_3, the latter being included to limit grid current should $V_{1(a)}$ cathode go positive of chassis. A 12AT7 was employed in the circuit since this valve has a relatively short grid base and should in consequence give large variations in anode current for small changes in grid voltage. An h.t. voltage of 200 was employed, thereby simulating conditions in a television receiver, and an additional 45 volts negative for the cathode follower was provided by a battery.

The 9 volt tapping into the battery for the negative plate of C_1 was decided upon after initial checks. It was intended to operate the capacitor with voltages across its plates ranging from zero to 3 volts; whilst, with the particular 12AT7 employed, the cathode of $V_{1(a)}$ was 4 volts positive of its grid. The 9 volt tapping would then result in a range of voltages on the cathode of $V_{1(a)}$ covering 5 to 2 volts negative of chassis according to the charge in C_1. These voltages would be applied to the grid of $V_{1(b)}$ and give corresponding changes in anode current.

The results obtained with the circuit of Fig. 2 are illustrated in Fig. 3, which shows the anode current in $V_{1(b)}$ over an hour and a half for differing charges in C_1. The curves

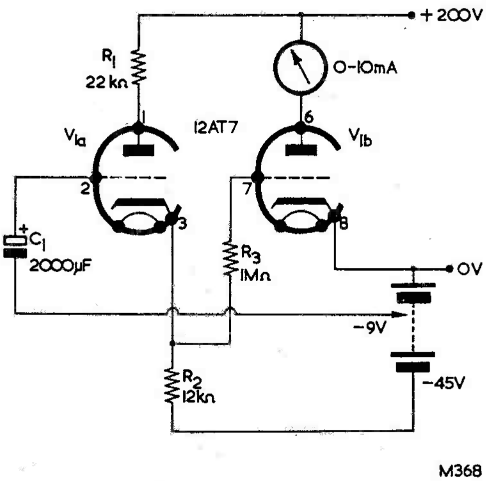

Fig. 2. An experimental "memory" circuit

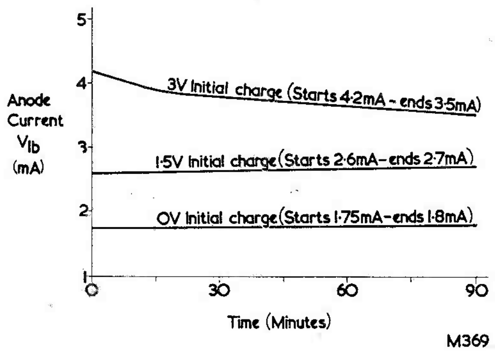

Fig. 3. Results obtained with the circuit of Fig. 2

were obtained by initially charging C_1 to 3 volts and 1.5 volts, and by discharging it completely. Anode current readings were then taken from time to time and the curves drawn. Results with the initial 3 volt charge are obviously unsatisfactory since, at the end of the period, anode current has dropped from 4.2 to 3.5mA. On the other hand, the only change in anode current for the 1.5 volt initial charge condition is an increase from 2.6 to 2.7mA, and for the initially discharged condition is an increase of 1.75 to 1.8mA. This is satisfactory for all practical requirements and infers that, in this particular case, the 2,000µF capacitor could function as a reliable "memory" over periods of an hour or more for voltages ranging from zero to 1.5. In practice it would probably be possible to get reliable results up to 2 volts, but no readings were taken for this voltage. The reason for the slight *increase* in anode current over the zero and 1.5 volt periods is not known; although it may have been due to reverse grid current in the valve or to a gradual increase in emission in $V_{1(b)}$.

The circuit of Fig. 2 would appear to offer a practical arrangement wherein television receiver functions may be controlled by the near-constant potential appearing across C_1. As will be readily understood, this point can only be claimed with the particular electrolytic capacitor used by the writer. Other high-value capacitors may have even lower leakage currents than those found here and may allow the capacitor to function reliably over a wider range of voltages. Alternatively, capacitors may be encountered whose leakage currents are higher, and which would be quite useless for the present purpose. It can be suggested, nevertheless, that at least *some* capacitors having values of the order of 2,000µF or more should give results as good as those experienced by the writer.

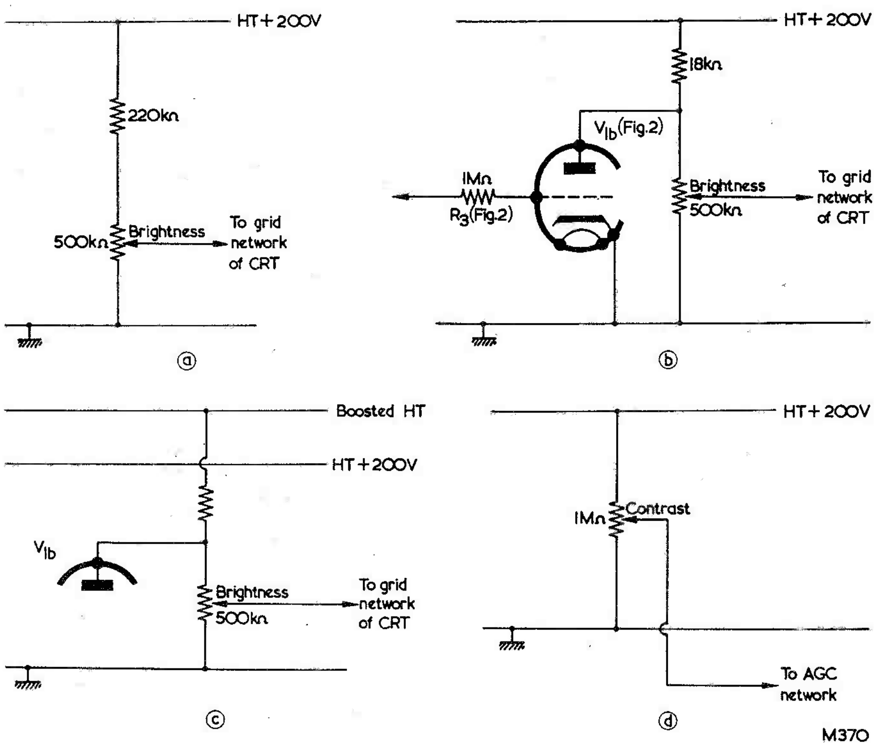

Fig. 4. (a). A typical brightness control circuit
(b). A suggested modification which allows brightness to be controlled by the charge on C_1 of Fig. 2
(c). A greater range of brightness control may be achieved by returning the upper resistor to the boosted h.t. lin
(d). A commonly encountered contrast control circuit which may similarly be modified for remote control

In the circuits which follow, it is assumed that the range of control available is that given by a capacitor having the same characteristics as that discussed up to now.

Television Control Circuits

The manner in which a circuit similar to that of Fig. 2 may be connected into the control circuits of a television receiver depends to a considerable extent upon the form the latter take. Nevertheless, some suggestions are now given which may be acted upon by the more experienced constructor. An anode current ratio of 1 : 1.5 in $V_{1(b)}$ will be assumed (i.e. 1.8 to 2.7mA, as in Fig. 3), although a much greater current ratio for the same change in grid voltage could be given by using sharp cut-off valves such as the 6BH6 in the $V_{1(b)}$ position.

Fig. 4 (a) illustrates a typical brightness control circuit in a television receiver. A potential of some 140 volts appears at the upper end of the potentiometer, and 0.3mA flows through both this and the fixed resistor. Control of brilliance could then be obtained by adding $V_{1(b)}$ in the manner shown in Fig. 4 (b). Assuming a control current range of, say, 3 to 4.5mA in $V_{1(b)}$, and an 18kΩ resistor in place of the 220kΩ component, the upper end of the potentiometer can then be varied through some 27 volts. A much wider range of control would be given by returning the upper resistor (with an increased value) to the boosted h.t. line, as in Fig. 4 (c). Care should be taken to ensure that these circuits do not allow excessive positive voltages to be applied to the grid of the cathode ray tube.

Fig. 4 (d) shows a contrast control circuit frequently encountered in current television receivers. The potentiometer passes a varying positive voltage to the a.g.c. network, the a.g.c. line being prevented from going positive of chassis by a clamp diode. By inserting a fixed resistor in series with the upper terminal of the potentiometer, either the control arrangement of Fig. 4 (b) or (c) could be employed.

The Supply Circuit

The circuit of Fig. 2 has the disadvantage that a 45 volt battery is used, and this is obviously undesirable in a practical arrangement. There is a second disadvantage also, this being given by the fact that if the 200 volt supply is switched off before the 45 volt supply the cathode of $V_{1(a)}$ goes negative of chassis and causes C_1 to be discharged via the cathode-grid diode of this valve. The same can happen if, after the valve heaters have warmed up, the 200 volt supply is applied after the 45 volt supply. Apart from possible damage to the capacitor resulting from the reverse voltage applied to it, there is the nuisance value that this effect causes the capacitor to lose the charge it held before switching off, and that the charge has to be re-set to the requisite level by the appropriate L.D.R. control when the receiver is switched on again.

A suggested power supply circuit for C_1 and $V_{1(a)}$ suitable for television receivers employing selenium or silicon h.t. rectifiers is shown in Fig. 5. An auxiliary power supply provides 45 volts negative of chassis and, since the current it provides is only of the order of 10mA, it can have low value smoothing capacitors. In consequence, its voltage should decay at a quicker rate than that of the main h.t. supply when the receiver is switched off. There should be little risk of discharging C_1 after switching on because both the 200 and 45 volt supplies appear before the valves warm up. The value of R_7 in the diagram is found empirically, and is that which allows a

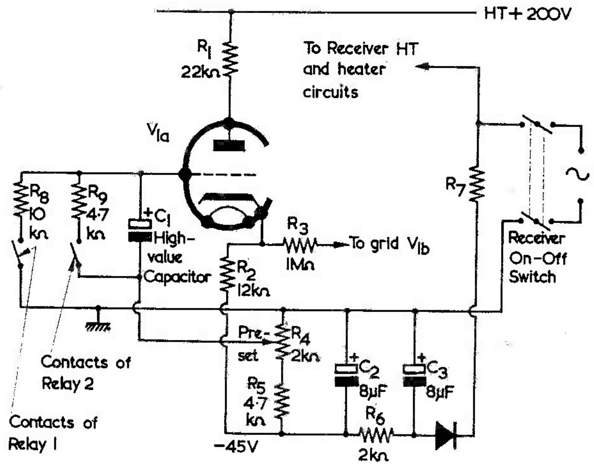

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Fig. 5. A suggested power supply circuit for C_1 and $V_{1(a)}$. Relays 1 and 2 are controlled by light dependent resistors

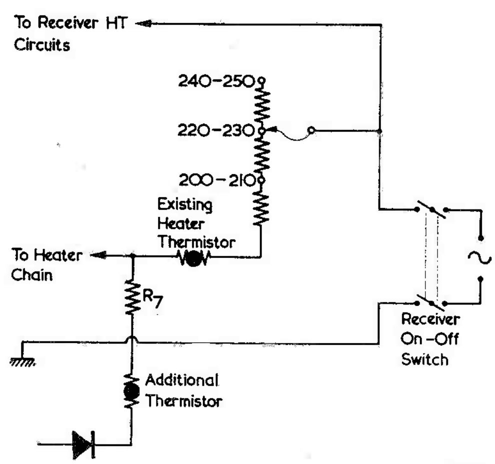

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Fig. 6. A simple method of delaying the appearance of the 45 volt supply after switching on

rectified voltage of 45 to appear across C_2.

The negative plate of C_1 is now returned to the slider of the pre-set potentiometer R_4 instead of to a fixed tap in the battery. R_4 is set up such that $V_{1(b)}$ anode current varies over the desired range corresponding to the range of usable voltages across C_1.

C_1 is charged and discharged by Relay 1 and Relay 2 respectively. When the contacts of Relay 1 are closed, the positive plate of C_1 is coupled to chassis via R_8. When Relay 2 is closed it is discharged via R_9. R_8 is given a higher value than R_9 since the charging voltage available will normally be greater than 3 volts (it depends on the setting of R_4) and it is desirable to make charge and discharge rates approximately the same.

With receivers having thermionic valve h.t. rectifiers it is necessary to ensure that C_1 does not discharge due to the appearance of the 45 volt supply before the h.t. supply. There are several thermal devices which can delay the appearance of the 45 volt supply, and any of these can be employed. A simple solution would consist of a thermistor in series with R_7 of Fig. 5, further delay being obtained by taking the a.c. supply after the heater thermistor, as in Fig. 6.

Conclusion

In conclusion, it must be reiterated that the circuits described in this month's article are entirely of an experimental nature and that they are best attempted by the more experienced constructor who understands the principles involved. The circuit of Fig. 2 and the curves of Fig. 3 are the result of practical experimental work by the author.

The most important component is, obviously, the high value electrolytic capacitor C_1 and it would be pointless to attempt any further work until the leakage current of the particular component chosen by the constructor has been initially measured and found satsfactory. It would also be very desirable to employ the capacitor in an experimental set-up such as that of Fig. 2 before trying it in a working circuit. It is interesting to note that leakage current in the sample checked was satisfactorily low at a small fraction of the working voltage, and this could indicate that a greater range of operating voltages would be given by a capacitor with a higher working voltage. It has to be re-stated also that all electrolytic capacitors will not exhibit the low leakage currents encountered in the writer's sample and that some selection may be necessary before a suitable component is found.

CAN ANYONE HELP?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received and to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time

3FP7 Tube.—P. Booth, 38 West Street, Farnham, Surrey, is in urgent need of information in respect of working voltages and the base connections for this tube.

* * *

RF Unit Type 26.—S. Jesson, 181 Kings Acre Road, Hereford, would like to obtain the circuit diagram of this unit.

* * *

"S" Band Signal Generator.—P. W. Fairlamb, 93 Beach Road, Cleveleys, Blackpool, Lancs., would like to obtain the manual for this equipment. The case is marked with the legend G210-AP53920B and it is believed that this is an ex-Admiralty unit.

* * *

Monitor Type 33.—J. H. Cater, 30 Junction Road, Blackburn, Victoria, Australia, is seeking for the circuit of this ex-Air Ministry unit. Marked 10T/564, it has a VCR138 tube and it is hoped to convert the unit into a c.r.o. Willing to pay for photostat copies.

* * *

"The Radio Constructor", April 1950.—N. Whitelegg, 4 Laverdene Road, Totley, Sheffield, urgently requires this issue of the magazine which contained an article on conversion of the R1155 receiver.

* * *

Analogue or Digital Computers.—G. R. Gaiger, 132 Westbourne Street, Hove 3, Sussex, requires to purchase or borrow and relevant data, especially circuitry (with component values) of any home-built or designed computers either transistor, or preferably valve-operated types.

Indicator Unit 277.—D. Scarlett, 26 Queens Avenue, London, N.20, wishes to obtain any information regarding the circuit and power supply requirements of this unit and any information on the conversion into a portable oscilloscope.

* * *

R109 Receiver.—R. J. Sayers, 120 Birmingham Road, Redditch, Worcs., would like to obtain the manual for this receiver.

* * *

Crystal Calibrator No. 10.—C. D. Hawkins, 67 Warwick Road, London, N.11, requires to borrow or purchase the circuit, and any other details, of this unit.

* * *

Test Set No. 74A.—R. D. Green, 767 Woodbridge Road, Ipswich, Suffolk, wishes to convert this unit into an oscilloscope. Can anyone provide a circuit diagram of the unit and any details of the conversion.

* * *

MCR1 Receiver.—J. E. Loades, G3OTL, 17 Manor Park Road, West Wickham, Kent, urgently requires to borrow the manual or circuit of this receiver.

* * *

"The Radio Constructor".—K. R. Goodley, 3 Highland Road, Parkstone, Dorset, urgently requires to purchase copies of the magazine dated April to September (inc.) 1948, condition not important provided they are reasonable copies.

* * *

Emerson TV Model No. 1183 Series J.—F. J. Brooks, 26 Ennismore Road, Stanley, Liverpool 13, would like to purchase or borrow the circuit of this receiver.

Precautions

IN THE USE OF VOLTAGE STABILISERS

By J. B. DANCE, M.Sc.

MANY AMATEUR CONSTRUCTORS USE VOLTAGE stabiliser tubes without having studied the manufacturer's operating recommendations and may not therefore obtain satisfactory performance or tube life. Some manufacturers publish general operating recommendations applying to all their stabiliser tubes separately from the data sheets for specific tubes; it is important that all this information is studied.

Ignition

A value is normally quoted for the maximum ignition voltage of each type of tube. The supply voltage should not be less than this value if reliable ignition is to be obtained after switching on the apparatus. In absolute darkness some considerable delay may occur before ignition takes place.

Burning Current

The component values should be chosen so that the current passing through the stabiliser tube always lies between the maximum and minimum values quoted for that particular tube. If the current is too low the tube voltage will not be stable, whilst an excessive current will lead to a large heat dissipation and possible loss of stability and/or damage to the tube.

It is, however, permissible to operate most stabiliser tubes for periods of up to about ten seconds with a current of two or three times the normal maximum rated current whilst indirectly heated valves in the associated equipment warm up.

The so-called "Reference tubes" provide a very stable source of voltage and should be operated at the preferred operating current quoted by the manufacturer, as such an operating point has maximum stability over life and is free from any discontinuities. If the current is changed from the preferred value during the life of the tube and is then returned back to it, the good initial voltage stability may never be regained.

Burning Voltage Spread

The burning voltage of normal stabiliser tubes of a specified type varies by about $\pm 3\%$ from tube to tube about the nominal mean value.

Temperature

The temperature coefficient of the burning voltage can be about 2 to 10 millivolts per degree C. according to type, but the temperature of the tube normally becomes reasonably constant after approximately three minutes.

Alternating Voltage

If the voltage supply to the tube contains an alternating component or if the stabilised current taken from the circuit varies at a fairly high frequency some alternating voltage will be present in the stabilised output. This effect will be worse at higher frequencies, as the internal impedance of the tubes increase with frequency. Generally it is advisable to connect a capacitor across the stabiliser tube if alternating voltages are likely to appear across it. This capacitor should not be too large or relaxation oscillations may occur and large initial currents would pass immediately after ignition. Values of less than 1μF are generally suitable.

Series Operation

Voltage stabiliser tubes should not be operated in parallel, as under such conditions it would be impossible to ensure that each of the tubes passed a suitable current.

Stabiliser tubes may, however, be operated in series in order to obtain a larger stabilised voltage than that obtainable from any single tube, but if the series connected tubes are not all of the same type, care must be taken to ensure that the common burning current will always fall within the ratings of all the tubes.

Resistors (of value about 220kΩ) may be connected across some of the stabilisers in series in order to facilitate the striking of the tubes. It is not always necessary to provide a supply voltage as great as the sum of all the ignition voltages of the various tubes. (The ignition voltage of a tube is considerably greater than the normal burning voltage.)

Polarity

There is no objection to the use of a voltage stabiliser tube under such conditions that the anode becomes negative with respect to the cathode provided that no reverse current passes. This condition can be satisfied by ensuring that the maximum reverse voltage ever applied to the tube is less than nine-tenths of the normal burning voltage. The passage of reverse current may reduce the life and/or stability of a tube.

TWO - VALVE

Stereo Amplifier

By B. W. HOLLINSHEAD

THE GROWING POPULARITY OF stereophonic records has, no doubt, led many to consider installing equipment on which to reproduce such recordings. However, high fidelity stereo amplifiers are often elaborate and expensive and, like the writer, many have probably wished for a simple amplifier using cheap and readily available components and which is still capable of providing a reasonable standard of reproduction.

The writer believes that this amplifier will appeal to many such constructors for the reason that, feeding into a pair of bass reflex cabinets, the quality of sound is quite good.

The amplifier was designed with the following in mind:

(1) Enough power for the average size room
(2) Low cost
(3) Economy in power consumption
(4) Availability of components

The ECL80 triode-pentode is readily available at a reasonable price and is economical in both its heater and h.t. requirements. Used in this circuit, adequate output is available when employed with a crystal pick-up.

Circuit

The circuit shown in Fig. 1 is quite conventional. The triode section of the ECL80 acts as a voltage amplifier of the signal fed to its grid via a 1MΩ volume control and a simple top-cut tone control. Ganged potentiometers are somewhat expensive and therefore the ordinary single types were used to control the volume of each channel and also dispense with the need for a balance control. The volume controls used in the prototype were ex-Government types as, also, was the 500 + 500kΩ ganged tone control.

The pentode section of the ECL80 acts as an output valve in a single ended circuit. The transformers are Wharfedale "P" types having a 60:1 ratio. These are adequate for use in this circuit and results are no doubt better than those which would be obtained using cheaper or surplus components.

The power supply is quite conventional and employs a double-wound mains transformer with secondary windings capable of delivering 60mA at 200 volts and 6.3 volts at 1 amp. A contact cooled rectifier is mounted below the chassis and smoothing is carried out with a resistance-capacitance circuit. A double electrolytic capacitor of either 16 + 16μF or 32 + 32μF having a working voltage of 350 may be used, both being tried in the prototype with no difference in performance.

Components List

Resistors (All ¼ watt unless otherwise stated)

R_1	220kΩ 10%
R_2	470kΩ 10%
R_3	2.2kΩ 20%
R_4	390Ω 10% ½ watt
R_5	680kΩ 20%
R_6	2kΩ wirewound 3 watt
VR_1	1MΩ log
VR_2	500+500kΩ log

Mains Transformer

T_1 200, 220, 240V primary, 200V 60mA, 6.3V 1A secondaries

Output Transformer

T_2 60:1 Wharfedale type P

Switch

S_1 d.p. toggle

Capacitors

C_1	0.005μF 350 w.v.
C_2	100μF electrolytic 25 w.v.
C_3	0.002μF 350 w.v.
C_4	16μF electrolytic 350 w.v.
C_5	16μF electrolytic 350 w.v.
C_6	390pF silver mica

Valves

ECL80 Mullard

Valveholders

B9A

Metal Rectifier

250V 60mA contact cooled

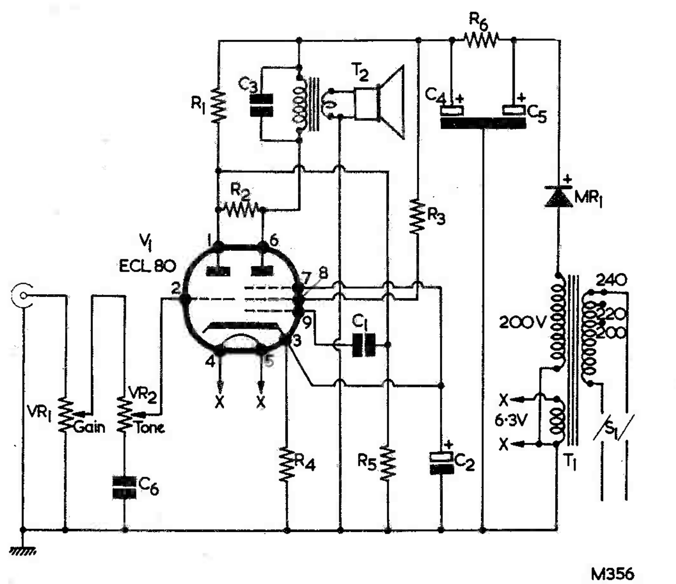


Fig. 1. The amplifier circuit. Only one channel is shown here, all components being duplicated except, of course, those of the power supply and smoothing circuit, viz. C_4, C_5, R_6, MR_1 and the mains transformer

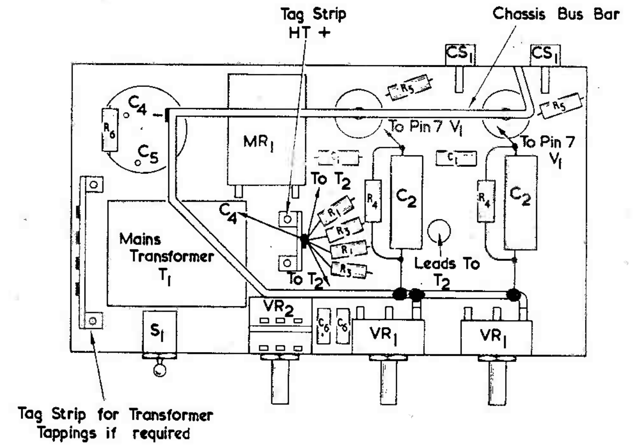


Fig. 3. Below-chassis layout showing components for both channels

A toggle switch was employed as a mains on/off switch to avoid altering control settings, but a switch ganged with one of the potentiometers could similarly be used if desired.

Construction

The prototype was built on a 16 s.w.g. aluminium chassis measuring 8 x 4½in with two 1½in sides. See Fig. 2. Using the specified components, this chassis was just large enough, but different components to those used with the prototype would possibly entail changes with respect to chassis dimensions.

Figs. 2 and 3 show the component layout both above and below the chassis. The mains transformer is of the drop-through type and a cut-out was made in the chassis to suit. Constructors who use other mains transformers can mount their components in the most convenient manner.

To avoid hum, all chassis connections were made to a 16 s.w.g. copper busbar earthed at the input sockets only, this extending around the chassis and terminating at VR_1 as in Fig. 3. Two V-shaped bends are made in the busbar so that it may be soldered to the centre spigots of the valveholders. No hum in the audio output should be experienced when using this method of earthing.

The final wiring is quite conventional, the components being suspended in the wiring. Signal-carrying connections in the input circuit were made with screened leads, these being reliably earthed at each end. Two small loudspeaker sockets were mounted on aluminium brackets, as shown, on top of the chassis, and the leads from the output transformer secondaries soldered directly to them. Fig. 4 shows the socket mounting.

If the mains transformer has primary tappings, as in the writer's case, these can be taken to a tagstrip suitably arranged below the chassis and the appropriate connections made. To change taps requires re-soldering but as this is probably a rare occurence it entails no undue inconvenience.

Care must be taken to see that all burrs are removed from holes drilled in the chassis, particularly those holding the rectifier. This last point ensures that there is a large area in contact with the aluminium to ensure good heat dissipation.

Setting Up

No difficulty should be experienced in setting up. The feedback resistors between the anodes of the ECL80s can be adjusted, if desired, to suit the constructor, and may lie between 380kΩ and 2MΩ. Also the tone correction capacitor C_3 may be experimented with, although the value specified appears to work admirably.

The completed amplifier was fitted in a shelf-mounted cabinet with a panel of $\frac{3}{16}$in mahogany faced plywood.

For those who require it, enough spare power—0.4A at 6.3V and 15mA at 200V—is available if a mains transformer of the specified rating is used, and this should be sufficient to power a simple AM tuner of the r.f. pentode/germanium diode type, or a similar unit.

Although most constructors will have their own ideas for a suitable housing for the amplifier, details of the writer's shelf-mounting cabinet

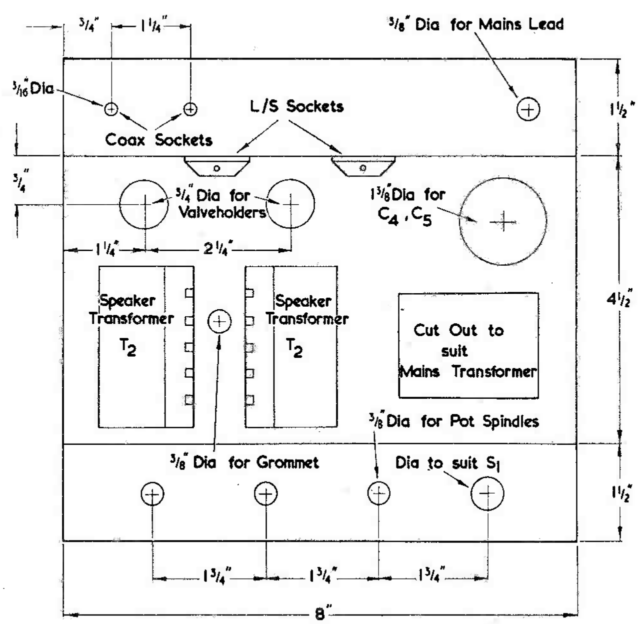


Fig. 2. Above-chassis layout

are given for those who consider that it will suit their requirements.

The Cabinet

The cabinet was made up from $\frac{3}{4}$in faced chipboard which is comparatively cheap to buy and easy to work and which, when suitably finished and polished, makes a pleasing case for the unit. The chipboard is cut to size, four panels being required. After cutting, the edges of the panels with the exception of those which face the rear of the cabinet are bevelled at 45°, care being taken during this operation to ensure a good fit without unsightly gaps. When all panels are a good fit they are glued together, checked with a square and further held with panel pins. The heads of the pins should be punched below the surface and the holes filled with plastic wood.

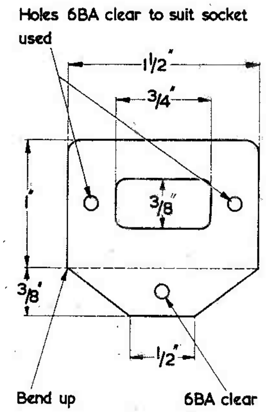


Fig. 4. The loudspeaker mounting socket, of which two are required. The material is 18 s.w.g. aluminium

The bevelled front edges of the cabinet reveal the chipboard surfaces and these should be filled with several coats of grain filler, rubbing down with fine sandpaper between each coat until a smooth surface is obtained. These edges can then be stained or painted a contrasting colour to the rest of the case.

A cut-out measuring 5in by $1\frac{1}{2}$in is made in the top of the case to allow the heat from the valves to escape. Similarly a cut-out is made in the $\frac{3}{16}$in rear panel so that cooling air can flow right through the unit. Both these openings are covered by wire gauze or expanded metal. The rear panel, in which holes are made to allow the coaxial input sockets to protrude through, is held in position by six small wood screws and the finished unit gives quite a pleasing appearance.

WHY IS — f.m. — BETTER?

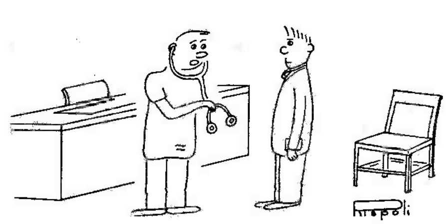
IT IS A COMMONLY BELIEVED FALLACY THAT BETTER reproduction can be obtained from f.m. transmissions than from a.m. transmissions because the maximum audio frequency transmitted by the f.m. stations is greater. In actual fact the pass bands of the B.B.C. transmitters themselves are level from about 30 c/s to 15 kc/s to within ± 1 dB. This applies to f.m., medium and long-wave a.m., television sound and also to the short-wave a.m. transmissions to other countries.

In practice the upper audio frequency transmitted is limited by the signal available from the Post Office land lines. Where the Post Office land lines are less than about 20 miles in length, the upper frequency limit of 15 kc/s will actually be transmitted, but where the land lines are about 200 miles or so in length, the maximum frequency transmitted will be about 10 kc/s. If a programme originates in the North of Scotland or in Northern Ireland and is transmitted from London, the uppermost transmitted frequency may be of the order of 8 kc/s. These figures apply to all f.m. and a.m. transmissions.

Conventional medium-wave a.m. receivers do not have a level pass band which is broad enough to accept audio frequencies up to 15 kc/s. It is, in fact, almost always necessary to use a fairly narrow pass band at medium-wave frequencies in order to prevent adjacent channel interference. If one is close to the transmitter, it should be possible to obtain a good high frequency response from medium-wave transmissions by means of a specially designed receiver, as a wide pass band can be used if there is no danger of interference.

With f.m. receivers the situation is different, as there is no interference from foreign stations, and the full frequency response of the transmitted signal can be obtained from a well designed receiver. In addition less noise (except car ignition noise) is present at v.h.f. The use of f.m. also reduces the effect of any noise pulses which are received.

High fidelity is also possible from television sound, but the average television receiver is not designed to provide high quality sound.



"Oh, don't worry sir, these are stereophonic!"

A Transistorised Single Sideband Transmitter

By R. J. BARRETT, GW3DFF

IT IS BECOMING INCREASINGLY OBVIOUS THAT transistors are coming into favour in amateur radio circles, both in receivers and low power transmitters. Their advantages regarding power supply and weight cannot be overlooked, and most progressive amateurs will have tried at least one or two circuits using them. Any keen listeners to the amateur bands will have noticed how popular single sideband transmission is becoming. This article describes an experimental single sideband transistorised transmitter which is relatively simple to construct and performs very well in spite of its modest power output and power supply requirements. It is assumed that anyone building this equipment will have had some experience with transistors, and that the usual precautions regarding soldering, etc., will be observed.

For experimental work using transistors the writer would recommend the "breadboard" method of construction. A piece of softwood about ½in thick is used for the board, and has panel pins driven in to support the transistors and components. Wiring may be fabricated by stretching 16 s.w.g. tinned copper wire between the pins. Small capacitors and resistors may then be soldered directly to the pins or on the wire as required. Most transistor components are very small and light in weight and are self supporting. Major modifications can be carried out on this "breadboard", and odd components can be used up if necessary. Yet, if carefully constructed, the finished job can look quite neat and presentable.

General Circuit Description

The transmitter was designed for use in the 160 metre amateur band. In Fig. 1 TR_1 is a crystal oscillator with its collector circuit tuned to the crystal frequency, which in the writer's case is 1,875 kc/s. L_1 and L_2 provide the necessary 90° r.f. phase shift. The output is passed through a double balanced modulator which consists of four diodes so arranged that the signal is cancelled out in L_3. TR_2 and TR_3 are r.f. amplifiers working in class AB. These are supplied with a small amount of bias so that advantage may be taken of the full gain of the transistor at the very low signal levels at which they operate. TR_4 is a class B output stage, its input peaking to 50mW. The audio unit (Fig. 2) consists of two OC71 audio amplifiers transformer coupled into a 90° phase shift network. The output is balanced and split and taken to relatively high input impedance grounded emitter stages. These in turn are transformer coupled to the balanced modulator at points XX and YY. The unit was designed to work from a low impedance moving coil microphone.

Crystal Oscillator

In Fig. 1 the coil L_{1b} supplies the required feedback to enable the circuit to oscillate. If oscillations are not obtained as the slug in L_1 is adjusted its connections should be reversed. When oscillating the collector current of TR_1 should be approximately 5mA. Coils L_1 and L_2 should be mounted parallel to each other and separated by about 1½ diameters. It is preferable that the whole oscillator be screened, as radiation from it can beat with the final s.s.b. signal and make it difficult to monitor on the station receiver.

Balanced Modulator

This should be constructed using a symmetrical layout, and all earthing points marked with an asterisk should be short and taken to a common point. The diodes should be checked for forward and back resistances with a resistance meter, and the forward resistances (the lower readings) should agree within 10%. The radio frequency choke should be placed at right-angles to L_3 in order to minimise coupling between these components.

R.F. Amplifiers

Careful screening is important between each r.f. amplifier, or instability will result. Both TR_2 and TR_3 draw approximately 1mA standing current, rising with modulation. TR_4 will draw little or no standing current, but its input will peak to 5mA with full modulation. The writer does not consider it necessary to leave meters permanently connected to check the currents flowing through these transistors, but should it be desired to do so a 10mA meter could be conveniently connected at points MM on the circuit diagram.

The Audio Section

The first part of this unit (Fig. 2) consists of two grounded emitter OC71 transistors in the usual RC configuration. TR_5 and TR_6 have collector currents of 1 and 1.5mA respectively. The audio signal is

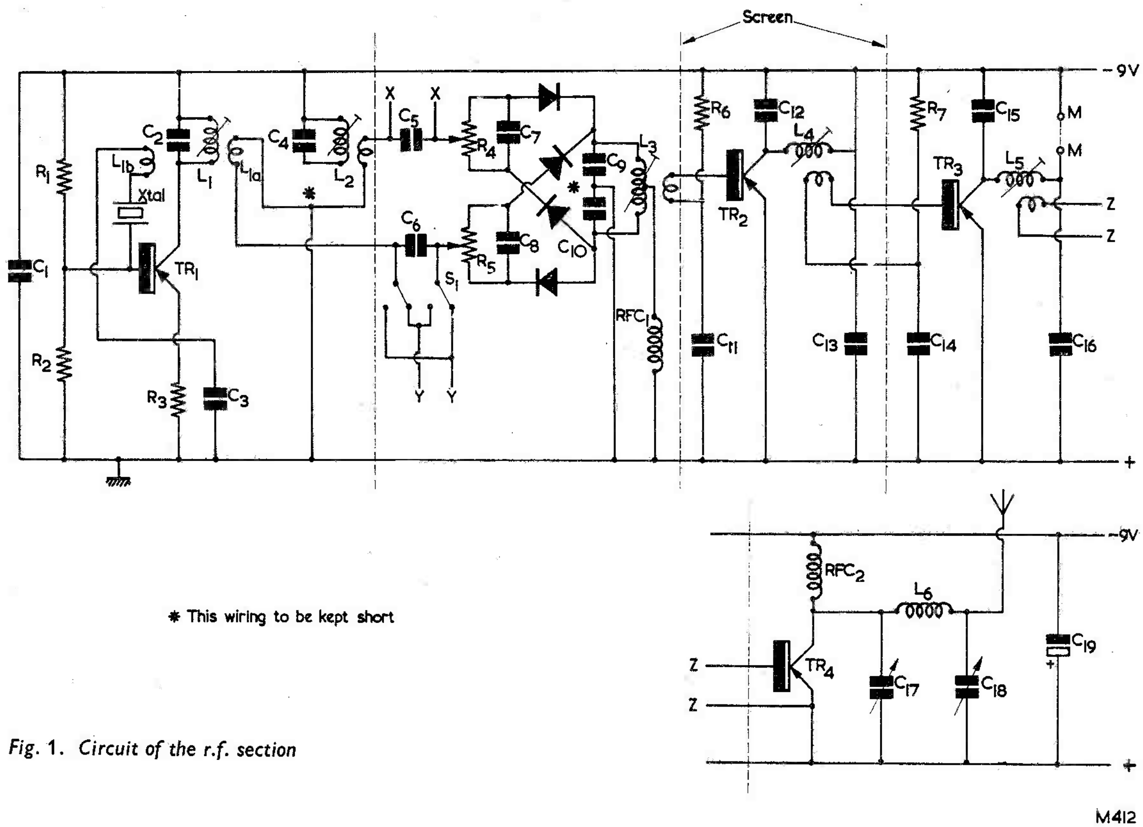


Fig. 1. Circuit of the r.f. section

Components List
(Figs. 1 and 2)

Resistors (all ¼ watt, 10% unless otherwise stated)

R_1 15kΩ
R_2 4.7kΩ
R_3 470Ω
R_4 1kΩ potentiometer, carbon, linear
R_5 1kΩ potentiometer, carbon, linear
R_6 220kΩ
R_7 220kΩ
R_8 10kΩ potentiometer, carbon, log
R_9 62kΩ
R_{10} 10kΩ
R_{11} 3.9kΩ
R_{12} 1kΩ
R_{13} 39kΩ
R_{14} 10kΩ
R_{15} 1kΩ
R_{16} 100kΩ
R_{17} 15kΩ
R_{18} 15kΩ
R_{19} 100kΩ
R_{20} 50kΩ
R_{21} 50kΩ
(R_{16}–R_{21}) Close tolerance. Values to be as accurate as possible
R_{22} 500kΩ potentiometer, carbon, linear
R_{23} 500kΩ
R_{24} 680kΩ
R_{25} 330kΩ
R_{26} 150kΩ
R_{27} 150kΩ
R_{28} 39kΩ 5%
R_{29} 10kΩ 5%
R_{30} 10kΩ 5%
R_{31} 39kΩ 5%
R_{32} 1kΩ 5%
R_{33} 1kΩ 5%

Capacitors

C_1 0.01μF
C_2 200pF
C_3 0.01μF
C_4 200pF
C_5 0.001μF
C_6 0.001μF
C_7 0.005μF
C_8 0.005μF

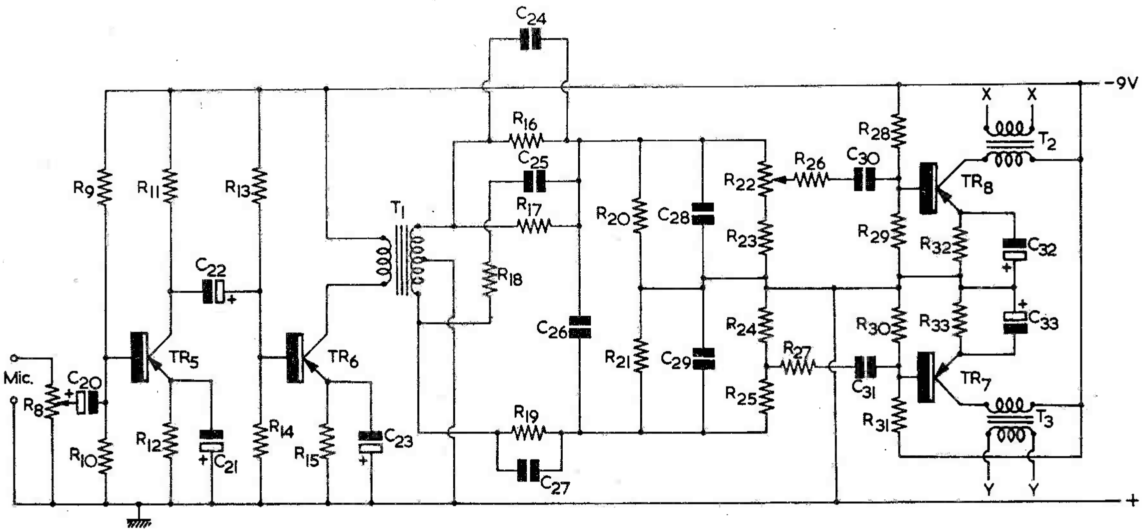


Fig. 2. Audio unit of the transmitter

M413

C_9	0.002μF
C_{10}	0.002μF
C_{11}	0.002μF
C_{12}	200pF
C_{13}	0.01μF
C_{14}	0.002μF
C_{15}	200pF
C_{16}	0.01μF
C_{17}	300pF variable
C_{18}	600pF variable
C_{19}	50μF 12 w.v. electrolytic
C_{20}	8μF 6 w.v. electrolytic
C_{21}	25μF 6 w.v. electrolytic
C_{22}	8μF 12 w.v. electrolytic
C_{23}	25μF 12 w.v. electrolytic
C_{24}	0.00105μF
C_{25}	0.0063μF
C_{26}	0.0285μF
C_{27}	0.00475μF
C_{28}	0.0021μF
C_{29}	0.0095μF
C_{30}	1μF
C_{31}	1μF
C_{32}	25μF 6 w.v. electrolytic
C_{33}	25μF 6 w.v. electrolytic

C_{24}–C_{29}: Close tolerance. To be as accurate as possible

Semiconductors

$TR_{1, 2, 3, 4}$	Mullard OC44, Mazda XA112
$TR_{5, 6, 7, 8}$	Mullard OC71, Mazda XB113
$D_{1, 2, 3, 4}$	Mullard OA81

Switch

S_1 2-pole, 2-way, toggle

Transformers

$T_{1, 2, 3}$ Radiospares type TT1 driver transformers, ratio 1:1. These transformers have centre-tap secondaries. In order to preserve the 1:1 ratio, only half of the secondary is used on T_2 and T_3

Chokes

$RFC_{1, 2}$ 2.5mH radio frequency chokes

Coils

See Coil Winding table

transformer coupled to a Dome phase shift network. The components in this network must be selected with care and it is suggested that access be gained to a good resistance-capacitance bridge. Components can be selected from standard good quality supplies, or resource may be made to the junk box providing the components therein are in good condition. Checking a number of components of similar values should reveal that the manufacturer's limits are sufficiently wide to include one exactly of the value required. For instance, for the 0.0021μF capacitor a number of 0.002μF components should be checked until one of the required value is found. It is preferable that the phase shift components be mounted on a Paxolin panel, and the whole panel can then be fitted inside a large i.f. transformer can. In order to ensure that both signals taken from the phase shift network are of equal amplitude, arrangements are made for the outputs to appear across potential dividers, one of which, R_{22}, is variable. TR_7 and TR_8 are high impedance input audio amplifiers. They have collector currents of approximately 1mA and their output transformers should be mounted at least 2in apart to eliminate stray coupling between them. The toggle switch connected to points YY (Fig. 1) is to provide selection of upper or lower sideband at will. Should it be required to use one sideband permanently this switch may be left out.

Adjustment

After the wiring has been carefully checked a crystal should be plugged in and the slug in L_1 adjusted until oscillations are obtained. This may be checked on a receiver or with an absorption wavemeter held close to L_1. L_3, L_4, L_5, and L_6 should then all be tuned for maximum output, the signal being checked on a receiver for any roughness that would indicate instability. L_6 is tuned by C_{17} and C_{18}. The two 1kΩ balance potentiometers, R_4 and R_5, should next be adjusted for minimum output. The carrier should now have been reduced to a very low value.

Inject an audio tone of about 1,000 c/s into the microphone socket. Advance the gain control, R_8, and check the a.c. voltage on the collectors of TR_7 and TR_8 with a valve voltmeter or oscilloscope. If they are not equal adjust R_{22} until they are. Listening to the signal or checking it with an oscilloscope will probably give a modulated signal. L_2 should now be adjusted until the modulation is minimised. While it may not be possible to eliminate the modulation entirely it will be possible to reduce it to a satisfactory low level. Conditions that will prevent this are incorrect r.f. phasing, (readjust L_1 and L_2), lack of carrier suppression (readjust balance potentiometers R_4 and R_5), or lack of audio balance (readjust R_{22}). An oscilloscope will prove a most valuable piece of equipment when dealing with single sideband units, and the experimenter is strongly advised to use one for testing purposes. An absorption wavemeter can be placed near L_6 and it will be noted that only with modulation applied is any indication given. The signal may finally be checked on the station receiver for sideband suppression and carrier suppression.

Results Obtained

In spite of the very low power output of this transmitter, S9, reports have been obtained from stations up to 10 miles distant, when using an aerial approximately 200ft long. Once the signal has been located and correctly tuned, station have reported excellent readability even through heavy interference. The total power consumption is of the order of 180mW. A grid bias battery is used in the writer's case. It is hoped in the future to build a higher powered p.a. stage when a suitable transistor becomes available to the author.

Coil Winding Table

Coils L_1, L_2, L_3, L_4 and L_5 are wound on $\frac{7}{16}$in Aladdin slug tuned formers.

L_1. 50 turns of 28 s.w.g. enamel copper close wound.

L_{1A}, L_{1B}. 5 turns of 26 s.w.g. plastic covered wire wound over earthy end of L_1.

L_2, L_4 and L_5. 50 turns of 28 s.w.g. enamel copper close wound with 5 turn link of 26 s.w.g. plastic covered over earthy end.

L_3. 28 turns of 28 s.w.g. enamel copper centre tapped with 4 turn link over centre of 26 s.w.g. plastic covered.

L_6. 65 turns of 19 s.w.g. enamel copper on $1\frac{1}{8}$in diameter former.

Tadic Helps London University to Study the Skies

Equipment has now been installed at University College, London, by E.M.I. Electronics Ltd. for use in the analysis of data obtained from Skylark high-altitude research rockets. This information concerns ultra-violet radiation and soft X-rays from the sun, stars and space, and the conditions of ionisation in the upper atmosphere—its temperature, concentration and character.

Known as TADIC, the Telemetry Analogue-to-Digital Information Convertor, it is the first fully transistorised equipment of its kind in this country. It will process data in 10 hours which would take three people, working manually, three weeks to process.

Skylark firings take place in Australia, and the telemetered information is recorded on magnetic tape, on coded frequencies in the range 35–65 kc/s. TADIC is used to convert this analogue tape recording into a form in which it can be analysed on a digital computer.

The magnetic tape is first replayed into a frequency discriminator, to produce a voltage output of the same form as the time division multiplexed input to the telemetry transmitter. This waveform is fed to a fast analogue-to-digital convertor and the digital output recorded on a secondary magnetic tape.

At the same time as data are replayed from one track, time of flight to millisecond accuracy is replayed from another. This time is digitised and recorded on the secondary magnetic tape at periodic intervals.

At present, the computer being used by University College requires a punched paper tape input. It is therefore necessary to replay the digital magnetic tape on TADIC at a reduced speed, to produce another recording on punched paper tape.

The eleventh in a series of articles which, starting from first principles, describes the basic theory and practice of radio

part 11

understanding radio

By W. G. MORLEY

IN LAST MONTH'S CONTRIBUTION IN THIS SERIES WE completed our discussion of practical fixed capacitors, covering ceramic and electrolytic components. We also listed the colour codes employed for indicating capacitor value, tolerance and temperature coefficient. We shall now carry on to practical variable capacitors.

Variable Capacitors

Many circuits require a capacitor whose value may be varied by means of a simple control. This need is met by variable capacitors.

We have already seen[1] that the value of a capacitor may be altered either by varying the area of overlap of the two plates or by varying the distance between them. Either of these methods can be utilised in the design of a variable capacitor. However, variable capacitors capable of being manually controlled by means of a knob almost invariably rely on varying areas of overlap, and we shall consider these first.

Fig. 48 illustrates the basic variable capacitor construction. In Fig. 48 (*a*) a set of semi-circular plates is fitted to a spindle which is free to rotate. As the spindle is turned these plates enmesh to a greater or lesser degree with the stationary plates. The two sets of plates are insulated from each other, with the result that a capacitance appears between them which varies as the spindle is rotated. Minimum capacitance is given when the rotating plates have the position illustrated in Fig. 48 (*b*), and maximum capacitance is given when the rotating plates are as shown in Fig. 48 (*c*).

In the construction shown in Fig. 48 (*a*) the rotating plates would be connected to the metal frame of the capacitor by means of a spring contact pressing against the spindle (this providing a more

[1] In "Understanding Radio", Part 8, April 1962 issue.

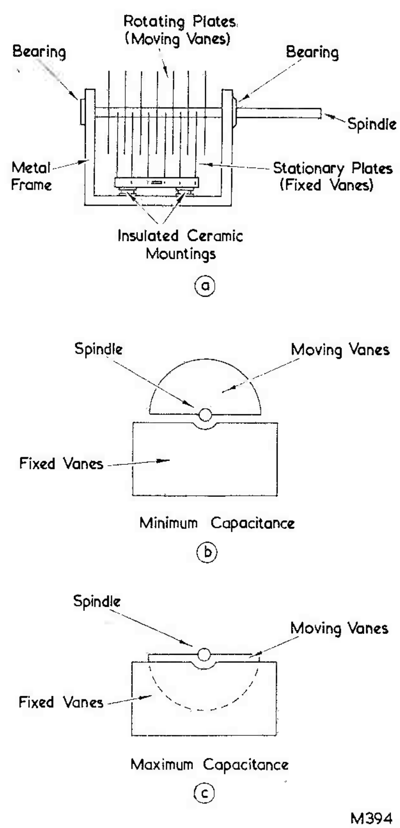


Fig. 48 (a). The basic variable capacitor
(b). Minimum capacitance setting
(c). Maximum capacitance setting

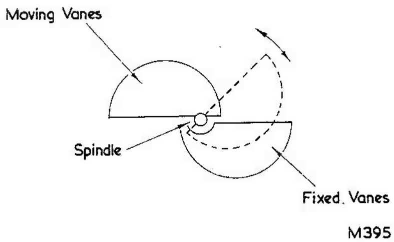


Fig. 49. Vane shapes similar to that shown here are frequently employed in practical variable capacitors

reliable contact than would be provided through the spindle bearings). Such a method of assembly is very common, and results in the rotating plates having the same potential as any metal panel or chassis to which the capacitor is fitted, unless some form of insulated mounting is employed. Normally, circuit requirements are such that this connection to chassis is acceptable. In practice, the rotating plates are referred to as the *moving vanes*, or *rotor vanes*, and the stationary plates as the *fixed vanes*, or *stator vanes*. Frequently, the word *plates* is used instead of *vanes*.

According to circuit requirements, practical variable capacitors may consist of almost endless variations on the basic design of Fig. 48. If larger maximum capacitances are required, a greater number of fixed and moving vanes will be employed in the construction. If lower capacitances are required fewer vanes are fitted, and a very low value component may have one moving and one fixed vane only. A greater maximum capacitance will be given if the spacing between fixed and moving vanes is reduced, and modern miniaturised variable capacitors have very small spacing between vanes, care having been taken in design to ensure that the vanes and mountings are sufficiently rigid to ensure that correct spacing is maintained for all settings of the spindle. It is worth pointing out, incidentally, that variable capacitors of this type should always be handled with the moving vanes fully enmeshed with the fixed vanes. Otherwise, one or more of the moving vanes can be accidentally bent out of position and will short-circuit to the fixed vanes when the vanes are enmeshed.

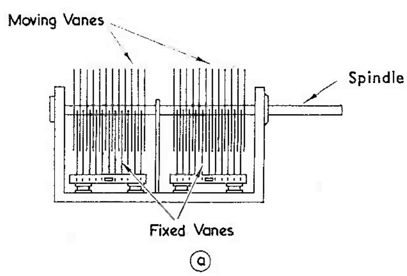
Most modern applications do not require a variable capacitor with semi-circular vanes, as is shown in Fig. 48. A more usual shape would be similar to that illustrated in Fig. 49. In Fig. 48, increase in capacitance is approximately proportional to spindle rotation whereas, in Fig. 49, the initial increase in capacitance is more gradual. The vane shape employed in practice depends upon the function for which the variable capacitor is intended, and the graph given by drawing capacitance change against spindle rotation is described as the *characteristic* or *law* of the capacitor. Radio receivers employ variable capacitors for tuning purposes, and these are given a characteristic which enables the receiver scale to be graduated fairly evenly in units of wavelength.

It is frequently necessary for two or more variable capacitors to be operated from one spindle, and a typical arrangement is illustrated in Fig. 50 (*a*). Here, two variable capacitors are *ganged*, and the component is known as a *two-gang* capacitor. *Three-gang* and *four-gang* variable capacitors may be made up in a similar manner. It is desirable, in some instances, to ensure that the capacitors of a gang component all have almost exactly the same capacitance throughout the rotation of the spindle. The rotor end vanes are usually slotted, as in Fig. 50 (*b*), to allow adjustments to be made when this degree of accuracy is required. The sectors between the slots may be bent out to reduce capacitance over the corresponding angle of spindle rotation.

Many two-gang tuning capacitors intended for medium-wave, or for medium and long-wave, receivers are made with one of the sections lower in maximum capacitance value than the other.

Figs. 51 (*a*) and (*b*) show two alternative vane arrangements which may be encountered in single variable capacitors (i.e. not ganged components). In Fig. 51 (*a*) two sets of fixed vanes are so arranged that, as the spindle rotates, the capacitance of one half of the variable capacitor increases and that of the other half decreases. This component is known as a *differential capacitor*. Another vane combination is illustrated in Fig. 51 (*b*), wherein the two sets of fixed vanes are insulated from each other. This is described as a *butterfly capacitor*, the name deriving from the shape of the moving vanes.

The capacitors we have considered up to now are sometimes referred to as "air-spaced" to differentiate them from the *solid dielectric variable capacitor* illustrated in Fig. 52. The latter has fixed and moving vanes made of thin brass, these being



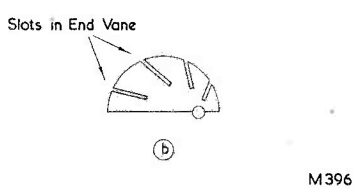


Fig. 50 (a). The two-gang capacitor
(b). Slotted end vanes allow the sections of a gang capacitor to have nearly equal capacitance throughout the range of adjustment

separated from each other by thin sheets of insulating material. The insulating sheets prevent the sets of vanes from short-circuiting, and the close spacing and thin vanes enable a very compact assembly to be constructed. Also, since there is no necessity to accurately position the vanes during manufacture, the component is cheaper (especially on the component retail market) than its air-spaced equivalent. Unfortunately, the dielectric used is not as efficient as air for many radio requirements and variable capacitors of this nature are more frequently used by the home-constructor than by the commercial set-maker. The re-set accuracy (i.e. the ability to present the same capacitance when returned to a previous setting) of solid dielectric capacitors is not high and they are rarely employed in ganged assemblies.

Pre-Set Variable Capacitors—The Trimmer

Pre-set variable capacitors, or *trimmers*, are used very often in radio circuits. They consist of variable capacitors which are required to be adjusted occasionally only and which do not, therefore, form part of the manually operated controls of the equipment in which they are used. According to their design and construction, trimmers are adjusted by screwdrivers or by special *trimming tools*. Trimmers are normally required to have lower maximum capacitances than variable capacitors, and they do not have to withstand continual adjustment or to present specific characteristics as does the variable capacitor. In consequence, trimmers can be made considerably smaller in size and simpler in design than variable capacitors.

Trimmers function by varying the area of overlap between plates, as with the variable capacitor, or by varying the distance between plates. We shall examine the latter type of operation first.

In Fig. 53 (*a*) we see a pre-set variable capacitor in which the distance between two flat circular plates is adjusted by a threaded spindle attached to one of the plates. Rotating the spindle varies the distance between the plates. Components of this type are normally employed in amateur transmitters to provide very small pre-set values of capacitance in applications where a high voltage appears between the plates. Such a component is much larger in size than the trimmers employed in radio equipment, but it illustrates the simplest manner in which capacitance may be pre-set by a varying distance between plates.

A very commonly encountered trimmer is shown in Fig. 53 (*b*). This has a fixed plate and a moving plate separated by a thin sheet of mica and the distance between the two is varied by adjusting the screw. The moving plate is made of springy material which opposes the pressure exerted by the screw. It also has a slightly curved surface which can be flattened out by the screw when the latter is set for maximum capacitance. Two solder tags integral with the plates are provided, and the latter are eyeletted in position on an inexpensive ceramic base. Typical dimensions for the component are 0.75in long by 0.6in wide. Trimmers of this type are usually known as *mica trimmers* or as *postage stamp trimmers*. Sometimes, two or three such trimmers are mounted on a single base of insulating material.

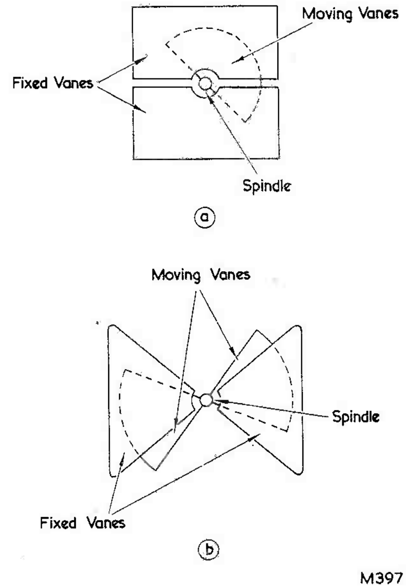


Fig. 51 (a). The vane layout of the differential capacitor
(b). The butterfly variable capacitor

Alternative constructions to that of Fig. 53 (*b*) may employ a Paxolin base or may have a metal base which also acts as the fixed plate. These alternatives function in the same basic manner.

The mica trimmer offers only a small change in capacitance when the adjusting screw is initially adjusted from the minimum capacitance position. The rate of change of capacitance rises steeply when the moving plate closely approaches the fixed plate, being at a maximum when the adjusting screw finally flattens out the moving plate. This varying rate of change of capacitance is not a disadvantage for most trimmer applications. Despite its simple construction, the long term stability of the postage stamp trimmer is quite good, and is certainly

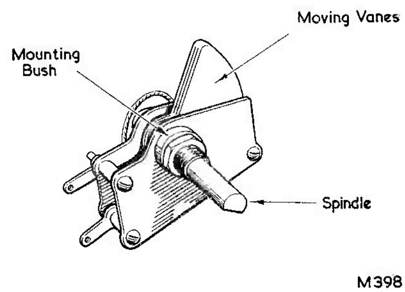


Fig. 52. A typical solid dielectric variable capacitor

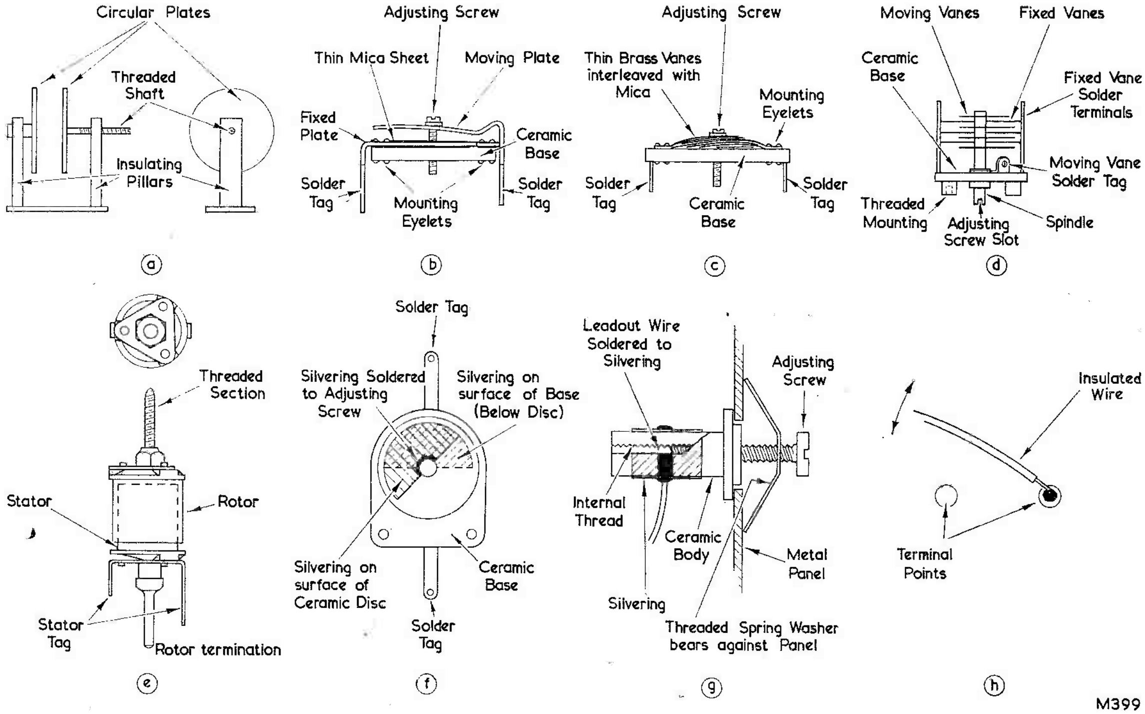


Fig. 53 (a). A pre-set variable capacitor, frequently employed in amateur transmitting equipment
(b). The mica trimmer
(c) The compression trimmer
(d). An air-spaced trimmer
(e) The Philips, or Mullard, concentric trimmer
(f). A ceramic disc trimmer
(g). A tubular ceramic trimmer, mounted on a metal panel. Part of the ceramic is shown cut away to illustrate the internal thread
(h). The "gimmick wire"

adequate for such requirements as tuning circuit adjustments in medium and long-wave receivers. Capacitance is most liable to shift with time when the trimmer is set very near the minimum or maximum capacitance positions. In the first case a low degree of friction is applied to the adjusting screw which may then shift due to mechanical shock; and in the second case there may be capacitance drifts due to flexing of the heavily stressed moving plate. It is always desirable to employ mica trimmers in such a manner that the desired capacitance is not close to the minimum or maximum capacitance settings.

Typical maximum capacitances for mica trimmers range between 40 and 100pF.

Fig. 53 (*c*) illustrates a *compression trimmer*. This is similar to the postage stamp trimmer with the exception that there are several sets of plates, together with interposed sheets of mica. The adjusting screw compresses the plates together as it is rotated, and thereby increases capacitance. Trimmers of this nature have high values of minimum capacitance and a typical component would offer a range of some 100 to 400pF. The long term stability of a compression trimmer is not quite as good as that of a postage stamp trimmer. Compression trimmers are not enountered frequently at the present, but they have given reliable service in the past in the tuning circuits of medium and long-wave receivers.

A typical instance of a trimmer which functions by varying the area of overlap between two plates is shown in Fig. 53 (*d*). As may be seen, this is a scaled-down version of a normal variable capacitor. By means of a spring washer, or similar device, friction is applied to the rotor spindle to maintain it in position after adjustment.

Fig. 53 (*e*) illustrates an alternative form of trimmer. This is the *Mullard*, or *Philips concentric trimmer*. The trimmer employs two concentric metal tubes, the lower one in the diagram (the stator) extending inside the upper. As the upper tube (or rotor) is turned it travels up or down the threaded section, with the result that the area of overlap between the two tubes, and hence the capacitance, is varied. Higher values of maximum capacitance may be given by adding further sets of concentric tubes inside the two outer tubes. Connection to the stator is obtained by means of two solder tags, whilst connection to the rotor is given via the threaded section. The latter extends through a ceramic sleeve in the body of the trimmer, appearing at the bottom as a plain conductor to which connection may be made. The rotor is maintained in a concentric position relative to the stator by means of a sleeve which fits closely over the ceramic sleeve in the body of the trimmer. The construction offers a wide range of capacitances, typical values for a single component being from 4pF or less minimum to 60pF or more maximum, or from 2pF or less minimum to 8pF or more maximum. A trimming tool, fitting over the hexagonal section at the top of the rotor, is required.

Another type of trimmer is shown in Fig. 53(*f*). In this, a ceramic disc free to rotate upon a ceramic base is fitted with an adjusting screw. Fired over 180° of the surface of the disc is a layer of silvering which is soldered to the adjusting screw. A similarly shaped area of silvering is fired over the ceramic base of the trimmer. As may be seen, rotating the disc causes the overlap between the two silvered areas to be varied, and the device functions, in consequence, as a trimmer. Connections to the two silvered layers are made via solder tags, that for the rotor silvering coupling to the adjusting screw.

An alternative ceramic trimmer is illustrated in Fig. 53 (*g*). This employs a ceramic tube, on the outside of which is fired a layer of silvering. The inside of the tube is threaded and accepts a metal screw, maximum capacitance being given when the screw is fully inserted in the ceramic tube. A specially-shaped threaded spring washer is fitted to the screw and this not only provides a means of mounting but also offers a connection to the screw, together with a degree of friction to maintain it in the required position. Connection to the outside silvering on the ceramic tube is achieved by soldering on a lead-out wire. The small size, ingenious design and inexpensive construction of this particular type of trimmer has caused it to be widely employed in television tuner units, in which only low values of trimming capacitance are required. A typical range for such a trimmer is of the order of 0.5 to 5pF, although maximum capacitances up to some 30pF are available.

The trimmers of Figs. 53 (*d*), (*e*), (*f*) and (*g*) have a higher long-term stability than those of Figs. 53 (*b*) and (*c*) and have better temperature coefficient characteristics. If desired, the trimmers of Figs. 53 (*f*) and (*g*) can employ ceramic having a specific temperature coefficient, whereupon the component may offer a degree of "temperature compensation".

Although not exactly a trimmer in the true sense of the word, the arrangement shown in Fig. 53 (*h*) should be included here for the sake of completeness. It consists, quite simply, of a piece of insulated wire which is bent closer to, or further away from, another conductor. In consequence, it offers a varying capacitance which can be adjusted up to a maximum of some 1 to 2pF. This device is quite often employed in commercial receiving equipment and is sometimes referred to as a "gimmick wire". A strip of malleable metal may sometimes be employed instead of the wire.

Capacitor Symbols

The circuit symbol for a fixed capacitor is shown in Fig. 54 (*a*). Each parallel line in the symbol represents a plate. An electrolytic capacitor is

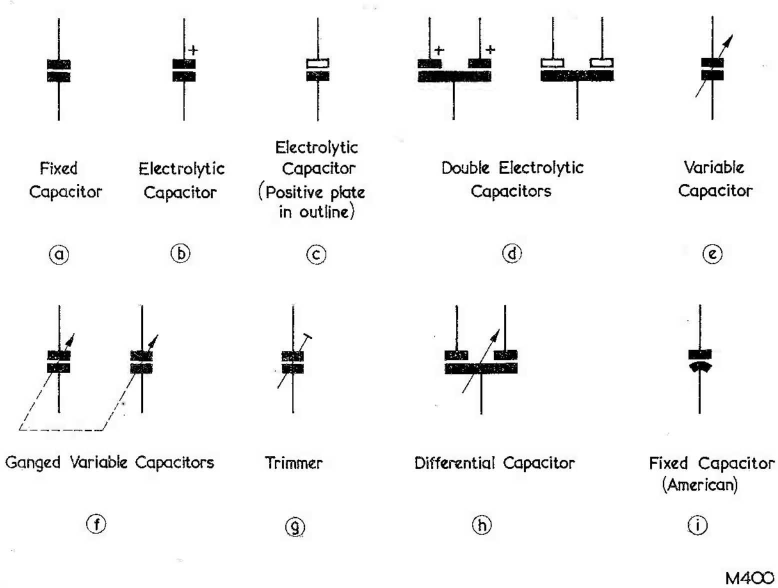


Fig. 54. Symbols for different types of capacitor. These are discussed in the text

shown as in Fig. 54 (*b*) in which the positive plate is indicated by the plus sign, or as in Fig. 54 (*c*) in which the positive plate is shown in outline only. Sometimes the plus sign may be added to this symbol as well. If an electrolytic component has two capacitors inside the one can, these may be shown as in one of the combined symbols of Fig. 54 (*d*).

A variable capacitor is depicted as shown in Fig. 54 (*e*), the arrow indicating variable. If two variable capacitors are ganged together, the capacitors are drawn in separate parts of the circuit and the two arrows are linked together by a dashed line, as in Fig. 54 (*f*). A trimmer is depicted as in Fig, 54 (*g*), the T-shaped symbol indicating "pre-set". A differential variable capacitor is shown as in Fig. 54 (*h*), the rotor vanes being represented by the long line.

In American circuits it is common practice to show one of the plates in the symbol curved, as in Fig. 54 (*i*). In circuits where such a connection is applicable, the curved plate is usually that which is at chassis potential, whilst with variable capacitors it represents the rotor. Apart from the use of the curved plate, American capacitor symbols are the same as those shown here, with the exception that electrolytic capacitors normally employ the Fig. 54 (*b*) presentation and not that illustrated in Fig. 54 (*c*).

Individual capacitors in a circuit diagram are normally identified by the letter C and a number suffix: e.g. C_1, C_2, etc. The letter C may be applied to fixed capacitors, variable capacitors, and trimmers alike. Occasionally, variable capacitors may be identified by the letters VC and a suffix number.

Capacitors in Parallel and Series

When we considered multi-plate capacitors[2] we saw that capacitance increased as additional plates were added to the assembly. In effect, single capacitors appeared between adjacent plates, and the total capacitance of the assembly was equal to the sum of these individual capacitances.

This concept is helpful here, since it illustrates the fact that when two or more capacitors are connected together in parallel the total capacitance is equal to the sum of the individual capacitances. In Fig. 55 (*a*) we have a 500pF and a 250pF capacitor connected in parallel. The total capacitance is 750pF. In Fig. 55 (*b*) there are four capacitors in parallel, these having values of 0.01μF, 0.02μF, 0.05μF and 0.1μF. The total capacitance is their sum, i.e. 0.18μF.

When two equal value capacitors are connected together in series, the total capacitance at the outside terminals is half that of either capacitance. This effect is fairly easy to appreciate; and it may prove helpful to assume that both capacitors have exactly the same type and thickness of dielectric. When the two are in series, twice the thickness of dielectric then appears between the outside plates and a consequent halving of capacitance is not difficult to visualise. If a third capacitor of equal value were connected in series, the total capacitance becomes one third of each individual capacitance, and the same reasoning can be applied here again.

The effect of connecting capacitors in series is similar to that of connecting resistors in parallel and the total capacitance is represented by the formula:

$$\frac{1}{C}=\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}+\ldots$$

where C represents the total capacitance and C_1, C_2, C_3, etc., the individual capacitances.

[2] In "Understanding Radio", Part 8.

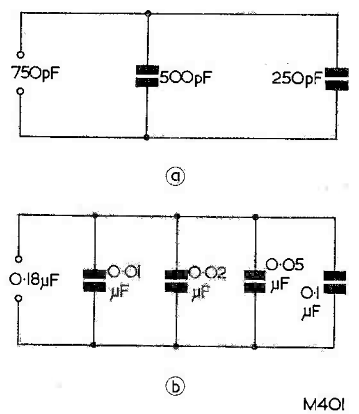


Fig. 55. Capacitors in parallel offer a total capacitance equal to the sum of the individual capacitances

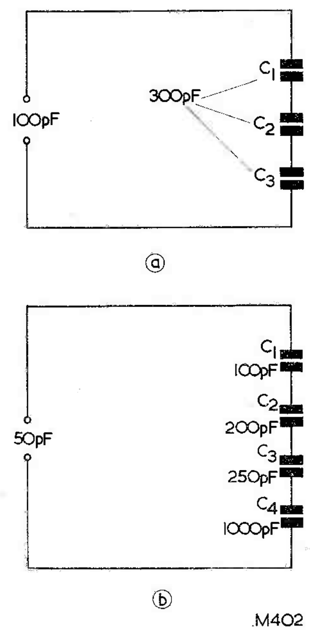


Fig. 56 (a). Three 300pF capacitors in series offer a total capacitance of 100pF
(b). Four capacitors with different values connected in series

Fig. 56 (*a*) shows three 300pF capacitors in series. From our formula we get:

$$\frac{1}{C}=\frac{1}{300}+\frac{1}{300}+\frac{1}{300}$$

$$=\frac{3}{300}$$

$$\therefore C=\frac{300}{3}$$

$$=100\text{pF}.$$

As we would expect, the total capacitance is a third of the individual equal capacitances.

In Fig. 56 (*b*) we have four capacitors in series, these having values of 100pF, 200pF, 250pF and 1,000pF. The total capacitance is given by:

$$\frac{1}{C}=\frac{1}{100}+\frac{1}{200}+\frac{1}{250}+\frac{1}{1{,}000}$$

$$=\frac{10+5+4+1}{1{,}000}$$

$$=\frac{20}{1{,}000}$$

$$\therefore C=\frac{1{,}000}{20}$$

$$=50\text{pF}.$$

The total capacitance is 50pF.

If only two capacitors are connected in series, the formula may be simplified to:

$$C=\frac{C_1\,C_2}{C_1+C_2}$$

When capacitors are connected in series, it is important to ensure that the working voltage of any single capacitor is not exceeded. If the voltage applied to the capacitors is lower than the working voltage of any single capacitor no difficulty on this count exists.

To take an example, Fig. 57 (*a*) illustrates two equal value electrolytic capacitors in series coupled to a source of e.m.f. Each capacitor has a working voltage of 350, and the source voltage is 600. The source voltage will very probably not divide equally between the two capacitors since their leakage resistances will almost certainly be dissimilar. Let us assume that the leakage resistance of the upper capacitor, C_1, is 1MΩ and that of the lower capacitor C_2, is 200kΩ. We can add these resistances to the diagram as physical resistors to see what action they perform, and this we do in Fig. 57 (*b*), wherein the capacitors themselves are now assumed to have an infinite leakage resistance. As, is at once apparent, a potential divider circuit is given, with

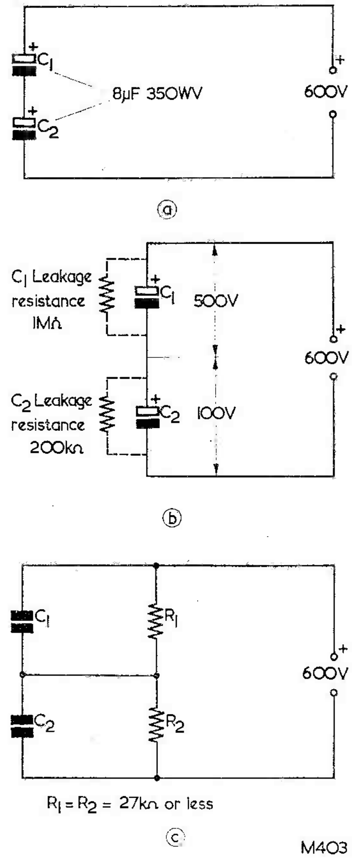


Fig. 57 (a) and (b). It is unwise to connect capacitors as shown in (a) because different leakage resistance may cause excessive voltage to appear across one of them

(c). Additional resistors ensure a more equal voltage distribution

one sixth of the supply voltage appearing across C_2 and five-sixths across C_1. The result of this may be quite catastrophic because, if C_1 breaks down due to the 500 volts applied across its plates, it will function as a short-circuit and cause the full 600 volts to be applied to C_2; which will then break down in its turn!

This risk may be overcome by connecting equal value physical resistors across C_1 and C_2 as in Fig. 57 (*c*). These resistors should have a value significantly lower than the lowest leakage resistance and, in this instance, could conveniently be 27kΩ or less. Such resistors ensure that each capacitor has approximately half the source voltage applied across its plates, and they thereby obviate the risk of breakdown.

We employed electrolytic capacitors in the illustration just given, because these represent an instance of series capacitor connection which is often encountered in practice. Other types of capacitor have much higher leakage resistances than electrolytic components, but if the voltage applied across two such capacitors in series is greater than the working voltage of either, additional resistors should still be added as shown in Fig. 57 (*c*). In this instance the additional resistors would normally offer sufficient protection if they had values around 470kΩ or so.

Next Month

In next month's issue we shall introduce the subject of inductance.

The NOMOTRON

By J. ANDERSON

THE NOMOTRON VALVE HAS SUCH A WIDE RANGE of uses, and is of such value to the experimenter, that it is a continual source of surprise that more are not in use at the present time: accordingly, a short explanation of their principles and application may not be out of place at the present time, especially since they are now becoming more easy to obtain, as well as a little cheaper.

The tube consists of ten separate cathodes, all of which have an individual base connection: these are specially shaped, and separated from each other by electrodes (which are connected in parallel to a single base-pin) specially shaped again, and known as the transfer electrodes. The entire ring is covered by a cup-shaped anode, in which there are small holes, one to correspond with each cathode, and within which there is a further electrode known as the shield.

The tube is in fact a gas-discharge tube, the glow existing on one cathode at any one time, and the purpose of the shield electrode is to limit the glow to one electrode at any state of the valve: the shield is charged to a moderately high positive potential.

In the "start" state, a glow discharge exists between the first cathode, K_O, and the anode, and for purposes of observation this glow can be observed through the appropriate hole in the anode. A negative pulse is now applied to the transfer electrode, and the glow spreads to the first transfer electrode, T_1, as it has been primed by the discharge from K_O: the voltage between K_O and the anode, which is the normal maintaining voltage of a gas-filled tube, will fall due to the increased current in the load resistance, and this will therefore extinguish the discharge from K_O.

At the end of the negative pulse, T_1 will return to its normal state of positive bias, and since the cathode K_O is still positively biased because of the charge on the cathode capacitor, the glow will move to the nearest unbiased cathode, which in this case is K_1.

This process is repeated until after ten negative pulses are applied to the transfer electrodes, K_O will once more be the "live" cathode, and the process will begin again.

It will have been noticed that the pulse required to "trigger" the tube is a negative one, and in fact it should be greater than 12μs length, with 120±15V amplitude. The shorter the length of the pulse, the lower the time-constant of the cathode circuit can be made, and the more stable and consistent the circuit will be in operation. The author has operated this type of tube up to frequencies of 40 kc/s with no difficulty, but higher frequencies are probably easily obtainable.

The power supplies needed are as follows: shield, app. 100V positive. Anode 330±15V.

A Nomotron can be driven from the mains supply frequency, as shown in Fig. 1, but the usual form of supply is a pulse generator. There are various circuits which will fulfil the conditions needed, but

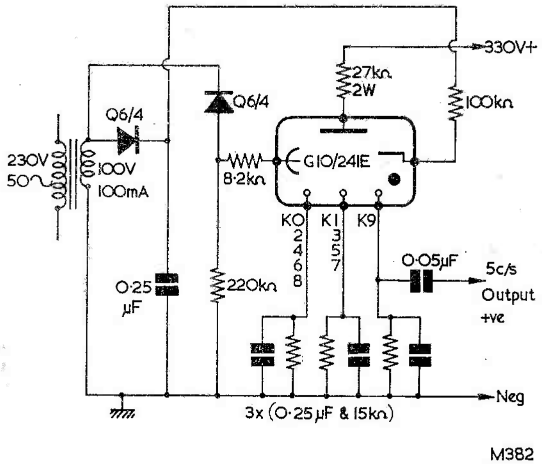


Fig. 1. Driving a Nomotron from 50 c/s a.c. mains

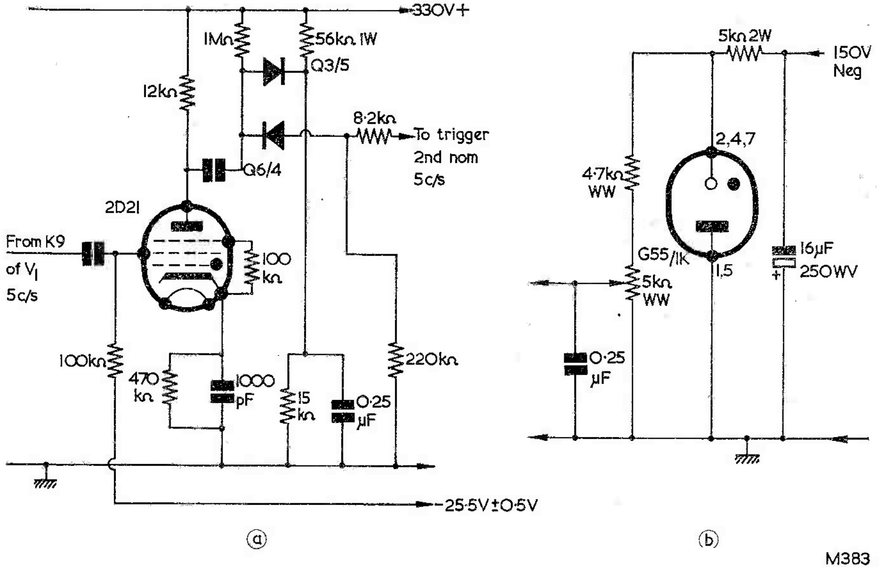


Fig. 2. (a) A pulse generator circuit which may be connected between Nomotrons and (b) a stabilised bias supply for the pulse generator

the most convenient is probably the circuit shown in Fig. 2 (*a*) using a 2D21 thyratron. This will need a carefully regulated negative voltage, which can be obtained from the circuit of Fig. 2 (*b*). All the resistors in this should be precision wirewound, but the actual supply need not be smoothed if this is more convenient.

The two Nomotrons shown in Fig. 3 are arranged to feed from the 50 c/s mains, the first passing one pulse in ten into the second tube, which will then pass one pulse in two. This gives an available output of 2½ slow pulses a second from the output of the second circuit.

It is possible to drive such a dividing circuit from an audio signal generator, and obtain a series of accurate lower frequencies simultaneously. If a rather bulky unit is not inconvenient, then a high-frequency crystal can be used to provide a drive which, after division down to 50 c/s, will drive an electric clock motor to provide a highly accurate time-source. In the same way, an electronic metronome can be made, and if the grid circuit of the pulse generator is fed from a telephone dial, an adding machine can be made. The possibilities, both for novelties and for serious uses, are legion, and it is well worth obtaining one of these fascinating valves in order to experiment with it.

The most easily obtained type is the G10/241.E Nomotron, which is sold for the amateur, complete with holder, by Messrs. Proops Bros. of Tottenham Court Road.

Editor's Note

The G55/1K stabiliser shown in Fig. 2 (*b*) has a nominal stabilising voltage of 55.

The Q3/5 rectifier in Fig. 2 (*a*) has a peak inverse voltage (for half-wave applications) of 340 and a nominal output current of 1mA.

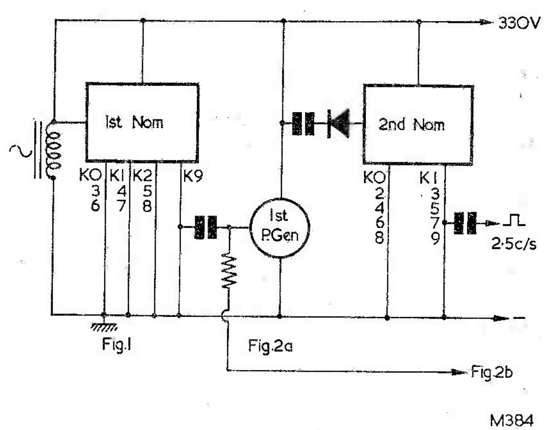


Fig. 3. Skeleton circuit employing two Nomotrons. Individual circuitry is as in the previous diagrams. The second Nomotron will have cathode resistors and capacitors as in Fig. 1

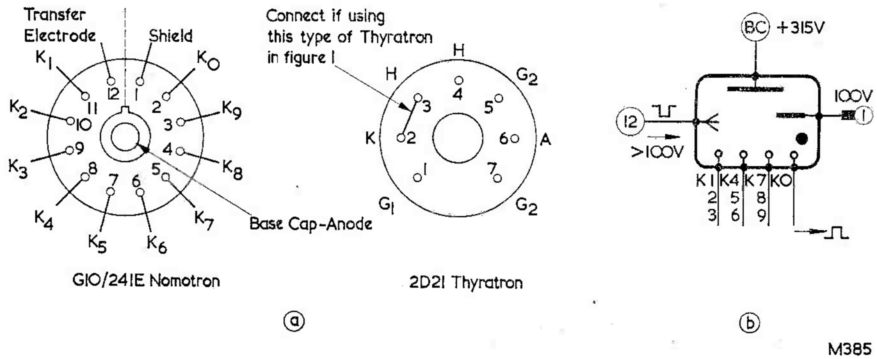


Fig. 4. (a) Pin layout of the Nomotron and the thyratron and (b) the Nomotron symbol

The Q6/4 rectifiers in Figs. 1 and 2 (*a*) are obsolete, although they may be available in surplus equipment employing Nomotrons (as, also, may the Q3/5 and the G55/1K). A rectifier capable of passing several mA with a P.I.V. of some 300volts should prove adequate in place of the Q6/4.

Montreal—Vancouver Communications Microwave Network

Construction of a $36 million general communications microwave network between Montreal and Vancouver has been announced by Donald Gordon, President, Canadian National and N. R. Crump, Chairman and President, Canadian Pacific.

The technical planning of the 3,000-mile network has already been completed and actual construction began this summer. It is scheduled to be ready for service by the end of 1963. The line will be owned and operated jointly, with Canadian Pacific Telecommunications responsible for administration and operating between Montreal and Melville, Sask., and Canadian National Telecommunications taking similar responsibility between Melville and Vancouver.

The new system is being built to provide high-quality, high-capacity circuits for use by Canadian business and to meet national defence requirements. For strategic defence reasons, the route of the new line will be generally well away from existing communications facilities spanning the country. Spur lines or "drop outs" from the main system will feed major centres across Canada.

The line will be tied to existing CN-CP microwave and UHF radio circuits servicing the Atlantic provinces, central Canada, the Yukon, the North-West Territories, and Vancouver Island as well as landline circuits operated by the two companies elsewhere in Canada.

Primary use of the network will be for commercial and business communications—telex, teletype circuits, data processing, facsimile transmission, telemetering, cable and message traffic and allied fields. Necessity for the line is based on the rapidly growing market for these services. Present facilities are not able to keep pace with the expanding communications field. Railway communications for CPR and CNR will also be handled.

RCA Victor Company of Canada Limited, Montreal, has been awarded a $12 million contract for manufacture and installation of electronic equipment. Specifications call for microwave gear of an advanced design to give high-speed, high-quality transmission necessary for newer commercial telecommunications equipment and business data processing systems planned by manufacturers for the future. Although not intended initially for television transmission, the network will be built to a standard capable of carrying black and white or colour television signals.

The system will follow a route north from Montreal with "drop outs" leading to Ottawa, Toronto, North Bay and Fort William, Ontario. The line will then swing north of Winnipeg and Regina, although connected to both prairie centres, pass close to Saskatoon and Edmonton with connectors, and then drop down to Vancouver.

A basic purpose behind the route which takes the line away from major centres, is to bypass built-up areas which might be affected in the event of hostilities. In this way, while a Canadian city might be destroyed or damaged in the event of an attack, the main cross-country network would continue in operation to other points.

Some 136 microwave relay towers will be built to complete the system. Initial survey of the planned route has been completed.

Initially, the microwave network will consist of two channels, each capable of providing 600 voice circuits. Provision has been made in the design and engineering, however, for additional channels to be superimposed on the system as needed.

Special attention has been given to the network to provide automatic remote control, monitoring and warnings systems. In areas where accessibility to towers will be difficult because of their location, radio equipment and power facilities capable of operating unattended for long periods have been specified.

NEWS and COMMENT

TV Telephone

A Special Correspondent of *The Times* recently wrote a very interesting article on the prospects for a visual telephone.

The National Research Development Corporation have, for some years, been financing a project which it is hoped will soon be tried out commercially. According to the article, the technique allows highly complicated signals representing television, etc., normally requiring a wide information channel, to be carried over more conventional circuits.

Dr. Colin Cherry of the Imperial College of Science and Technology, London University, is leading a small team of scientists in this work. He has stated that it is not science fiction any longer to imagine a conference or board room meeting of the future with some form of remote visual contact.

The above project gives point to the views of Mr. Sol Cornberg, an American, who is a believer in education by machine. (This is an over-simplification, of course.) In a recent interview on B.B.C. television Mr. Cornberg argued from the premise that, as the birth rate continues to outstrip the supply of teachers, the solution is "to assist the educator to multiply himself" and to feed information for students into a number of mechanical devices.

Well, we shall "see".

Guide to British Electronic Valve Industry

A guide to the structure of the British electronic valve and semiconductor industry, published recently in booklet form, broadly classifies 48 types of valves, tubes and other devices and gives the names of the firms which make each type mentioned.

In a brief historical foreword it is stated that British production of electronic valves and tubes exceeds 90 million annually while the current annual rate of manufacture of semiconductor devices in the United Kingdom is of the order of 32 million transistors, 28 million diodes and five million rectifiers (including selenium). Exports have been growing steadily and direct exports of valves for industrial purposes alone have multiplied more than three times over the last four years.

There is a reminder in the 800-word history that the thermionic valve, patented in 1904, resulted from research by a British scientist Sir Ambrose Fleming, and that the magnetron, which revolutionised radar, and travelling wave tubes were invented in the U.K.

Primarily intended as a brief for British Commercial Attaches and Information Officers abroad, the booklet is published by the British Radio Valve Manufacturers' Association (B.V.A.) and the Electronic Valve and Semiconductor Manufacturers' Association (V.A.S.C.A.) and is available post free from the secretary, B.V.A., Mappin House, 156 Oxford Street, London, W.1.

The B.V.A., formed in 1926, is concerned solely with entertainment types of valves and television cathode ray tubes, V.A.S.C.A. being responsible for all industrial valves and tubes and semiconductor devices. Each association is autonomous, but they share the same secretariat and offices and work closely together in all matters involving liaison with government departments, allied trade associations and international bodies.

Bird Watching

With the development of high power microwave radars, and their passage into operational use for both civil and military purposes, the phenomenon of radar "angels" has become a common occurrence.

To explain them, The Institution of Electrical Engineers' Electronics and Communications Section invited Dr. E. Eastwood, Director of Research, Marconi's Wireless Telegraph Co. Ltd., to take as his subject "Radar Observations on Bird Migration" at the Section's Annual Lecture.

A radar angel is a signal displayed upon the Plan Position Indicator (P.P.I.) of the radar station, which does not correspond to the echoes received from aircraft, from clouds or from hills and trees. For a long time the origin of such radar angels was in doubt, but it is now known that the majority of angels can be attributed to reflection from birds.

Bird effects can constitute an operational hazard in high power radars, and allowance has to be made for them in their design. On the other hand, radars can be designed as an ornithological tool for the study of bird migration, detecting and recording the echoes from moving birds.

At the Marconi experimental radar station, situated on Bushy Hill in Essex, film records have been obtained of the periodic changes which take place in the pattern of bird movement around the south-east corner of England. These studies have not only materially assisted the radar development work of the laboratory, but they have also revealed a number of exciting new facts concerned with bird migration.

The Television Society's Silver Medal Award for 1961

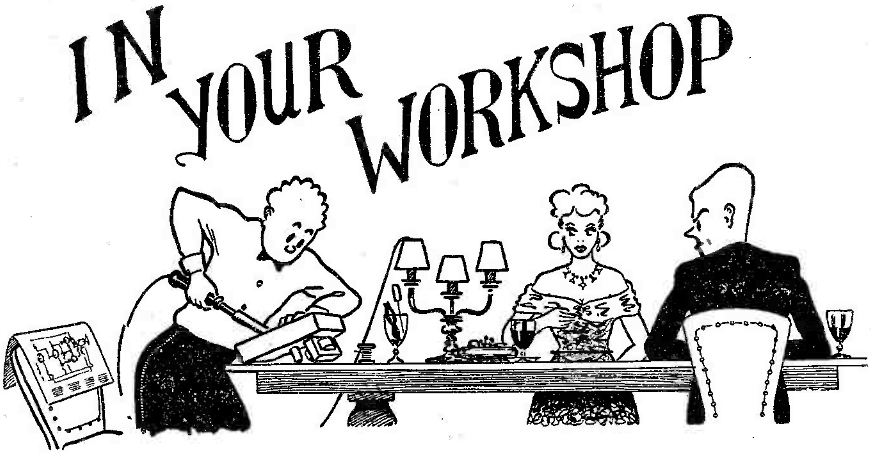
Mr. Richard Cawston, Documentary Film Producer, B.B.C. Television, was presented with the Society's 1961 award at the Annual Dinner of The Television Society held at The Dorchester Hotel, at which many TV celebrities were present.

The Society's Silver Medal is awarded for outstanding artistic achievement in television during the year. It is intended that this medal should acknowledge the work done by an author, actor, producer, or any other member of the television staff in promoting the entertainment, artistic or educational side of television programmes.

Mr. Cawston has been making films with the B.B.C. Television Service since 1947. In the early days of the B.B.C. Film Unit at Alexandra Palace first he was a Film Editor. From 1950 until 1954 he was producer of the original Television Newsreel, being responsible for nearly 700 editions, including all the B.B.C.'s Coronation Newsreels. Since 1955 he has been with Television Talks Department, producing documentary films: during the past few years he has written and produced some of the B.B.C.'s most ambitious and successful projects in this field.

Electric Power from a Kerosene Lamp

A thermo-electric generator, developed in America to run radios in areas not served with electricity, operates by means of a kerosene lamp. This practical, inexpensive device was made for the government of Mexico by the Minnesota Mining and Manufacturing Company, and is being used in rural schools to receive educational television programmes. One pint of kerosene keeps the generator going for 24 hours. The device is expected to be useful on boats, in weather stations and at mining and lumber camps, as it also provides small amounts of light and heat.



This month, Smithy the Serviceman, aided by his able assistant, Dick, settles down to the pleasurable task of discussing the latest batch of hints received from readers.

"DO YOU KNOW, SMITHY," SAID Dick, "this is one of those really *nice* times".

Smithy settled himself more comfortably.

"I must admit," he said reflectively, "that it is quite pleasant."

"Here we are," continued Dick, "at the end of the week. And we don't have to get up early tomorrow morning, either."

"You don't get up early," observed Smithy, "on *any* morning."

"What is more," said Dick, ignoring the Serviceman's comment, "we've cleared out the entire Workshop so far as sets are concerned. *And* we've given the place a thorough cleaning."

The pair sat, resting from their labours, and looked around the unusually neat and tidy Workshop. Evidence of the recent cleaning activities referred to by Dick was given by the golden motes of dust dancing in the slanting rays of the late afternoon sunlight. Had A. E. Housman observed this tranquil scene of Service Manager and Staff taking their ease he may well have written:

There sit the careless people
That call their souls their own;
There by their work they loiter,
How idle and alone.

Readers' Hints

It was the Staff who first broke the silence.

"Smithy."

The Serviceman turned a relaxed eye upon his assistant.

"Hullo."

"How much longer to packing-up time?"

"About half an hour or so," grunted Smithy. "Why, do you want to nip off early?"

"No, it's not that," replied Dick. "I thought that this would be an ideal time to go through the latest batch of hints from readers. We haven't had a hint session for quite a while, you know."

Smithy brightened.

"That's true enough," he remarked, "it will finish the day off perfectly."

He rose, walked over to his bench and extracted a sheaf of letters from a drawer. Dick waited expectantly.

"Here we are," said Smithy, settling himself back on his seat again, and examining a letter he had chosen. "Let's start right away. Now, the first hint has to do with tape recorders. When you're re-winding tape, it can often happen that you let the end of the tape run through without switching off the re-wind motor. The result is that the spool revolves at high speed, and you have a loose free end banging away at everything within reach. The end of the tape may be ruined because of this, and other damage can be caused elsewhere."

"That's true enough," observed Dick. "I've noticed the effect on some recorders myself."

"The cure," said Smithy, showing his assistant a sketch enclosed with

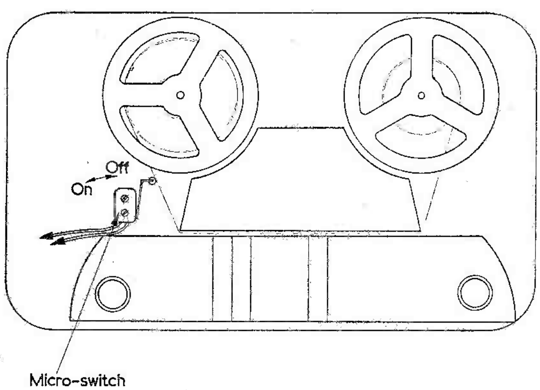


Fig. 1. A micro-switch fitted to a tape recorder can be used to switch off the motor when the tape is finally wound on to one of the spools

the letter (Fig. 1), "is to fit a micro-switch between the head cover and the spool. When the tape is under tension, this switch closes and allows the mains supply to be fed to the motor. When the tape is not under tension the switch opens and cuts off the motor. This idea can, incidentally, be adapted to cover other cases in which the tape may be subjected to stress. As, for instance, may happen if it is threaded loosely, and becomes subject to snatch when the spools take up the slack. I might add that it is possible to obtain micro-switches with a roller at the end of the arm which would be excellent for this application. A typical example would be the Bulgin micro-switches type S510/RP or S510/RSS. The first has a Tufnol roller and the second a stainless steel roller. The tape would, of course, run along this roller."

"That's a neat dodge," remarked Dick. "I can visualise other uses for a micro-switch working from tape tension. It could be used to cut playback or record amplification until the tape was under correct tension, and things like that."

"That seems possible," commented Smithy. "And you've just given a typical example of how one bright idea can spark off other bright ideas. Let's have a look at the next hint."

Smithy selected another letter.

"This one," he continued, "deals with waxed capacitors. Our correspondent says 'I strip my scrap sets and find that the waxed capacitors are usually covered with dust. This makes reading the values difficult. After some thought I hit upon the idea of putting paraffin on the affected component. Because paraffin has such a low surface tension it passes right through the dust and starts melting away the offending layer of wax. I tried this, and after a few seconds I rubbed over the surface with a dry rag; and to my satisfaction I found the component looking brand-new. At first the new surface appeared rather sticky but this vanished before any further dust could adhere.'"

"That's useful," remarked Dick. "I usually try to make the values on such capacitors decipherable by lightly passing a soldering iron barrel over them. But that's a process which tends to cause damage if you aren't careful."

Fuses

"True enough," replied Smithy. "Now there's another hint here which is not exactly new, but which is still worth mentioning because of its simplicity and advantages. The idea is, quite simply, to use 2.5 volt 0.3 amp torch bulbs instead of fuses in low current circuits such as are given by h.t. supplies and the like. There are quite a few advantages to using bulbs in this manner. Firstly, they are easy to replace. Secondly, they are very easily obtainable. Thirdly, they cost about half the normal price for fuses. Fourthly, they give a visual warning of overload before they blow. And, fifthly, by using parallel combinations, most fusing values from 300mA upwards can be obtained."

"Torch bulbs are certainly cheap enough in the chain stores," commented Dick, "and, for people who aren't near radio component shops, are a jolly sight easier to obtain than fuses. Under these conditions, it's easier also to get torch bulb holders than fuse holders. As you say, using torch bulbs as fuses is not exactly a new idea, but it's certainly very attractive when you consider *all* the advantages."

"I've got another one on fuses here," said Smithy, who had been looking through his sheaf of letters. "And it describes a cheap and efficient way of inserting a cartridge fuse in a chassis. What you do is to fit a valve grid-cap clip on each end of the fuse and then wire it into circuit like a resistor. The fuse can be fitted at any accessible point, including below the chassis if the associated receiver has a removable base board. If it blows, a new one can easily be clipped in place."

"That *is* a knobby idea," said Dick enthusiastically. "Have you got any more hints on fuses?"

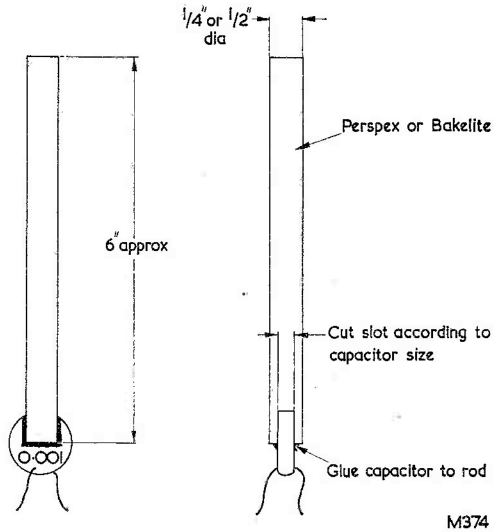


Fig. 2. A simple testing device for checking decoupling capacitors

Testing Decoupling Capacitors

"Not for the time being," replied Smithy. "The next hint has to do with capacitors. Actually, this letter discusses two hints. The first describes a simple but very useful tool for checking decoupling capacitors in heater chains, i.f. circuits and tuner units. The tool consists of a 1,000pF disc ceramic capacitor fitted to a slot at the end of a Perspex or Bakelite rod. (Fig. 2). If you suspect an open-circuit decoupling capacitor you simply apply the tool so that the test capacitor leads bridge the connections to the suspect component. The tool is quick and easy to use and, since the test capacitor leads are short, it does not introduce excessive lead lengths into the decoupling circuit. Also, you can bend the test capacitor leads to any shape you like, and this is particularly useful if the circuit to be bridged is awkwardly placed. As you can see, the cost of the tool is pretty negligible."

"That," pronounced Dick, "is a gadget I can use myself. I'll knock one up first thing on Monday. What's the second hint?"

"The second hint," said Smithy, "will be appreciated mainly by the service engineer who can obtain the essential component required. This consists of a high pulse voltage ceramic capacitor of the type you encounter in t.v. line output stages. It needs to have a value around 220pF, and its central lead is coupled to a flexible wire terminated in a crocodile clip. (Fig. 3). You

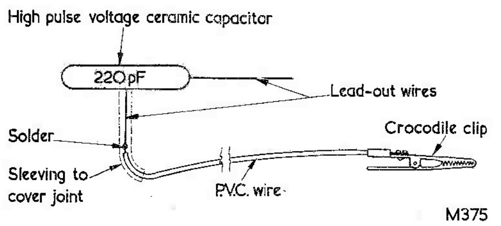


Fig. 3. A high pulse voltage ceramic capacitor may be employed to feed an output from the line timebase to the a.f. circuits of a television receiver

employ this device for checking line speed in television receivers by clipping the crocodile clip to the sound output grid and using the remaining lead-out wire of the capacitor as a probe. The latter can be applied anywhere around the line oscillator stage. This arrangement gives a quick check as to whether the line speed is right or wrong, as the speed is reproduced by the speaker as a whistle of corresponding frequency. If the whistle is high the speed is too fast, and if it is low the speed is too slow."

"The device would be especially useful," said Dick thoughtfully, "if you suspected the line output stage and wanted to see if you were getting the right frequency at the line output grid."

"Very true," agreed Smithy. "Also, you occasionally get the case where there appears to be drive at the line output grid but the e.h.t. rectifier heater isn't quite warm enough to give you adequate e.h.t. A drive whose frequency is too low could give you that effect, and the test device we're discussing would soon inform you of the fact. Incidentally, I would suggest that a good place to apply the capacitor initially would be at the line output grid itself. This would minimise the effect of adding extra capacitance to the timebase circuit."

"I've thought of another use," put in Dick. "If you have a set which won't resolve a picture you can use the tester to check that the line oscillator is both running *and* syncing. When there is reliable sync the note from the speaker will hold steady at correct line frequency over a wide range of travel of the hold control. You will then hear it break off above and below line frequency as the control passes outside the sync range. Also, if you aren't getting a drive on your line output grid, you can work back to the line oscillator just as though you had a signal tracer."

Smithy chuckled.

"You certainly seem to be full of ideas this afternoon," he said. "These hints seem to be giving you something to think about!"

"They are," agreed Dick. "Any more?"

Transistor Mounting

"Stacks," replied Smithy. "The next one is rather unusual. It describes a method of mounting transistors without soldering. (Fig. 4). Instead of being soldered the leads are terminated in brass eyelets which can be mounted on a piece of stiff card or Paxolin. The eyelets are available in the form of a do-it-yourself kit manufactured by Alexandra Products and retailed at Woolworths. The inside diameter of the eyelets is quite large, and you can easily pass a 4BA bolt through them. The method of connection is quick and safe, since heat is never applied to the transistor. The eyelets could fit over small bolts on a chassis or, alternatively, bolts fitted to the eyelets could be employed as terminals. Again, solder tags may be fitted to the bolts. Another point about the scheme is that the transistor type can be marked on the card together with any other remarks. Also, the eyelets connecting to the collector, base and emitter can be similarly marked."

Dick looked thoughtful.

"It strikes me," he said after a while, "that mounting transistors in this manner could be rather useful in training schools and places like that where transistors are connected up into a number of different experimental rigs. The transistors would stand up to a considerable amount of handling because there is no strain on the lead-out wires, and the emitter, base and collector would also be obviously connected to the appropriate parts of the circuit for visual demonstrations."

"You've got a point there," remarked Smithy. "Anyway, we must proceed! I have here no less than four hints from one of our readers. We've already discussed the difficulties of deciphering the values of dirty wax-covered capacitors. The first of the present four hints concerns the same problem, but this time it's with wax-covered resistors. Sometimes the wax on these resistors gets sufficiently dirty to make it difficult to read the colour code. The hint suggests that such components may be cleaned by gently rubbing with a small amount of Dura-Glit "Magic" wadding. Just a little application causes the resistor to become spotlessly clean without removing any painted colour-coding. Also, a piece of the wadding will last a considerable time if it is put back into the tin after use."

"Well, *that's* a new idea for a well-known product," remarked Dick. "I used to use Dura-Glit when I was in the Boys' Brigade!"

"*You* were in the Boys' Brigade?"

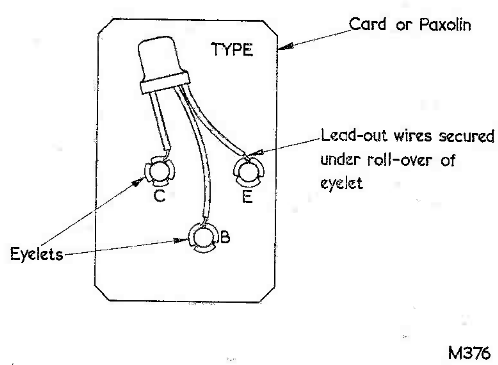


Fig. 4. Mounting a transistor to a sheet of card or Paxolin

"Of course I was," replied Dick, incensed. "What is more, we had a band and played at the local football pitch. People used to throw orange peel at us."

"There are facets in your background," remarked Smithy, "that astound me sometimes."

"I thought you'd be interested," said Dick cheerfully. "What's the second hint in that group of four?"

"It has to do with twisting wire for a.c. heater circuits," replied Smithy. "The idea is not exactly new but it is worth airing again here. The two wires to be twisted should be single strand and p.v.c. insulated. They should also have the same length. The first two or three inches is twisted together by hand, and this section is then secured in a vice. The other ends are tightly held in the chuck of a hand-brace. The wires are held taut, and the drill handle turned so as to twist them together. When a resistance against the rotation is felt the handle is released, whereupon it will turn back on itself for a second or so. A few more twists are put into the wire, jerking it once or twice to relieve strains. When the wire is released it will be found that it is twisted evenly and tightly, the copper conductors and p.v.c. insulation both having taken up the strain imparted to them. When you have wire as tightly twisted as this, the resultant a.c. field in a high-gain amplifier should be noticeably lower than is given with the more loosely twisted wires which are usually employed."

"I like that idea," said Dick. "Especially the point about the tightly twisted wire having a reduced a.c. field."

"The third hint," continued Smithy, "concerns outdoor shacks and workshops. Some people often paint the walls with black bituminous paint because it is cheap, looks fairly tidy, and offers protection. Unfortunately, it tends to stain anything brought into contact with it and, if it is painted over with ordinary flat or gloss paint, it tends to come through and leave dark oily patches. The present hint is, quite simply, to paint the inside walls of the shack with aluminium paint, allow this to dry, and then put on any other covering that may be required. The aluminium paint is a good thermal insulator and looks quite presentable, even if left on its own. On its own, it also brightens the place up and saves electric light since it acts as a reflector. Our reader has painted the walls and ceiling of his own shack with aluminium paint and says that it looks very good."

"Well, that's a novel idea," remarked Dick. "What's the fourth hint is this group?"

"It's a tip," replied Smithy, "for renovating french-polished or varnished cabinets which have become dirty and dull. They can be cleaned with the aid of a mixture containing equal parts, by volume, of pure linseed oil and pure turpentine. Emphasis must be placed on the word 'pure' and no substitutes must be used. The mixture should be applied exceedingly sparingly to the cabinet with a soft cloth or, preferably, a camel hair brush. It is next left for two or three minutes and then polished off with a soft cloth. The dirt comes off on to the cloth and the cabinet attains a deep, long-lasting shine.

"The polish can be made for only a few pence and will last for a long time. It takes about one half teaspoonful to do a large TV cabinet."

"I must make a note of that mixture," commented Dick. "I wonder if it would work with cellulose or polyester finished cabinets."

"Probably not," said Smithy. "I would, incidentally, advise anyone using this idea to get a little practice in first. Also, I would state that the polish should be tried out on an odd corner of any cabinet you handle before attacking large surfaces, and that it might be advisable to keep it away from transparent tuning scales."

Modifying Surplus Equipment

Smithy looked at the Workshop clock and started.

"Aren't you going out tonight?" he asked.

"Who, me?"

"Yes, you," said Smithy. "It's packing-up time, you know."

Normally, the speed with which Dick left the Workshop in the evening was only exceeded by the speed with which he arrived in the morning.

"I'm in no hurry," said Dick airily. "Besides, these hints are interesting."

Smithy raised an incredulous eyebrow.

"Am I to understand that you have no extra-mural activities to entice you from the Workshop?"

"I don't get you," said Dick, puzzled. "You mean, should I be painting walls or something?"

"By 'extra-mural'," explained Smithy, "I mean 'out-of-doors'. A young lad like you should be out in the open on a lovely evening like this."

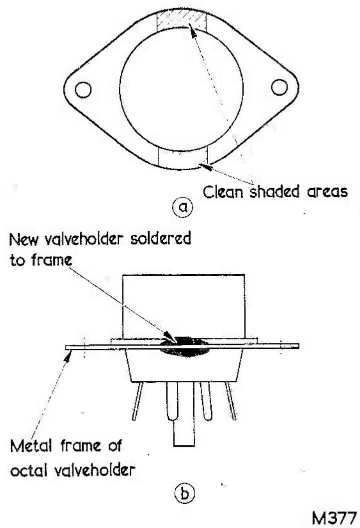


Fig. 5. Replacing octal valveholders by B7G or B9A types. If the Amphenol insulation is broken away from the octal valveholder, the metal frame shown in (a) is left. The new valveholder may then be wired and soldered to this frame, as in (b)

"Oh, I've got nothing special to do," said Dick, carelessly. "Let's hear a few more hints."

"As you like," said Smithy. "Well, it so happens that the next letter also includes four hints. The first of these had to do with modifying American surplus equipment."

"That sounds interesting," remarked Dick. "Fire away!"

"One of the difficulties," began Smithy, "of modifying American surplus equipment is that of replacing octal valveholders with the more modern B7G or B9A types. In the method suggested here, the original valveholder is removed from the chassis and its Amphenol insulation broken away, leaving a metal frame. (Fig. 5 (*a*)). The portions shown shaded in the sketch are cleaned up with a file, as also are the areas around the bolt-holes on the replacement valveholder. The latter is then placed over the metal frame and secured to it with 26 s.w.g. bare wire. The new valveholder is then soldered to the metal frame, employing enough solder to cover the wire at the joint. (Fig. 5 (*b*)). The whole assembly is finally fitted to the chassis, the metal frame taking up the same position as it had before. The new valveholder will be found rigidly mounted, and the complete operation takes only two minutes, which is much quicker than the time needed for drilling out ordinary mounting plates. This idea has, incidentally, also been used for converting from B9G, UX5, UX6, UX7 and MO valveholders to B7G, B8G and B9A."

"That's a very useful wheeze," commented Dick. "And it should certainly prove to be a time-saver."

"Well, the second hint," remarked Smithy, "is a time-delayer! It seems that a time delay mechanism was required which would give approximately 40 seconds delay for a mercury vapour rectifier. A thermal delay was not available, and so a PY81 boosted h.t. diode was pressed into service instead. (Fig. 6). The PY81 was used because of its long warm-up time, this being 45 seconds in the prototype. Operation is, of course, quite straightforward. The 17 volt supply is fed to the PY81 at the same time as the heater supply for the mercury vapour rectifier is switched on. When the PY81 has reached emitting temperature, a rectified d.c. potential appears across the 100μF electrolytic capacitor and causes the relay to energize. The contacts of the relay then complete the h.t. circuit to the mercury vapour rectifier. The electrolytic capacitor prevents relay buzz, particularly if the PY81 is low-emission; and the prototype functioned satisfactorily with a PY81 which was so worn-out that it wouldn't function in a television receiver."

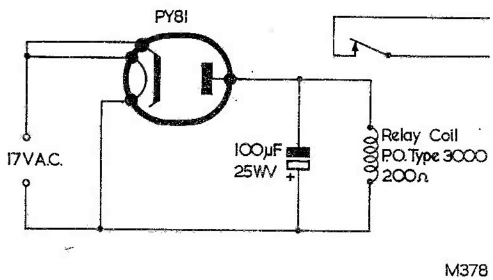


Fig. 6. A simple time delay circuit

"Time delay circuits are always of interest," commented Dick. "This appears to be one of the simplest I've encountered to date. Inexpensive, too, considering that you can employ valves which would otherwise be chucked out."

"It is," agreed Smithy, "a neat arrangement. The third hint in this letter is quite a simple idea and is, again, partly applicable to surplus equipment. It concerns crackle black finishes. When these have become dull and dirty they can be rejuvenated by first washing with soap suds, rinsing, and drying, and by then rubbing in a fine oil. The oil should be applied sparingly, and the excess wiped off. Transformer oil is ideal for this application."

"I should imagine," said Dick, "that a detergent would be just as good as the soap suds for the original cleaning."

"I would think so."

"In which case," said Dick, triumphantly, "you could end up with a finish which is 'blacker than black'."

Smithy sighed.

"The fourth hint," he continued, completely ignoring Dick's remark, "has to do with service sheets. It is often difficult to refer to service sheets or circuit diagrams whilst working on a set. If, for instance, you are chasing an open-circuit heater you may often have to look away from the chassis, refocus your eyes on a circuit propped up against the wall at a distance of some three feet or so, and then look back again at the chassis. Not only is this tiring but there is quite a little risk involved if a test prod slips whilst you're looking up. Also, your hands may stray and result in your getting a shock. The suggested solution to this problem consists of covering the working surface with ¼in Perspex or glass implosion guards, and putting the requisite circuit diagram underneath. The result is that the circuit, the chassis and the testmeter all come into the same field of vision, and are all approximately the same distance from the eye."

Demagnetising Screwdrivers

"There are certainly some good ideas going today," remarked Dick. "Have you any more hints?"

"Plenty," replied Smithy, rummaging through his sheaf of letters. "We next have a letter with two simple hints. The first concerns screwdrivers, pliers and other metal tools. As you know, these tools frequently get magnetised in radio work owing to the fact that they come into contact with speaker magnets and things like that. When magnetised they tend to be a nuisance, especially when doing close work, because steel washers and other parts become attracted to them. Such tools can, however, be demagnetised quite easily by placing them on top of a mains transformer for some time. I presume it would be advisable also to draw them slowly out of the transformer field before switching the latter off. Our correspondent says that the bigger the transformer the better.

"The second tip is another cabinet-cleaning idea. Only, in this case, it's plastic cabinets. It is possible to get rid of shallow scratches in plastic cabinets quite

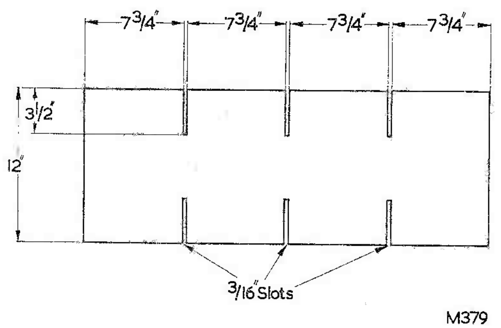


Fig. 7. The dimensions of a typical example of foil lined cardboard referred to in the text

easily, by rubbing on a small quantity of Brasso with a piece of cloth. Brasso is slightly abrasive and soon brings the surface up to an even finish."

"First Dura-Glit and now Brasso," commented Dick. "It's like the Sergeant-Major's reunion dinner! I bet the next hint will tell us how to build an Oxometer."

Smithy was temporarily off his guard.

"What's an Oxometer?"

"A device," replied Dick promptly, "for measuring bull-shine!"

Smithy grinned.

"O.K.," he chuckled. "I fell for that one. I think I should add that the Brasso tip might not be applicable to all plastic cabinets. Some of these are sprayed a different colour to the plastic of which they're made, and too much abrasion could then remove the outer coat of paint. Also, I would, as always, advise keeping cleaning materials away from transparent tuning scales."

"Any more hints on cabinet finishes?" asked Dick.

"Yes," replied Smithy. "There's quite a nice one here. This points out that front panels for equipment such as audio amplifiers, recording amplifiers and tuner units can be given an original and pleasing finish by making them from 18 s.w.g. aluminium bonded to a woodgrain Formica panel. Evo-Stik 528 or any similar impact adhesive is ideal for this job. Our reader is fortunate enough in having access to an engraving machine and so he is able to engrave all necessary lettering. On the other hand, a really professional finish can be given with Panel Signs transfers. If white knobs are used, the whole effect is very pleasing indeed."

Screening

"We seem," remarked Dick, "to have covered a pretty wide range in this session."

"We have, indeed," replied Smithy. "However, one aspect we haven't touched on is screening, and I have a hint here which can be of particular interest to the audio man or the experimenter. Frequently, the underside of a home-built a.f. amplifier is not screened. This deficiency can be made good, either temporarily as an experiment or permanently, by the use of foil-lined cardboard. Foil-lined cardboard can be obtained free of charge from many photographic dealers, because it is used for despatching batches of flash-bulbs. If the box is opened out carefully, you can obtain a large area of the cardboard, a typical example measuring approximately 12in by 31½in. (Fig. 7). The whole area of a sheet of this nature could be employed, or you could cut out four sections measuring 12in by 7⅞in. The cardboard backing is quite tough and strong, and the foil is aluminium. Material of this nature represents a good way, also, of providing inexpensive screening inside the cabinet of a TV or radio set."

"The foil-lined cardboard could also be bent very easily into any particular shape you wanted," remarked Dick. "Which is another advantage."

"That's true enough," replied Smithy. "Another tip on screening comes from a different reader, and it applies to metallised valves of the EF9 and EF39 variety. You only meet these valves in old a.m. receivers but they're still doing yeoman service, nevertheless. A common fault is that their metallising becomes disconnected from the earthing contact, whereupon you are liable to get crackles and instability. When the valve concerned is the i.f. amplifier, instability is almost inevitable. The receivers in which these valves are fitted are pretty venerable and don't merit an expensive repair. In practice, the valve can be fixed by the simple expedient of wrapping tin foil around the bulb and holding it in place with several turns of tinned copper wire. (Fig. 8). Run the tinned copper wire down to the earthing pin or contact at the base and the valve once more becomes reliably screened. Whereupon, it will probably give another twenty to thirty years of good service!"

"They certainly seemed to make valves to last in those days," remarked Dick. "I had a set only the other day with side-contact valves, and they were still working merrily away despite the bashing they've had over the years."

"My own memories of side-contact valves," remaked Smithy nostalgically, "seems to consist of pulling out the glass section and leaving the base stuck in the valve-holder! Still, let's carry on to the next hint. Which must, also, I'm afraid, be the last in this present session.

"This hint." continued Smithy, "describes a simple device for starting screws in awkward places. (Fig. 9). It consists of a length of $\frac{3}{16}$in metal rod having a slot at one end into which two strips of spring steel are fitted. These strips are taken from an old clock spring. If the bottom of the rod is put in a vice, the slot can be squeezed down on to the springs, whereupon they are held very securely. The projecting springs are opened out slightly, with the result that they grip the internal sides of the slot in the screw."

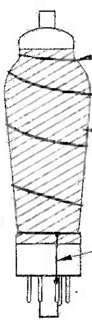


Fig. 8. Screening a valve whose metallising has broken away from its earthing connection

Going Home

With an air of finality, Smithy took up his letters and returned them to the drawer in his bench.

"Is that the lot?" asked Dick.

"It is for now," replied Smithy. "But there are still quite a few outstanding. We shall have to have another hint session pretty soon, I'm thinking."

"Good show," said Dick. "They always make a pleasant break from ordinary servicing."

By now, the dust in the Workshop had settled, and the evening sun shone clearly across the benches and the test equipment. The pair leisurely made their departure and wandered off to their separate homes through the quiet air. Their day was over. We have already put words into the mouth of A. E. Housman and we can now only

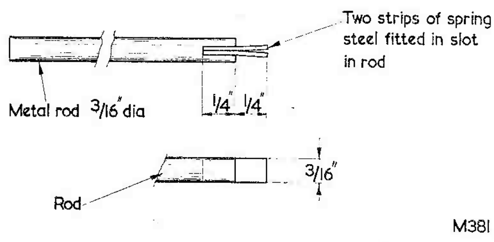


Fig. 9. A useful tool for starting screws in difficult positions. The two strips of spring steel grip the inside edges of the screw slot

conclude this particular episode by saying that, even in a moment of acute aberration, Thomas Gray could *never* have perpetrated the following:

The curfew tolls the knell of parting day,
The lowing herd wind slowly o'er the lea;
Whilst Smithy homeward plods his weary way,
Leaving the world to darkness, for his tea.

The hints described in this month's episode of "In Your Workshop" were contributed (in the order in which they appear) by P. S. Anderson, B. Slight, D. M-Evans, D. Watson, B. M. Jeffery, K. Summersgill, D. J. Pratt, D. Powell, J. D. F. Hewson, R. D. Raby, N. L. Cowell, N. O'Riordan and J. Greenway.

Further hints for this feature are welcomed, and payment is made for all that are published.—Editor

Test Instruments Need Testing

By G. A. W. PARTRIDGE

ELECTRICAL MEASURING INSTRUMENTS such as voltmeters, ammeters, and universal meters, tend to become inaccurate after years of faithful service. It is therefore a great help if these instruments can be checked now and again, even if only to satisfy one's self that they are maintaining a reasonable margin of accuracy.

The checking circuits described here are simple but, with good components, extremely efficient.

Fig. 1 shows the volt-box circuit connected to a voltmeter under test. There are ten instrument-type one-watt resistors connected in series, and their values are:

A=1,000Ω
B=3,000Ω
C=4,000Ω
D=7,000Ω
E=15,000Ω
F=30,000Ω
G=65,000Ω
H=125,000Ω
I=250,000Ω
J=500,000Ω

Resistor A is connected to a morse key, a 0-1 milliammeter, and a Weston Standard Cell* which has a very accurate p.d. of 1.0183 volts when *no current* is being drawn from it. The voltmeter under test, along with a suitable d.c. supply (either from a power-pack or batteries) is connected to say, the 500 volt tap and the voltage adjusted so that the voltmeter indicates this value by the rheostat. The key is quickly pressed and released. If the milliammeter needle moves the rheostat is again adjusted and the key "touched". This procedure continues until there is no movement of the milliammeter needle, thus indicating balance. The voltage applied to the voltmeter is now 500 (accurate to about 1%). The voltmeter reading is then checked for any discrepancy. Various points on the voltmeter scale on different ranges can be checked in this manner by selecting suitable taps.

* A suitable Weston Standard Cell is available from Doran Instrument Company Ltd., Stroud, Gloucester. Instrument resistors are available through trade channels, although it should be pointed out that these may be expensive if purchased new.—Editor

A complete volt-box is shown in Fig. 2. The resistors are mounted inside the box which can be made of stiff cardboard.

Testing a milliammeter is just as simple. The circuit in Fig. 3 shows that the same principle is used. The resistor values are:

A=2Ω
B=2Ω
C=6Ω
D=90Ω
E=900Ω

Again, they are mounted in a box which is, this time, known as an amp-box.

In Fig. 3 the milliammeter is being tested on the 10mA tap. The rheostat is adjusted until 10mA is indicated with the Standard Cell circuit open. Now the key is

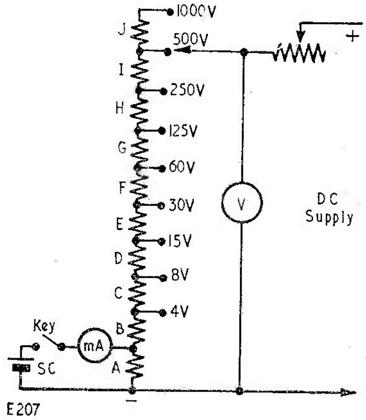
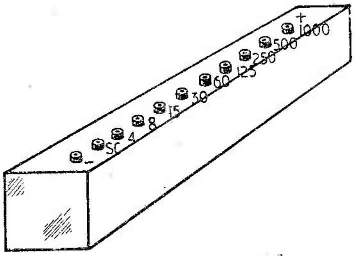


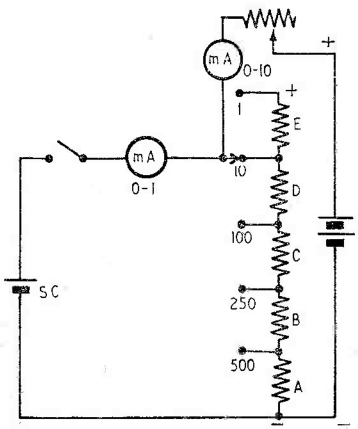
Fig. 1. Testing a voltmeter



E208

Fig. 2. The volt-box

quickly pressed and released while the rheostat is again adjusted until there is no movement noted on the 0–1 milliammeter. The current flowing through the milliammeter under test is now 10mA. Similar tests can also be carried out on the 1, 100, 250, and 500mA taps depending, of course, upon the range of the instrument under test.



F209

Fig. 3. Testing a milliameter

It is also possible to test a.c. instruments but, in this case, a dynamometer voltmeter is necessary. This meter operates with equal accuracy on d.c. as well as on a.c. It is tested with the volt-box as a d.c. instrument and then connected to an a.c. meter under test as shown in Fig. 4. The readings are checked by comparison.

A.C. milliammeters can be tested with the same dynamometer voltmeter but the current readings have to be checked by Ohm's Law:

$$I=\frac{E}{R}$$

To take an example let us assume that the milliammeter reads from 0 to 500mA, and that the dynamometer voltmeter reads up to 150 volts. First, we calculate the load resistor R. See Fig. 5. The milliammeter internal resistance is neglected for the present.

$$R=\frac{E}{I}$$

$$=\frac{150}{0.5}$$

$$=300\Omega$$

Therefore a load resistance, R, of 300Ω is required. It must also be able to pass half an ampere (500mA).

The milliammeter is now checked in the following manner:

Say the milliammeter has a resistance of 2Ω. The total resistance will then equal $300+2=302\Omega$.

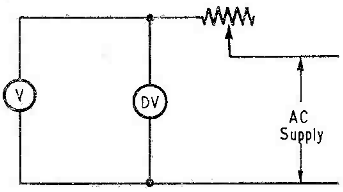
The rheostat is adjusted until the the dynamometer voltmeter reads exactly 150 volts.

$$\text{Now } I=\frac{E}{R}$$

$$=\frac{150}{302}$$

$$=0.497\text{A or } 497\text{mA}.$$

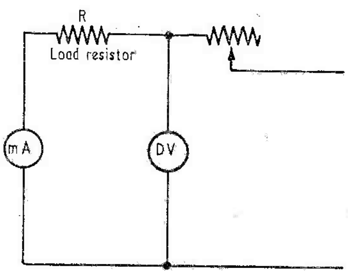
This should be the reading on the milliammeter. Other readings can be taken and calculated at say, 125, 100, 75, 50 volts, and so on.



E210

Fig. 4. Testing an a.c. voltmeter

Finally, a few points which need to be remembered. Keep the Standard Cell in a cool dry place, and never allow current to be drawn from it for more than a fraction of a second at a time. *When working from the mains remember that all connections are live. A resistor does not reduce the possibility of shock, nor does a low voltage reading in a voltmeter.*



E211

Fig. 5. Testing an a.c. milliameter

All connections must be made as tight as possible, and the resistors used must be suitable for test instruments. The 0–1 milliammeter acts as a galvometer. If a centre zero instrument can be obtained, so much the better.

BOOK REVIEW . . .

TAPE RECORDING FOR EVERYONE, by F. C. Judd, A.Inst.E. 134 pages, 5¼in by 8½in. Published by Blackie and Son, Ltd. Price 10s. 6d.

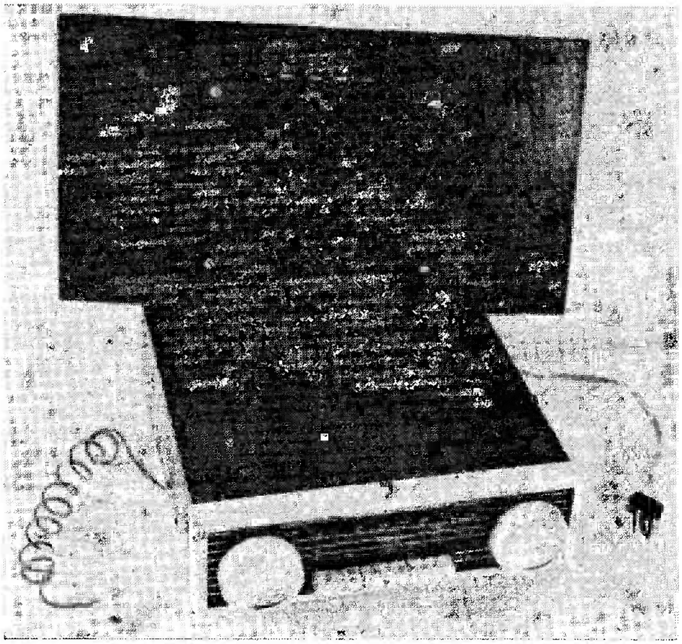
Mr. F. C. Judd is well-known amongst tape recording enthusiasts, not only on account of his articles and publications but also because of his lively approach to allied subjects including, in particular, the composition and recording of *Musique Concrète*. In consequence, one can expect this book to be of considerable value to anyone interested in tape recording. And one is not disappointed.

The book covers all aspects of tape recording, and will be especially useful for the non-professional. A number of electronic devices and circuits are described, and their methods of operation are clearly explained.

After dealing with the basic theory of tape recording, the book reviews the range of machines currently available, giving succinct details of performance and price. A helpful chapter describes how a recorder may be assessed both in terms of performance and manufacturers' specifications. Details are given of practical recording and editing, together with accessories such as pre-amplifiers, mixers, radio tuners and telephone pick-up coils. Special recording techniques both for normal programme work and synthetic music are described, and a further chapter covers attenuators, volume indicators and distortion. There is also a glossary of technical terms, and a list of clubs and associations.

Cover Feature

The 'Highwayman' Transistorised Car Radio



Described by **E. GOVIER**

CAR RADIO DESIGNS EXPRESSLY FOR THE HOME constructor are few and far between, those that have already appeared now being several years old with, in some cases, certain of the components no longer available. The design about to be described is the result of intensive development and research, being transistorised for economy and silent operation (no background buzz) and having printed circuit reliability and simplicity in construction.

Push button wavechange for fingertip control is featured together with a low battery consumption —the total is less than 0.5A—thereby enabling the radio to be used for hours with the car engine switched off.

The radio, once completed, is completely contained with a cabinet measuring some 7 x 2 x 7in (deep) and will therefore fit almost any car which has a 12 volt supply. The output is some 1.5 watts undistorted, this being adequate for the confines of any car, and fidelity is provided by a push-pull transistor output stage.

Sensitivity and selectivity are excellent and complete medium-wave coverage together with reception of the long-wave B.B.C. Light programme (tuneable) is provided.

An illuminated dial with gilt control knobs ensure that the front panel is attractive to the eye and an enhancement to any car.

It is important to note that the receiver is intended for use with cars having the positive 12 volt supply earthed. Reversal of supply polarity can damage the transistors permanently.

The Highwayman can be installed satisfactorily by anyone who has a basic knowledge of car electrical systems together with some mechanical ability and although the fitting of this receiver will be described fully, it is only fair to point out that there are no "short cuts" to achieving a satisfactory installation. The vibration and electrical interference in a moving vehicle is severe and a car radio that is poorly installed is most likely to become a constant source of trouble and annoyance. If the reader is in doubt regarding his ability to install the receiver, we would recommend that it be carried out by a competent car radio mechanic. Similar reservations apply also to the actual construction of the receiver.

The Circuit

This is shown in Fig. 1, from which it will be seen that it comprises a mixer/oscillator, V_1 (ECH83); a 470 kc/s i.f. amplifier, V_2 (EBF83); a driver transistor, TR_1 (OC82D) and a transistor push-pull output stage TR_2, TR_3 (OC82 matched pair), working into a 3Ω speaker.

L_1 is a 25μH r.f. choke and L_2 is the medium-wave aerial tuning coil, this tuning over the medium waveband by mechanically withdrawing the internal iron-dust slug from the centre of the coil (permeability tuning) when S_1 is in the appropriate position. TC_2 is a trimmer capacitor. With S_1 in the long-wave position, both C_1 and TC_1 are brought into circuit, effectively covering the Light programme wavelength. L_3 is the long-wave loading coil, this being connected to chassis when

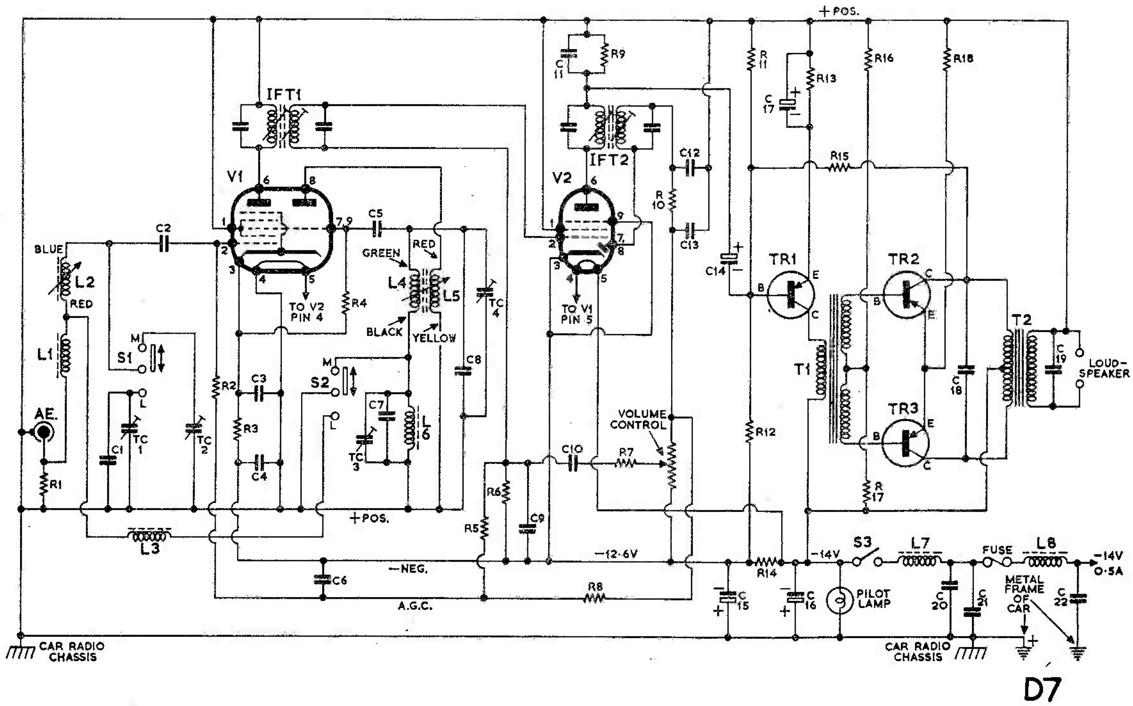


Fig. 1. Circuit of the "Highwayman" car radio

Components List

Resistors ($\frac{1}{4}$ watt unless otherwise stated)

- R_1 330kΩ 20%
- R_2 470kΩ 20%
- R_3 47Ω 10%
- R_4 47kΩ 10%
- R_5 10MΩ 20%
- R_6 4.7MΩ 20%
- R_7 330kΩ 20%
- R_8 1MΩ 20%
- R_9 2.7kΩ 10%
- R_{10} 100kΩ 20%
- R_{11} 10kΩ 10%
- R_{12} 68kΩ 10%
- R_{13} 1kΩ 10%
- R_{14} 220Ω 10%
- R_{15} 680kΩ 20%
- R_{16} 18Ω 5%
- R_{17} 1.5kΩ 5%
- R_{18} 6.8Ω 10% 1 watt
- VR_1 500kΩ log.

Capacitors

- C_1 330pF 2.5% Polycap
- C_2 70pF ceramic
- C_3 0.1μF Polycap
- C_4 0.1μF Polycap
- C_5 56pF ceramic
- C_6 0.04μF Polycap
- C_7 150pF 2.5% Polycap
- C_8 330pF 2.5% Polycap
- C_9 220pF ceramic
- C_{10} 0.01μF ceramic
- C_{11} 0.01μF ceramic
- C_{12} 100pF ceramic
- C_{13} 470pF ceramic
- C_{14} 2μF electrolytic
- C_{15} 100μF electrolytic
- C_{16} 100μF electrolytic
- C_{17} 25μF electrolytic
- C_{18} 0.1μF Polycap
- C_{19} 0.04μF Polycap
- C_{20} R.F. Bypass (see text)
- C_{21} 0.5μF paper
- C_{22} 0.5μF paper

Valves

- V_1 ECH83 (6DS8)
- V_2 EBF83 (6DR8)

Transistors

- TR_1 OC82D
- TR_2, TR_3 OC82 (matched pair)

Inductors

- L_1, L_7, L_8 25μH RF chokes
- L_2 MW aerial coil
- L_3 LW aerial loading coil
- L_4/L_5 MW oscillator coil
- L_6 LW oscillator loading coil
  (All Clyne Radio Ltd.)

Loudspeaker
3Ω Elliptical complete with baffle board (Clyne Radio Ltd.)

Fuse
2A rating, complete with plastic holder assembly. (Clyne Radio Ltd.)

Pilot Bulb
12V 2.2W MES

Transformers
T_1 Push-pull driver (Clyne Radio Ltd.)
T_2 Push-pull output (Clyne Radio Ltd.)

Miscellaneous
Chassis, tuning unit, printed circuit board, valveholders, screening cans, chassis cover, wire, solder, nuts, bolts and washers, etc., etc. (Clyne Radio Ltd.)

S_2 is in the appropriate position.

V_1 functions in the normal manner, L_4 and L_5 being the medium-wave oscillator coils. The lower end of L_4 is connected to chassis when S_2 is in the medium-wave position, this effectively shorting out the long-wave oscillator loading coil L_6 together with the associated capacitors C_7 and TC_3. TC_4 is the trimmer capacitor for the medium-wave oscillator coil L_4. In the long-wave position, L_6 together with the two associated capacitors TC_3 and C_7, are switched into series with L_4. The i.f. signal from V_1 is applied, via the secondary winding of IFT_1, to the grid of the i.f. stage V_2.

The output voltage appearing across IFT_2 is taken, via R_{10}, to the diode load formed by the volume control (500kΩ). The signal is now applied back to the grid of V_2 via the slider of this control, R_7, C_{10}, and the secondary of IFT_1. Amplification at a.f. is carried out by the pentode section of V_2 and the resultant output is applied to the base of the driver transistor TR_1 via the electrolytic capacitor C_{14}.

T_1 is the push-pull driver transformer, the secondary of which applies the audio signal output from TR_1 into the bases of TR_2 and TR_3, the output from these appearing across the push-pull output transformer T_2.

R_8 and C_6 together provide the a.g.c. time constant, a.g.c. then being applied to V_2 via the resistor R_5 and the mixer/oscillator stage via R_2.

The inductor L_8 and the associated capacitor C_{22} are the initial pulse interference suppression components, these being mounted as near to the car battery as possible. L_7 together with C_{21} provides additional suppression at the receiver power input, C_{20} being an r.f. bypass component.

Construction—Printed Circuit Board Assembly

All components should be fitted to the Paxolin side of the printed circuit board and solder joints made on the copper side.

The first task is to fit and solder the two valveholders to the printed circuit board, see Figs. 2 and 3.

With reference to Fig. 2, solder the following resistors in the positions indicated:

R_2	470kΩ 20%—yellow, violet, yellow
R_3	47Ω 10%—yellow, violet, black—silver
R_4	47kΩ 10%—yellow, violet, orange—silver
R_5	10MΩ—brown, black, blue
R_6	4.7MΩ—yellow, violet, green
R_7	330kΩ—orange, orange, yellow
R_8	1MΩ—brown, black, green
R_{12}	68kΩ 10%—blue, grey, orange—silver
R_{10}	100kΩ—brown, black, yellow

DI

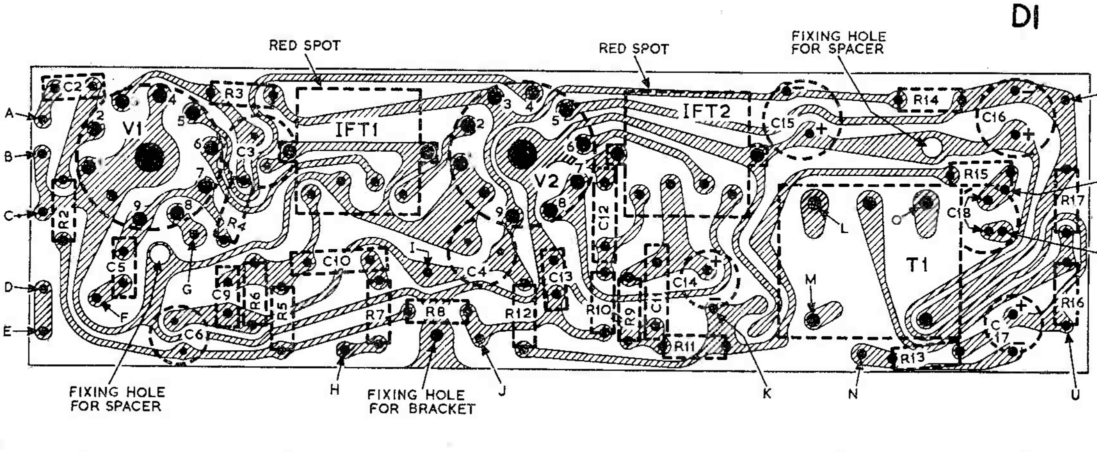


Fig. 2. The printed circuit board (copper side) showing the position of components. For additional printed circuit board information, see Figs. 3 and 4. Note that all black spots indicate soldered joints and that black spots designated with a letter are lead destinations. Solder leads K, L. M, N, O, P, R and U to the copper side of the board and all remaining leads to the reverse side of the board

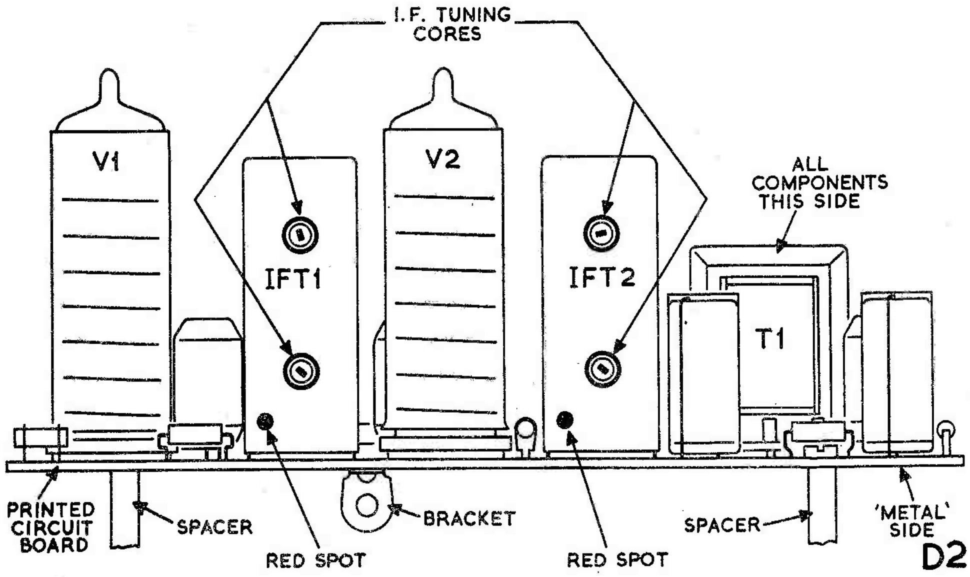


Fig. 3. Showing the positions of the main components when mounted on the printed circuit board

R_9 2.7kΩ 10%—red, violet, red—silver
R_{11} 10kΩ 10%—brown, black, orange—silver
R_{13} 1kΩ 10%—brown, black, red—silver
R_{14} 220Ω 10%—red, red, brown—silver
R_{15} 680kΩ—blue, grey, yellow
R_{17} 1.5kΩ 5%—brown, green, red—gold
R_{16} 18Ω 5%—brown, grey, black—gold

Having completed the foregoing, solder into position the following capacitors:

C_2 70pF ceramic—violet, violet, black, black, black
C_5 56pF ceramic—violet, green, blue, black, black
C_9 220pF ceramic—red, red, brown, black
C_{10} 0.01μF (10,000pF) ceramic—brown, black, orange
C_{13} 470pF ceramic—yellow, violet, brown, black
C_{11} 0.01μF (10,000pF) ceramic—brown, black, orange
C_{12} 100pF ceramic—yellow, brown, black, brown, black

Obtain a solder tag and bend it so that a right-angle is formed. (See Figs. 3 and 6.) This is then used as a bracket and is secured, using a self-tapping screw, to the copper side of the printed circuit board and soldered in order to hold it in position firmly. Examining the printed circuit board, a small hole will be found below R_8 (see Fig. 2) where this screw should be housed.

Cut a 7in length of single stranded lead and solder one end to point T on the printed circuit board. (See Figs. 2 and 6.)

Cut a 10in length of twin screened lead and prepare the ends as shown in Fig. 6. At one end, fit a short piece of sleeving over the braid lead (I) and solder the various wires, as shown, to points H, I, J, on the printed circuit board. (See Figs. 2 and 6.)

Solder IFT_1 into position on the printed circuit board as shown in Figs. 2 and 3, ensuring that the red spot on the side of the can is uppermost. Carefully ease the clips and leads through the board and solder both these leads and clips to the copper side.

Having completed the above, fit and solder the following components to the printed circuit board.

C_3 0.1μF Polycap
C_4 0.1μF Polycap
C_6 0.04μF Polycap
C_{14} 2μF electrolytic. Note the polarity markings on this component (+ and −) and on the printed circuit board diagram, Fig. 2. These markings must agree with each other.
C_{15} 100μF electrolytic, note the polarity markings.
C_{16} 100μF electrolytic, note the polarity markings
C_{17} 25μF electrolytic, note polarity markings
C_{18} 0.1μF Polycap

Next, obtain the driver transformer T_1 and note that this can only be fitted to the printed circuit board when the three tags are uppermost. Bend over the tags after insertion through the board, and solder them into circuit.

Solder IFT_2 into position as shown in Figs. 2 and 3, ensuring that the red spot on the side of the can is uppermost. Carefully ease the clips and leads through the board and solder them into position.

Fit the can earthing clips to each valveholder.

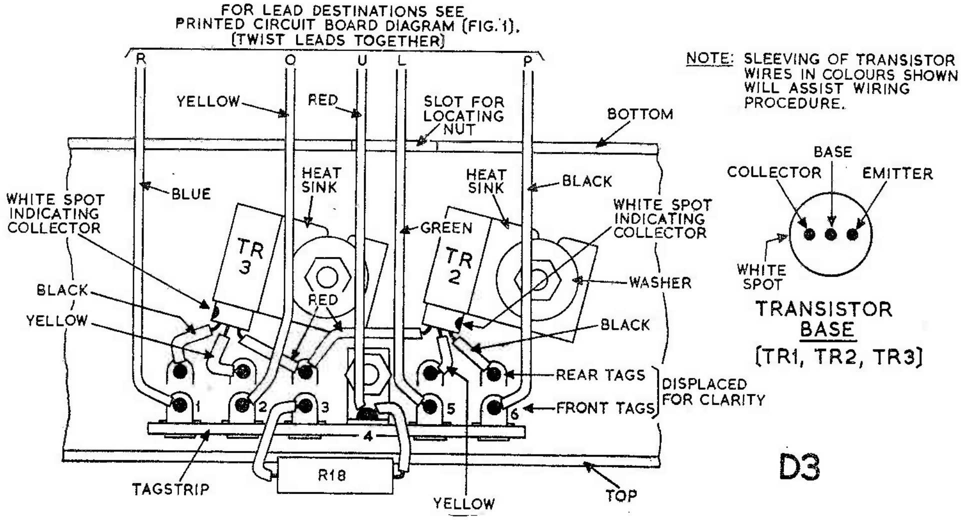


Fig. 4. The rear panel assembly and transistor connections

These clips fit between valveholder tags 1 and 9 and are pushed through the board and then soldered. They are mounted in such a manner that they bend away from the centre of the valveholder.

Fit the 4BA x $1\frac{1}{2}$in bolts and spacers to the printed circuit board, fitting a nut on the end of each bolt—see Figs. 2 and 6.

Take TR_1 (OC82D) and fit sleeving to each lead as in Fig. 6—red to emitter, yellow to base and black to the collector. *Do not cut the leads.* Solder to points N, K and M on the copper side of the board, see Fig. 2.

Main Chassis Assembly

Take the main chassis sub-assembly (see Fig. 6) and fit the following components into position.

The 4-bank trimmer, using two 6BA x $\frac{1}{4}$in bolts and nuts. Note here that a solder tag and the earth tag of a 3-way tagstrip is fitted under one of these bolts where shown.

The volume control potentiometer (500kΩ) with the tags uppermost as shown in Fig. 6.

The push-button unit using two 4BA x $\frac{1}{4}$in bolts and nuts through the front of the assembly.

Output transformer T_2—note the position of the

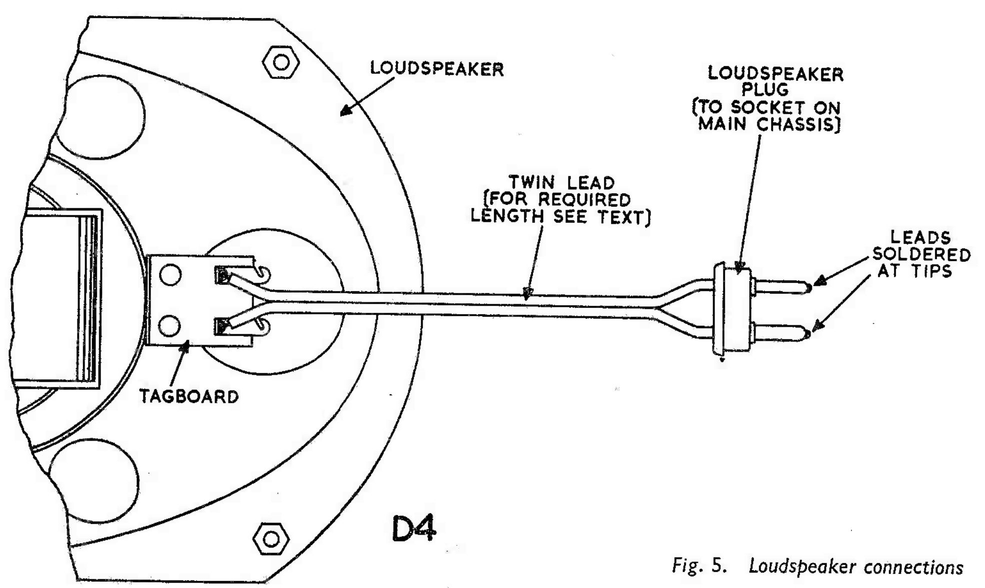


Fig. 5. Loudspeaker connections

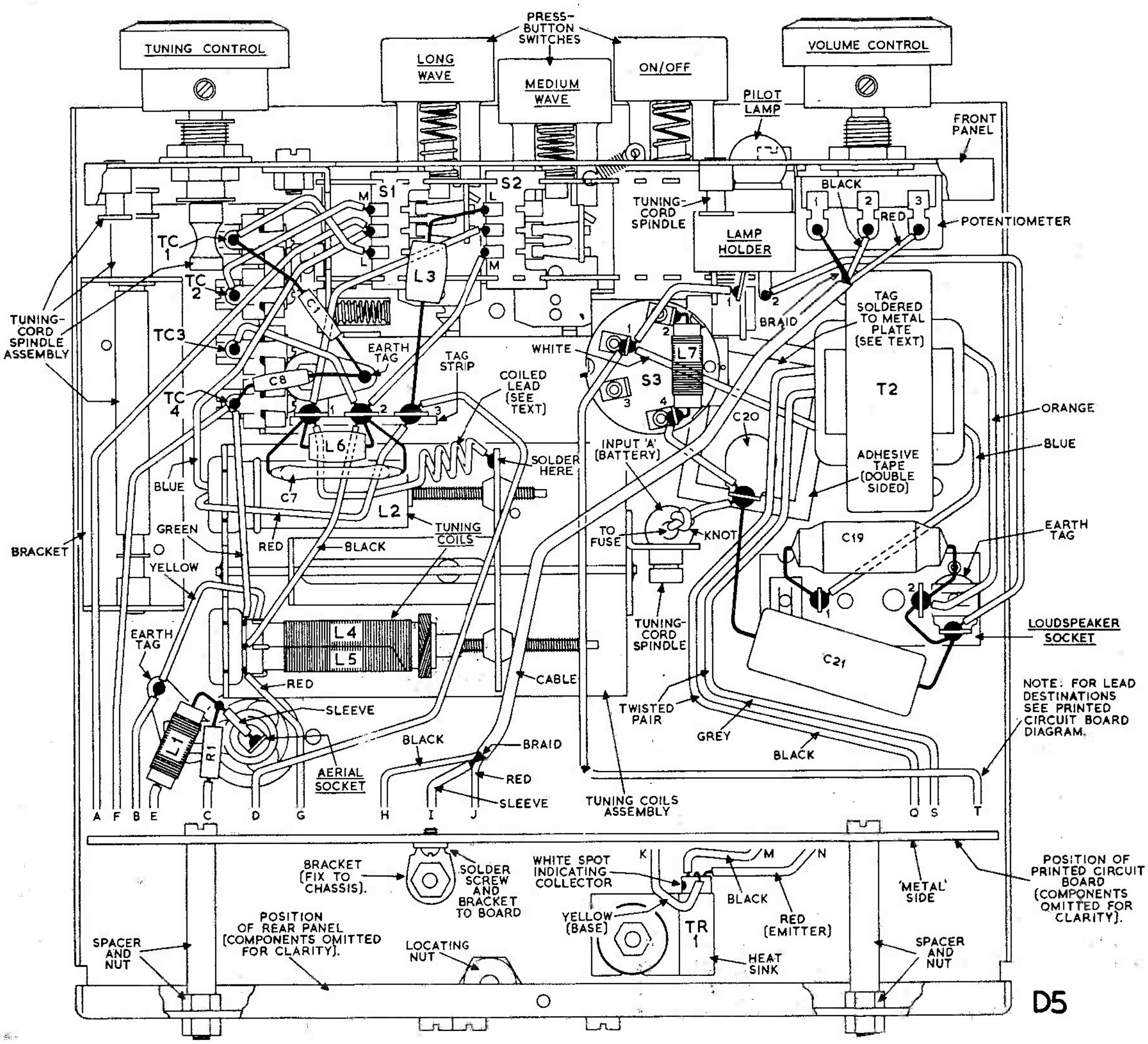


Fig. 6. Main chassis wiring details

coloured leads before fitting. Bend the two metal lugs over on the underside of the main chassis.

Large grommet to input hole "A".

Loudspeaker socket, using two 6BA x $\frac{1}{4}$in bolts and nuts plus a solder tag, as shown in Fig. 6. Note here that the plug holes in the socket are of differing sizes, and that this should be borne in mind when fitting the speaker into circuit.

Fit a 6BA x $\frac{1}{4}$in bolt and nut, together with an earthing solder tag, to the hole adjacent to the aerial input socket (under L_1—see Fig. 6).

Remove the backing material from both sides of the adhesive tape and press down firmly in the position indicated (adjacent to T_2). This forms the dielectric for C_{20}.

Press the small metal plate on to the top of the adhesive tape, thus completing the assembly of C_{20}.

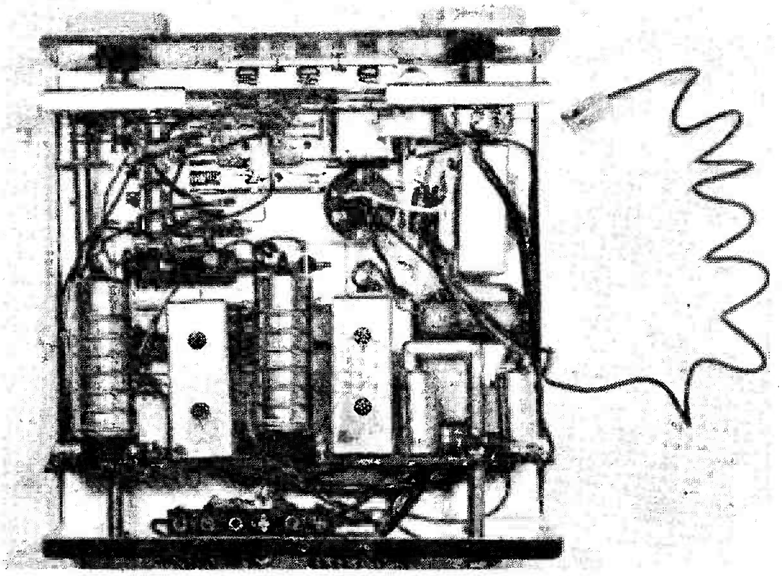
Solder tag 2 of the loudspeaker socket to the adjacent earth tag.

Solder the orange and blue leads from T_2 to the loudspeaker socket (see Fig. 6), also fitting C_{19} (0.04μF Polycap) into position at the same time.

Twist one end of L_1 (r.f. choke) and R_1 (330kΩ—orange, orange, yellow) together, and solder this junction to the centre tag of the aerial input socket, leaving the other ends of L_1 and R_1 free for the time being.

Rear Panel Assembly

Obtain the chassis rear panel and bolt a 6-way tagstrip in position using a 4BA x $\frac{1}{4}$in bolt and nut. Fig. 4 clearly shows the position of the tagstrip and, with reference to Fig. 6, the correct position may be easily ascertained.



Plan view of the completed car radio chassis with top cover removed

Remove the two OC82 transistors TR_2 and TR_3 from the package and identify the lead connections from Fig. 4. Fit coloured sleeving to each lead exactly as shown in the diagram and *do not cut the transistor leads*. Solder each OC82 transistor to the rear tags as shown.

Carefully fit a heat sink to each OC82 transistor and, using 4BA x $\frac{1}{4}$in bolts plus a washer under each nut, bolt them both securely to the rear panel.

Fit sleeving to the ends of R_{18} (6.8Ω 10% 1 watt —blue, grey, gold, silver) and solder into position between tags 3 and 4 (see Fig. 4).

Cut a 6in length of single stranded lead for each of the following colours: black, green, red, yellow and blue. Prepare one end of each lead and solder to the 6-way tagstrip exactly as shown in Fig. 4. Leave the other ends of these leads free for the time being.

This completes the rear panel assembly.

Fitting the Printed Circuit Board and Rear Panel

Take the printed circuit board assembly, prepare the free ends of the five coloured leads that have just been fitted to the rear panel and solder these ends to the printed circuit board as shown in Figs. 2 and 4. It will be noticed that these coloured leads are identified R, O, U, L and P, and they must be soldered to the points similarly identified on the printed circuit board.

Bolt the rear panel assembly to the printed circuit board (see Fig. 6) by pushing the ends of the extension bolts through the holes in the rear panel and then fitting 4BA nuts in order to hold these assemblies together.

Carefully align the lower edge of the rear panel with the rear edge of the main chassis and fit two small self-tapping screws through the holes in the underside of the main chassis that align with the holes in the lower edge of the rear panel.

Next, bolt the bracket (formed earlier by bending a solder tag) that is fixed to the lower edge of the printed circuit board securely to the main chassis using a 4BA x $\frac{1}{4}$in bolt and nut.

Carefully slide the remaining heat sink over TR_1 (OC82D) and bolt down securely to the main chassis using a 4BA x $\frac{1}{4}$in bolt, washer and nut.

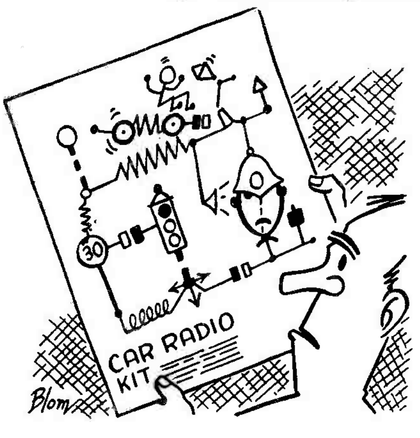
Solder into position C_{21} (0.5μF) between the tag of C_{20} and the earth tag fitted to the loudspeaker socket.

Solder the free end of lead T (earlier fitted to the printed circuit board) to tag 1 of the on/off switch S_3 (see Fig. 6).

Join the free end of the white lead from the output transformer T_2 also to tag 1 of S_3.

Solder into circuit choke L_7 between tags 2 and 4 of S_3.

Screw into position the 12V 2.2 watt bulb to the plastic lampholder and ease the holder on to the metal bracket adjacent to the volume control (see Fig. 6).



Join a short lead to tag 1 of the lampholder and tag 1 of S_3.

Solder a short lead between tag 2 of the lampholder and the earth tag on the loudspeaker socket.

Connect a short length of lead between the tag of C_{20} and tag 4 of S_3.

Join the grey and black leads Q and S from T_2 to points Q and S on the printed circuit board.

Solder the free ends of the twin screened cable that comes from the printed circuit board to the tags on the volume control potentiometer (see Fig. 6)—braid to tag 1; black to tag 2 and red to tag 3.

Fit a short length of sleeving to the free ends of both L_1 and R_1 (330kΩ, orange, orange, yellow) and solder to the printed circuit board (leads E and C).

Join a short lead (B) between the printed circuit board and the earth tag adjacent to the aerial socket.

Solder the free end of the yellow lead from L_4, L_5 coil to the same earth tag.

Join the free end of the red lead from the same coil to the printed circuit board (point G).

Connect the green lead from L_4, L_5 coil to the tag on TC_4 trimmer.

The free end of the black lead from the same coil is now soldered to tag 2 of the tagstrip adjacent to L_2 coil—see Fig. 6.

Connect C_7 (150pF 2.5% Polycap) between tags 1 and 2 on the same tagstrip.

In parallel with C_7, fit choke L_6—coded with a green sleeve.

From tag 3 of the same tagstrip connect lead D to the printed circuit board.

Join a short lead between tag M on S_2 wavechange switch and tag 2 on the 3-way tagstrip.

Connect a lead between the centre tag of S_2 and tag 1 on the 3-way tagstrip.

Solder the free end of the red lead from L_2 coil to tag 3 of the 3-way tagstrip.

Connect L_3, coded with a yellow sleeve, between tag L on S_2 and tag 3 of the 3-way tagstrip.

Connect C_1 (330pF 2.5% Polycap) between TC_1 trimmer tag and the adjacent earth tag.

C_8 (330pF 2.5% Polycap) is now connected between TC_4 trimmer tag and the adjacent earth tag.

Connect a short lead between TC_1 tag and tag L on S_1, also a short lead from TC_2 tag and tag M on S_1.

Similarly, connect a short lead between the tag of TC_3 and tag 2 of the 3-way tagstrip.

Connect lead F between the tag on TC_4 and point F on the printed circuit board.

The free end of the blue lead from L_2 coil is now connected to the centre tag of S_1—extend this lead if necessary by adding an extra length of p.v.c. covered wire.

Connect lead A between the printed circuit board and the centre tag of S_1.

Final Assembly

With reference to Fig. 7, assemble the fuseholder and the 2A fuse, and join the suppressor unit into circuit. Lead A is approximately 8in in length. The lead between the fuseholder and the suppressor unit and car battery supply is supplied ready fitted to the assembled suppressor unit. Any excess may be removed, this of course depending on the final position of the car radio when installed within the car itself.

Feed the end of lead A through the grommet in the main chassis and tie a large knot in this lead as shown in Fig. 6, soldering the end of the lead to the tag on C_{20}.

Obtain the loudspeaker and bolt securely to the baffle using four 4BA x ½in bolts and nuts together with washers. Should the holes between the loudspeaker frame and baffle fail to align correctly, force a hole or holes through the baffle using a pointed object—such as a small screwdriver, etc.

With reference to Fig. 5, join a suitable length—depending on the final position of the loudspeaker—of twin stranded lead to the loudspeaker tags

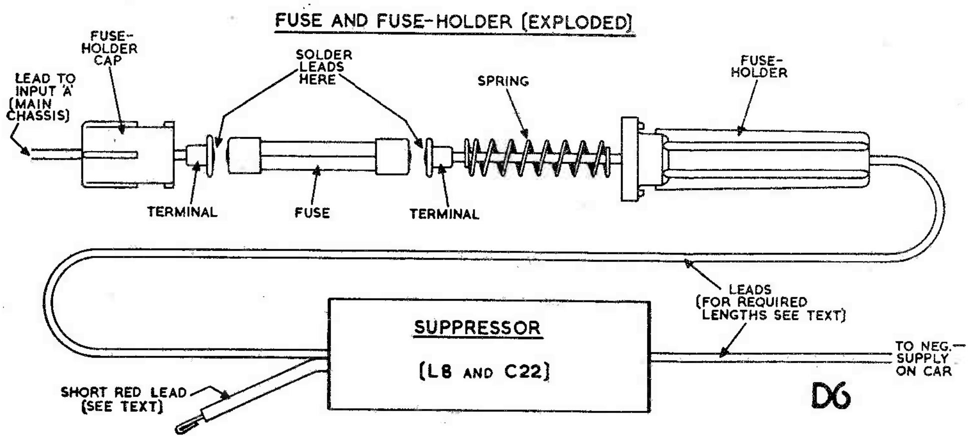


Fig. 7. Suppressor and fuseholder assembly

and, to the other ends, solder the 2-pin plug.

Take a 4in length of single stranded lead and wind closely around a small diameter screwdriver to form a coiled lead. This is soldered between the moving bar on the tuning unit and tag 1 on the 3-way tagstrip (see Fig. 6).

Insert the ECH83 (or the equivalent 6DS8) into V_1 valveholder carefully, and the EBF83 (or the equivalent 6DR8) into the V_2 valveholder.

Carefully slide the screening cans over both valves ensuring that the can earthing clips fitted to the valveholders are seated *inside* the cans.

Fit and secure into position the Perspex dial, front panel and both control knobs.

The assembly of the car radio is now complete.

Alignment

Connect a suitable source of 12V d.c. to the receiver, the positive (+) supply to the case or chassis and the negative (−) to the "A" lead input. Connect the loudspeaker by inserting the two-pin plug into the output socket.

Switch on the receiver, whereupon the dial bulb should light up. Allow sufficient time for the valves to warm up, set wavechange to the medium-wave band, advance the volume control and rotate the tuning control to 550 metres approximately. Set the signal generator to 470 kc/s and feed a modulated signal into the aerial input socket. Adjust the cores of IFT_1 and IFT_2 for maximum signal, reducing the output from the signal generator as necessary.

Alter the signal generator to 540 kc/s and adjust the core of L_4, L_5 for maximum signal by using a thin pair of pliers and drawing the brass threaded rod attached to the core either in or out of the coil. Adjust the core of L_2 in the same manner for maximum output. Set the signal generator to 1.5 Mc/s, tune the receiver to 200 metres and adjust TC_4 trimmer for maximum signal. Similarly, peak TC_2 and finally repeat the whole of the above procedure.

Press the long-wave push-button and alter the signal generator to 200 kc/s. Tune the receiver to 1,500 metres and adjust TC_3 trimmer for maximum signal and similarly adjust TC_1 trimmer.

Finally, the metal cover may be fitted over the receiver using the small self-tapping screws to secure it to the main receiver chassis.

Interference Suppression

As many readers will know, probably to their cost, a motor vehicle is a notorious generator of radio interference and it is essential that this interference be suppressed at the source—this is easily said but often very difficult to achieve satisfactorily.

The ignition system, if not efficiently suppressed, will produce a continual "clicking" or "popping" noise in the loudspeaker and similarly the dynamo, if not suppressed, will cause a "whine" which will increase in intensity as the engine is "revved".

Judicious attention to the following should ensure interference-free reception but it must be emphasised that no definite rules can be laid down that will apply to all and every car. As the writer has found in practice, age and various faults peculiar to individual vehicles (and makes) often produce variations with respect to the causes and cures (where one is possible) and each car must receive individual attention.

The first advice the writer would impart to readers installing *any* car radio is that the aerial should be mounted on the rear of the car when the engine is situated at the front and *vice versa*.

Some cars have r.f. "hot spots" around the engine and bulkhead—side valve engines being, in the writer's opinion, very troublesome in this respect. Mounting the aerial therefore, as far from the engine as possible, with good quality coaxial cable being fed *inside the body of the car* to the receiver is always a good start when battling against ignition interference.

Most modern cars will have a suppressor resistor already fitted to the distributor head and, where this is not the case, then one should be fitted. These are usually of the screw-in type and are easily available from most garages. If this type is not available then a cut-lead type of resistor (suppressor) may be fitted. This suppressor should be fitted in the main h.t. lead from the distributor to the coil and *must be sited as close as possible to the distributor.*

Suppressor resistors should be fitted to each sparking plug, the "clip-on" type being the best for this purpose although the cut-lead type having woodscrew connectors may be used, provided these are fitted as close as possible to the plugs.

Where suppressor resistors or resistive leads are already fitted to the distributor and/or plugs, the fitting of additional suppressors will worsen the interference.

A $1\mu F$ metal cased bypass capacitor should be fitted to the dynamo, the lug of the capacitor being mounted on the dynamo fixing nut and fixed securely so that a good earth connection is made. The flying lead of the capacitor must be connected to the live output terminal—the car lead connected to this terminal being usually coloured yellow. *On no account should this capacitor be connected to the dynamo field terminal otherwise severe damage will be caused to the dynamo.*

A similar bypass capacitor should be mounted on the ignition coil bracket and the flying lead of the capacitor connected to the "SW" terminal of the coil (i.e. the low tension lead connected to the ignition switch).

On some vehicles it may be found necessary to connect another bypass capacitor to the voltage regulator, although this is not generally required with the majority of cars. Where it is found necessary to fit such a capacitor it must be connected to the *voltage regulator terminal only.*

The $1\mu F$ bypass capacitors referred to above may be obtained from most large garages and most certainly from car electrical workshops.

Installation

The dimensions of the car radio are 7 x 2in and it will therefore fit into the standard cut-outs provided in the dashboards of some cars. Alternatively, the radio may be mounted on L brackets below the dashboard. Whichever method is used, the brackets should be of substantial material and all bolts well tightened—the use of shake-proof washers is strongly advised.

The bushes on the side of the receiver case are 2BA and the actual length of the bolt required will depend on the thickness of the brackets used. In any event, not more than ¼in of bolt should project into the bushes.

Scrape away the paint around one of the bushes and deal similarly with the corresponding bracket in order to ensure that a sound earth connection is made to the receiver.

The loudspeaker may be mounted in any convenient position, although suitable openings are usually now provided. It will be found that a considerable increase in volume will result in most cars if the speaker is mounted on the shelf behind the rear seat. The baffle board may require trimming in order to obtain a good fit and, as the baffle is of compressed cardboard, this presents no difficulties. No fixing holes have been provided to fix the baffle board to the car since the position of such holes will, of course, be determined both by the final position of the board and the make of car.

Connections

The live lead from the receiver must be connected to the A1 terminal of the junction box. This lead carries the fuseholder at the set end and has the suppression interference unit at the end remote from the set. The *black* lead from this unit is that which should be connected to the A1 terminal, the *red* lead being connected to the earthing point—a nearby screw head would suffice. If the suppression unit cannot be passed through the grommet hole in the bulkhead, then the lead should be cut and later reconnected.

The aerial plug should now be inserted into the coaxial socket (to the right underside of the receiver looking at the front) and pushed tightly home. The 2-pin loudspeaker plug is inserted into the 2-pin socket on the left-hand side of the bottom of the receiver. Note that the speaker plug has one pin of larger diameter than the other, the larger pin facing the left-hand side of the receiver when the plug is inserted into the socket.

Certification of High Fidelity Amplifiers

As mentioned in our feature "News and Comment" on page 835 of the June issue, we publish herewith some details of a certification scheme for high fidelity amplifiers, the end result of which is the protection of customers from exaggerated claims. For those readers who would like to pursue the matter further, see under Further Information, page 927.—**Editor.**

Manufacturers of high fidelity amplifying equipment can now apply for certification to show that performance claims have been checked by an independent testing authority. This certification scheme, together with a full test specification, has been introduced by the Audio Manufacturers' Group of the British Radic Equipment Manufacturers Association, and it forms an important landmark in the manufacturing and marketing of a.f. equipment in this country. Amplifiers which have undergone the necessary tests will be able to carry a "certification label" bearing the A.M.G. insignia and the information that the manufacturer's specification has been verified against A.M.G. Test Procedure. The label will indicate no specific performance for the particular amplifier which carries it, but it will mean that the validity of the manufacturer's claims has been independently confirmed.

All manufacturers of audio amplifiers may participate in the certification scheme, and it is not restricted to members of A.M.G. A number of approved "test houses" have been established for measurements on amplifiers. Amplifiers are checked at these test houses against the A.M.G. specification, after which application is made for the A.M.G. certification. To qualify for registration all data given in technical publicity material must be covered by test house certificate, and the manufacturer must undertake that all production of the equipment concerned will maintain the performance exemplified by the verified sample. Any modification to the specification must be notified to A.M.G. immediately it occurs.

The function of the certification scheme is to protect customers from exaggerated claims, and rigid rules have been drawn up specifying the minimum number of performance parameters that a manufacturer must present. It is not permissible, for instance, to quote figures for rated output and frequency response only.

It is stated by A.M.G. that "apart from its value to the industry, the certification scheme will be welcomed by the public. Purchasers of high quality amplifiers rarely have the necessary equipment or experience to carry out the elaborate tests needed to check the manufacturer's performance claims."

The certification covers pre-amplifiers, power amplifiers, integrated amplifiers and stereo equipment; and it excludes signal generating sources (such as pick-ups or tape decks) and loudspeakers.

Minimum Performance Data

To achieve certification the following minimum performance data must be submitted by the manufacturer:

- Harmonic distortion
- Rated output voltage (pre-amplifiers)
- Rated output power (power or integrated amplifiers)
- Sensitivity
- Frequency response for level position, with uncorrected inputs
- Frequency response for level position, with equalised inputs (pre-amplifiers and integrated amplifiers)
- Hum and noise
- Damping factor
- Cross-talk (stereo equipment)
- Power consumption and current drain.

The A.M.G. Specification

The A.M.G. Specification covers a wide range of parameters and methods of test. Those with most interest to the high fidelity enthusiast are detailed here in considerably abbreviated form.

Amplifiers shall be tested under standard conditions of measurement. For mains-operated apparatus, a.c. supply voltages shall be within $\pm 2\%$ of the rated figure, have a frequency within $\pm 2\%$ of the lowest rated supply frequency, and be sinusoidal with less than 2% harmonic content. Where applicable, d.c. supply ripple must not exceed 5%. Battery-operated amplifiers shall be checked with the battery type specified by the manufacturer. Unless an input impedance is specified, the input to the amplifier will be fed from a source impedance of 10kΩ, whilst the output terminals of power or integrated amplifiers will be loaded by a resistor within $\pm 5\%$ of the value specified by the manufacturer. Pre-amplifiers must be terminated by a 100kΩ resistor shunted by a 1,000pF capacitor unless otherwise specified by the manufacturer.

The measurement signal, unless otherwise specified, shall consist of a 1,000 c/s tone, the r.m.s. value of all frequency components other than the fundamental being less than 20% of the rated harmonic distortion of the amplifier.

Amplifiers using valves must be pre-conditioned for at least one hour with all covers in place. Amplifiers using transistors must be pre-conditioned for two hours with all covers in place, and with a 1,000 c/s input giving an output equal to 20% of the rated output.

Harmonic distortion may be measured with either a distortion percentage meter, which automatically sums the power in all the harmonics and gives the result as a percentage of output voltage, or a wave analyser. The latter measures the values of the individual harmonics, from which the total value can then be calculated. Where a simple harmonic distortion figure is quoted, this shall be at 1,000 c/s. If it is desired to plot the characteristic curve for harmonic distortion, the input voltage shall be adjusted such that the amplifier continually operates at rated output, input frequency being varied between the upper and lower limits where measured harmonic distortion is five times the value claimed by the manufacturer at 1,000 c/s.

The *frequency response characteristic* of an amplifier is defined as the curve showing variation of gain with frequency relative to gain at 1,000 c/s. With power amplifiers the input voltage is adjusted such that the amplifier continually operates at one-quarter of the rated output power, input frequency being varied between the limits of half the minimum to twice the maximum of the range of frequencies over which the manufacturer claims a level response (within $\pm$1dB). This process is then repeated at full output power, either over the previous range or between the frequency limits which require 20dB increase in input voltage to maintain the rated output, whichever is the smaller range. With pre-amplifiers, measurements are made over the same range as for power amplifiers at one-quarter of rated output power, the pre-amplifier output being at one-half the rated output voltage. Frequency response characteristics are then taken for level control position, with equalisation applied, with bass and treble controls at the full "cut" or "boost" positions, and for each position of filter controls.

No tests for *intermodulation distortion* are specified, it being considered that the study of measuring and expressing intermodulation distortion has not reached a stage where a standard method can be recommended. If intermodulation distortion tests are made, the method used should be stated with the results.

Hum and noise is defined as meaning all voltage components delivered to its load by an amplifier operating with no input signal applied. It must be measured by an instrument with full-wave rectifying characteristics, which responds to the average value, and which is calibrated to indicate the r.m.s. value of a sinusoidal waveform. For pre-amplifiers a test signal at 100 c/s is applied to give rated output voltage. The test signal is then removed and the input shunted by a non-inductive screened resistor of 47kΩ, unless the input is low impedance whereupon the resistor value equals the source impedance specified by the manufacturer. The output voltage is then measured The equivalent hum and noise signal input voltage is given by:

$$\frac{\text{Hum and noise output voltage}}{\text{Signal output voltage}} \times \text{Signal input voltage.}$$

The process is repeated with the gain control adjusted to give half the rated output voltage.

For power amplifiers the input is shunted by a non-inductive screened resistor of 47kΩ, unless the input is low impedance whereupon the resistor value equals the source impedance specified by the manufacturer. The hum and noise level in decibels is given by

$$10 \log_{10}$$

To measure the *damping factor* of a power amplifier, a 50 c/s input is initially applied to produce one quarter of the rated output power in the load resistor. The voltage across the output is then measured. Without adjusting the input, the load resistor is removed, and the open-circuit output voltage measured. Then:

$$D.F. = \frac{V_2}{V_1 - V_2}$$

where D.F. is the damping factor, and V_1 and V_2 the no-load and on-load voltages respectively.

The *stability* of a power amplifier is defined as its ability to operate without the generation of spurious oscillations when used with a capacitive load. The amplifier is tested with a capacitor connected across any output and no other load. If the amplifier is claimed to be unconditionally stable, the test is made with a range of capacitor values, in steps of 0.01μF from 0.01 to 0.1μF, and in steps of 0.1μF from 0.1 to 1μF. If no special claims for stability are made, the value of the capacitor shall be such that its reactance at 200 kc/s is equal to the nominal impedance of the output being used (e.g. 0.05μF approximately for 15Ω output). Capacitive loading in excess of this is unlikely in domestic installations. With the various capacitors connected, the output is coupled to a wide-band oscilloscope to check for evidence of spurious oscillation with no input applied, and with the input swept over 10 c/s to 70 c/s.

To measure *cross-talk* in stereo equipment, one amplifier has its input shunted by a non-inductive screened resistor of 47kΩ or, if the input is low impedance, with a resistor whose value equals the source impedance specified by the manufacturer. The output is coupled, via a high-pass filter having a cut-off frequency of 100 c/s, to an instrument calibrated to read the r.m.s. value of a sinusoidal waveform. The outputs of both amplifiers are terminated by the specified load resistance. A 200 c/s signal having the same amplitude as that which gives rated output at 1,000 c/s is then applied to the other amplifier, and any voltage appearing across the

$$\frac{\text{Output power with input shunted}}{\text{Rated output power}}$$

output of the first measured. Cross-talk in decibels is given by

$$20 \log_{10} \frac{\text{Cross-talk output voltage}}{\text{Signal output voltage}}$$

A second test is carried out with an input signal at 5,000 c/s, and the whole process is next repeated with the amplifiers reversed. The worst figure given by these four measurements is then specified as the cross-talk performance of the equipment at its rated output.

No test is specified for *transient response*, it being considered that none of the methods currently used are comprehensive enough to cover all transients. If transient tests are made, the method used, including measuring frequency, rise-time and overshoot, should be given with the results.

Treatment of Complaints

If a complaint concerning the performance of a particular amplifier in the certification scheme is made (within 90 days of the date of purchase) and if the manufacturer has serviced the amplifier and stated that it is up to standard, or has declined to take any action, the following procedure is adopted.

The amplifier under query shall be submitted to the test house which originally tested the equipment, the complainant and the manufacturer each depositing with A.M.G. a testing fee depending upon the parameter(s) to be checked. The A.M.G. will be notified of the result of the test. If the amplifier meets the manufacturer's specification, the complainant's fee will be forfeit and the manufacturer's fee returned to him. The complainant shall be provided with a copy of the test report. If the manufacturer declines to lodge a deposit, or to take any other action under the complaints procedure, the certificate shall be withdrawn and the Trade Press notified accordingly. Similarly, if the amplifier submitted for test fails to meet the manufacturer's specification, the certificate shall be withdrawn and the Trade Press notified; also the manufacturer's deposit shall be forfeited and the complainant's deposit returned to him. The manufacturer shall be provided with a copy of the test report.

The certificate will also be withdrawn and the Trade Press notified if, one calendar month after the manufacturer has been notified, any undertakings given in the application for registration are not being complied with.

If, for any reason, a manufacturer no longer wishes to be bound by the conditions attached to the certification, he may apply to A.M.G. to have his equipment withdrawn from the register. The Trade Press shall be notified that this is a voluntary withdrawal.

Further Information

The full title of the A.M.G. Specification is "Specification for methods of measuring and expressing the performance of Audio Frequency Amplifiers", and it is available at 10s. 6d. (plus postage) from the Secretary, Audio Manufacturers' Group, 49 Russell Square, London, W.C.1. Full details of the certification scheme are also available.

A FAMILY RADIOGRAM

PART 2

by A. S. CARPENTER

This article concludes our two-part series describing the construction of a comprehensive radiogram which is especially intended for family entertainment. A particular feature of the instrument is that it may be fitted into a ready-manufactured cabinet, thereby ensuring a professional presentation with the minimum of carpentry. Last month's article dealt mainly with the amplifier and its power pack, and we now carry on to the tuner unit

The Superhet Tuner

THE TUNER UNIT WILL DOUBTLESS APPEAL TO many readers since it is, as was mentioned earlier, a self-contained unit which can easily be put to uses other than in the present equipment. Major circuit details are shown in Fig. 9.

Compactness is the keynote here, plus efficiency and simplicity. Reliability of operation rules out trick circuitry and a conventional design is adopted. V_1 is a modern frequency changer and V_2 functions as intermediate frequency amplifier, signal demodulator and a.g.c. diode.

A self-contained, home-built coil pack is incorporated and this, together with efficient i.f. transformers, provides a good range of listening pleasure on both the medium and long wavebands.

The tuner is powered by a small mains isolating transformer, and half-wave rectification is used, the anodes of the valve rectifier, V_3, being strapped. If preferred, a miniature contact cooled metal rectifier can be used instead of V_3 for rectification. Audio signals are conveyed to the amplifier by screened cable from a stand-off insulator ("I" in Fig. 14) mounted on the tuner chassis top plate.

Components List (Fig. 9)

Resistors ($\frac{1}{2}$W except where stated)

R_1	18kΩ 1W
R_2	18kΩ 1W
R_3	33kΩ 1W
R_4	220Ω
R_5	56kΩ
R_6	56kΩ
R_7	470kΩ
R_8	1MΩ
R_9	100kΩ
R_{10}	190Ω
R_{11}	56kΩ
R_{12}	2.2kΩ 1W
R_{13}	2.2kΩ 1W
R_{14}	68Ω 1W
R_{15}	470kΩ
R_{16}	1MΩ

Capacitors (C_1 to C_3 are in coil pack)

C_4	0.01μF, paper
C_5	0.01μF, paper
C_6	50pF mica
C_7	50pF mica
C_8 (a and b)	500pF nominal, twin gang
C_9	0.01μF paper
C_{10}	0.01μF paper
C_{11}	0.01μF paper
C_{12}	50pF mica
C_{13}	0.01μF paper
C_{14}	200pF ceramic or mica
C_{15}	200pF ceramic or mica
C_{16}	0.01μF paper
C_{17}	4μF electrolytic, 350wV
C_{18}	16 x 16μF, electrolytic 350wV

Valves

V_1	ECH81
V_2	EBF80
V_3	EZ80

Transformers

T_1, T_2 Weymouth P6 or Denco IFT11.
T_3 Mains input Secondaries: 0–250V at 30mA, 6.3V at 1.5A.

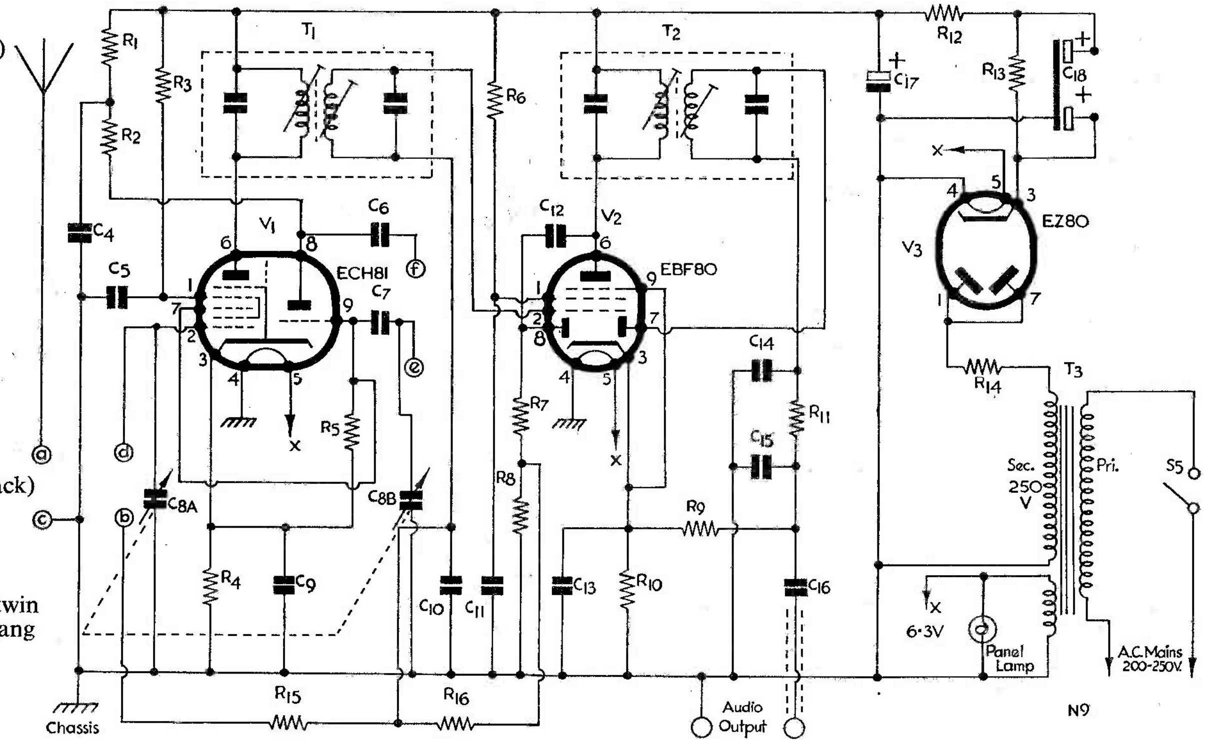


Fig. 9. Theoretical circuit of the tuner

Chassis
$8\frac{1}{4}$ x $4\frac{1}{4}$ x $1\frac{3}{4}$in. (Fig. 13)

Panel
$14\frac{1}{2}$ x 4 x $\frac{1}{8}$in. (Fig. 12)

Valveholders
B9A (3)

Panel Lamp and Holder
MES 6.3V, 0.15A

Lens and Bush
Bulgin 1-hole, $\frac{3}{8}$in fixing type D197

Switch
On/off toggle, 1-pole

Miscellaneous
Dial drum, $2\frac{3}{4}$in dia. and drive shaft (see text)
Aerial-earth socket strip
Control knobs (2)
Grommets, solder tags, etc.

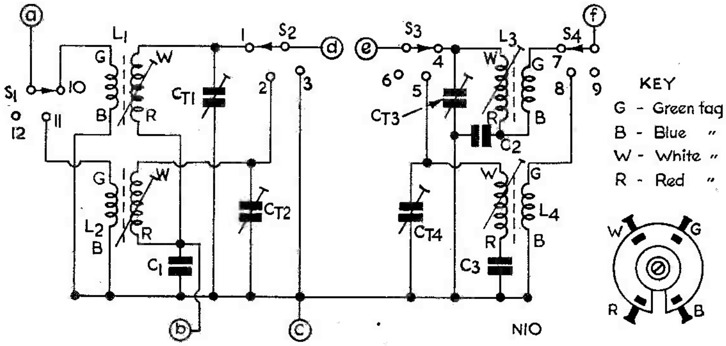


Fig. 10. Theoretical circuit of the coil pack

Components List (Fig. 10)

Coils

L_1	HA3	Weymouth "H" range
L_2	HA1	
L_3	HO3	
L_4	HO1	

Switch
4-pole, 3-way miniature

Capacitors

C_1	0.01μF ceramic
C_2	500pF mica
C_3	180pF mica

Trimmers
$CT_{1, 2, 3, 4}$ 3–30pF concentric

Chassis
See text

The Coil Pack

The coil pack used here is unique and is a companion to one previously built by the author of which details were given in an earlier issue.[1] The earlier version served a special purpose in that it selected three pre-set transmissions. The pack used here is identical in size and is built on a similar chassis, viz. a small size discarded Elastoplast waterproof dressing tin, the lid of which is removed and placed over the bottom of the tin to provide an extra thickness of metal. Since the pack is eventually fitted to a non-metal panel, the use of the tin is desirable to isolate the coils from unwanted hand effects.

Coils from the Weymouth "H" range are again chosen because of their simplicity of fixing, this requiring a single 6BA bolt. The dust cores are headed with brass stems for trimming purposes and these fracture less easily than those in which the screwdriver slot is part of the core material.

The theoretical circuit diagram of the coil pack is given in Fig. 10. Aerial coil, L_1, and oscillator coil, L_3, embrace the medium-waveband with L_2 and L_4 as their long-wave counterparts. A short-wave range is not fitted although there are sufficient contacts on the wavechange switch to include one; the pack would, however, tend to become congested.

Use of the pack enables the whole tuning "heart" to be wired up independently of the main chassis, and this aids construction. Six flying leads are used—including one for the chassis connection—to enable the pack to be connected into the remainder of the circuit. In the diagram these are lettered (*a*)–(*f*) and are connected into the main tuner circuit at the points marked in Fig. 9. Lead (*d*) for example connects to the signal grid of V_1 and S_2 is arranged to ensure that at all times this grid receives bias even if the switch is accidentally rotated to position 3. Position 3 mutes the tuner.

Mechanical Details—Coil Pack

The small physical dimensions of the pack "chassis"—see Figs. 11 (*a*), (*b*) and (*c*)—makes trimmer mounting a minor problem and the best method found was to use concentric trimmers (30pF) instead of the more usual type. The manufacturers recommend trimmer values of 50pF but the difference is negligible in practice. When the tin lid is placed over the bottom a lip due to its edge results, and this helps to secure the trimmers. Four equidistant slots are filed in this lip to accept the earthy lugs of the trimmers, which are then firmly soldered in position. The locations of the other items can be seen from the diagram and the coils should be oriented as shown.

Some coil packs use the threaded section of the wavechange switch for fixing but this means that the switch and its wiring are floating during the mounting process. Here, two separate mounting holes are provided (see Fig. 11 (*a*)). The switch spindle needs to be approximately ½in long (excluding the bush). In addition to the trimmers three fixed capacitors are required.

Wiring the Coil Pack

This is not a tedious operation but one that requires to be done carefully to avoid confusion. A soldering iron with a pencil bit is needed and this should be hot enough to allow very quick joints to be made. An assortment of differently coloured leads is also needed. Referring to Fig. 11 (*b*) it will be observed that the outermost tags, or "ways", of the rotary switch have been given numbers. The four "poles" at the centre are presumed to each control three of the "ways" with tags 1, 2 and 3 coming under the influence of the top right hand

[1] "A 3-Station Switched Coil Pack", by A. S. Carpenter, *The Radio Constructor*, July 1961.

"pole" tag and so on.[2] Connections should be made as follows, remembering that references to "chassis" are to the coil pack chassis.

(1) Brown lead from green tag, L_1 to tag 10 on switch.
(2) Brown lead from green tag, L_2 to tag 11 on switch.
(3) Red lead from white tag, L_1 to tag 1 on switch.
(4) Red lead from tag 1 on switch to CT_1.
(5) Red lead from white tag, L_2 to tag 2 on switch.
(6) Red lead from tag 2 on switch to CT_2.
(7) Blue lead from blue tag, L_1 to chassis.
(8) Blue lead from blue tag, L_2 to chassis.
(9) Connect tag 3 on switch to chassis.
(10) Green lead from red tag, L_1 to red tag, L_2 and connect C_1 from the junction to chassis. Fly lead (*b*) connects here also.
(11) White lead from white tag, L_3 to tag 4 on switch.
(12) White lead from tag 4 on switch to CT3.
(13) White lead from white tag, L_4 to tag 5 on switch.
(14) White lead from tag 5 on switch to CT_4.
(15) Black lead from red tag, L_3 to blue tag, L_3. Connect C_2 to chassis from this point.
(16) Connect C_3 from red tag, L_4 to chassis.
(17) Grey lead from green tag, L_3 to tag 7 on switch.
(18) Grey lead from green tag, L_4 to tag 8 on switch.
(19) Connect blue tag, L_4 to chassis.
(20) Connect flying leads to the appropriate switch poles and chassis. (See Fig. 10.)

Note: Trimmers CT_1 and CT_3 are medium-wave aerial and oscillator trimmers with CT_2 and CT_4 their long-wave counterparts.

The Tuner Panel

This extends the whole depth of the cabinet on the left side, as may be seen in the appropriate photograph, and carries the wavechange switch and coil pack, tuning scale, drive knob, warning lens and on/off switch. Details of the panel—which is made from hardboard and bolted to the tuner chassis—are shown in Fig. 12. In use the panel is bolted to the chassis front flange and the tuner rests on the motor board on its rear flange so that the valves are horizontal. A rectangle of wood 14½ x 4¼ x ⅜in then separates the tuner top from the turntable and supports the upper edge of the panel. Screws may be passed through the panel into this section if desired. The panel is eventually French polished.

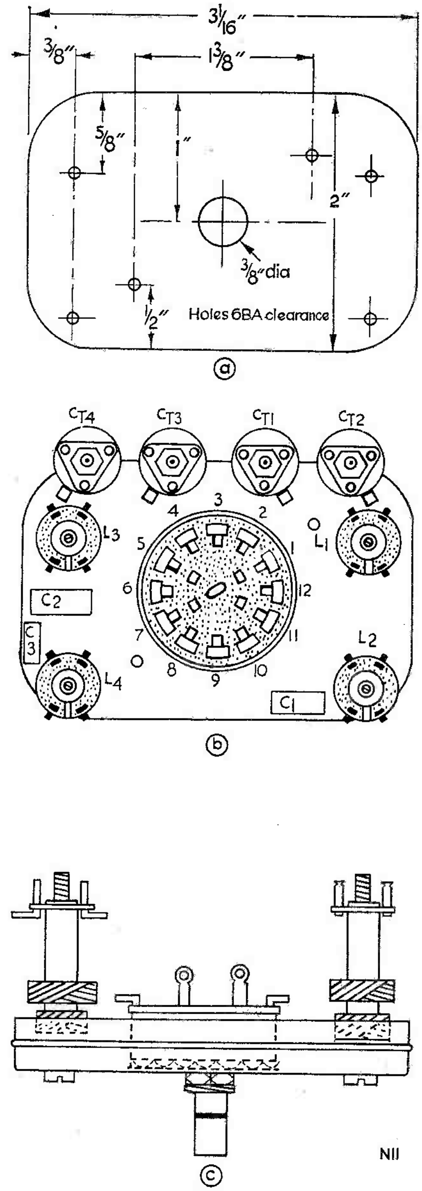
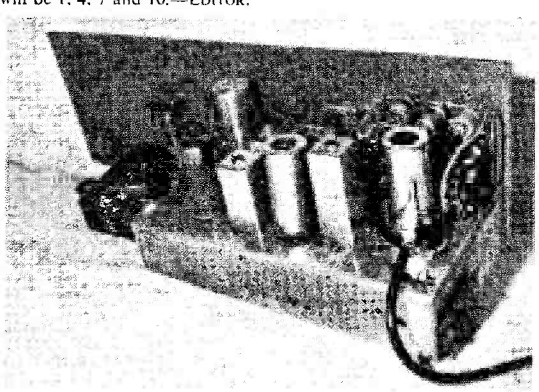


Fig. 11. Mechanical details of the coil pack

[2] Miniature 4-pole, 3-way switches of the type employed here may vary in the relative positions of the central and outside tags. The switch employed should be set fully counter-clockwise (spindle pointing to the reader) whereupon the outside contcts switched in will be 1, 4, 7 and 10.—EDITOR.



Above-chassis view of the tuner unit

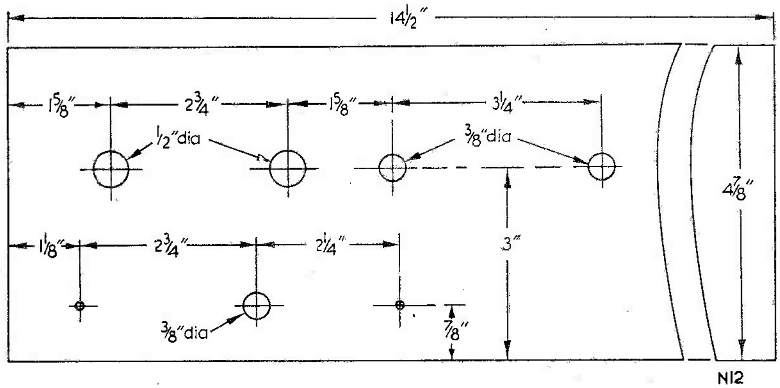


Fig. 12. The tuner control panel

Tuner Layout

Tuner unit chassis dimensions are illustrated in Fig. 13, and diagrams which show practically the whole wiring (with the exception of R_6 and C_{11}) are given in Figs. 14 and 15. The coil pack trimmer locations can be clearly seen in Fig. 14 and it will also be noted that the mains isolating transformer is mounted on the side of the chassis to afford more space. Resistors R_{12} and R_{13} comprise a tapped $5k\Omega$ wirewound component in the original, but separate items may be used. The only leads emanating from the tuner chassis are the mains supply pair and the screened signal lead.

Below the chassis several stand off insulators are used for anchoring purposes. The location of the aerial-earth socket strip permits plugs to be inserted at the rear of the cabinet.

Reduction Drive and Tuning Scale

Due to the narrowness of the tuner panel it is not easy to find a suitable reduction drive mechanism and dial from general supply sources. The unique and simple method adopted here is most satisfactory, however, and consists of a readily obtainable cord drive tuning drum of 2¾in dia. fitted to the tuning capacitor spindle with its flat side uppermost. A cord, in combination with a drive spindle and spring, is usually fitted to a drum of this type to obtain a slow motion effect, but a simpler method is adopted here and is depicted in Fig. 16. The drive spindle is fitted in such a way that a rubber grommet forced over the end associated with the knob makes contact with the concave edge of the drum and rotates it by friction as the drive shaft is rotated. A ratio of approximately 5:1 can be obtained by using a suitable grommet. A scale is then glued to the flat surface of the drum and serves admirably for tuning purposes. For good operation it is essential, firstly, to use a grommet that is a really tight fit on the spindle and, secondly,

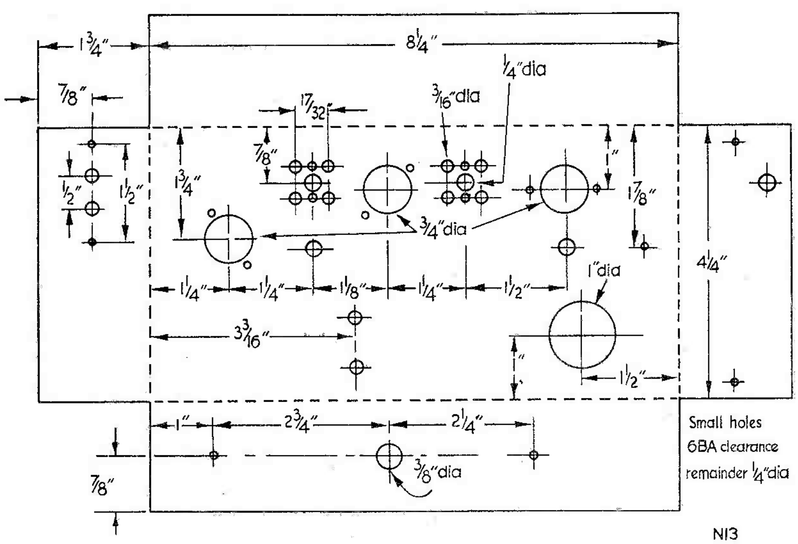


Fig. 13. Details of the tuner chassis

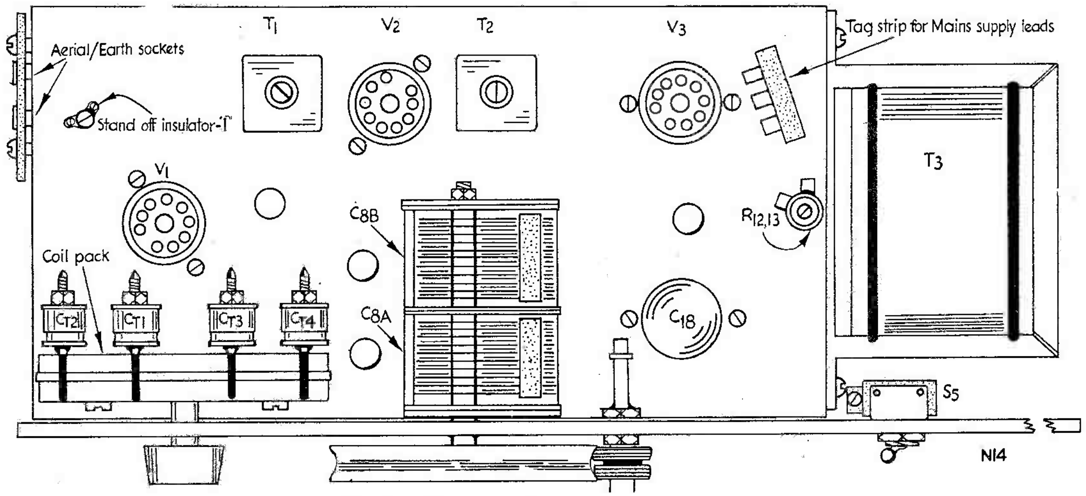


Fig. 14. The tuner above-chassis layout

to ensure that the driving shaft is correctly placed and cannot slip.

The Distributor Panel

As mentioned earlier, the distributor panel is used for inter-connecting purposes. It is illustrated in Fig. 17. It consists of a 2-pole on/off switch which ensures that the mains supply is completely disconnected when in the "off" position, a 5-way connecting block and a socket strip for feeding the external loudspeaker. The mains supply must be distributed to three points: (1) the gram motor, (2) the amplifier power pack, (3) the tuner. The way this is done is shown in the diagram. The panel is secured to the hardboard back of the cabinet (which is clip fitted) so that the on/off switch dolly is easily accessible. The separate units can then be connected or removed speedily and safely by laying the back of the cabinet flat. All leads should be made long enough to permit plenty of free movement.

Cabinet Preparation and Requirements

The cabinet was purchased from a reputable source together with the autochanger already fitted to order and mounted on its motor-board as described last month, not centrally, but to the right-hand side and allowing sufficient space for the on/off/reject control to be operated.

Prior to fixing the equipment three ½in holes are drilled in the motor board approximately 2in from the left hand side of the cabinet looking at it from the front. These are ventilation holes for the tuner. A long, horizontal slot is also cut in the hardboard back in the section appearing *above* the motor board for ventilation purposes. Next, four ⅜in holes are located with care and cut in the cabinet front to accept the amplifier control spindles. Another ⅜in hole is also located and cut for the warning lens.

The distributor panel is then fixed to the inside of the back panel and apertures cut for the tuner aerial-earth sockets, etc.

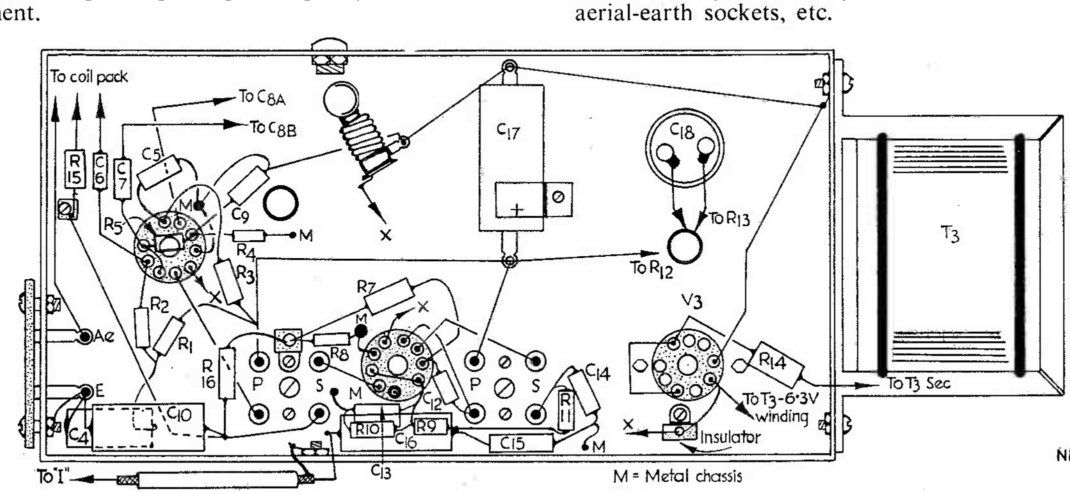


Fig. 15. The tuner below-chassis layout

Legs for the cabinet—purchased separately—are of modern styling with brass ferrules and are approximately 16in long. Although these can be fitted to the cabinet direct a superior method is to fix them to a suitable piece of plywood of the same size as the cabinet base (which must then be fitted with rubber feet to permit a cooling air flow) and so form a plinth.

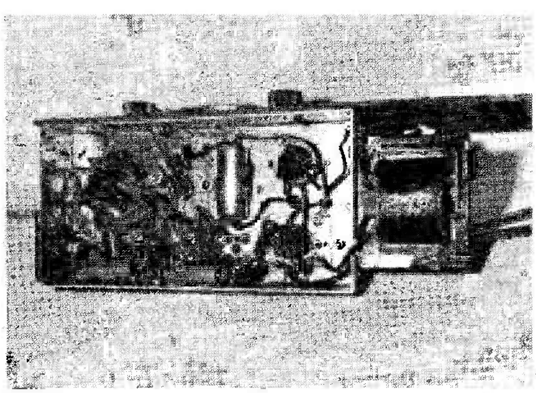
Fitted to the rear of the UA8 autochanger, just below the motor-board, is a tagstrip similar to that depicted in Fig. 18. A length of coaxial cable is connected here as follows: braiding to the black tags and inner conductor to the red tag. The yellow and blue tags are only required when a stereophonic set-up is used, so here they are not required. The free end of the coaxial cable is then connected to a coaxial plug for subsequent connection to the amplifier gram socket.

Setting up the Radiogram

Initially it is not necessary to fit the tuner and this is left until the gram function has been dealt with. Also, the remaining equipment should be primarily tried outside the cabinet before being fitted.

Assuming that the usual checks have been made for faults in wiring, etc., the amplifier, power pack, motor and speaker are all connected to the distributor panel, leaving the mains lead until last. The necessary inter-unit connections are completed, tone controls set at half travel (also VR_4) and the selector switch set to Gram. VR_1 is set to approximately quarter travel and the main on/off switch closed. As soon as possible, a voltage check should be made at pins 3 of the output valves. If the reading is low the apparatus should be switched off immediately and the fault located. A reading of approximately 11V will be satisfactory. Risk of incorrectly phased feedback is also likely and might necessitate reversing the feedback connections at T_1 secondary.

The following voltage readings above-chassis were obtained under no signal conditions on the prototype using a Weston Analyser (sensitivity 1,000Ω per volt) with VR_4 set to give a zero voltage reading across the primary winding of T_1.



Below-chassis view of the tuner unit

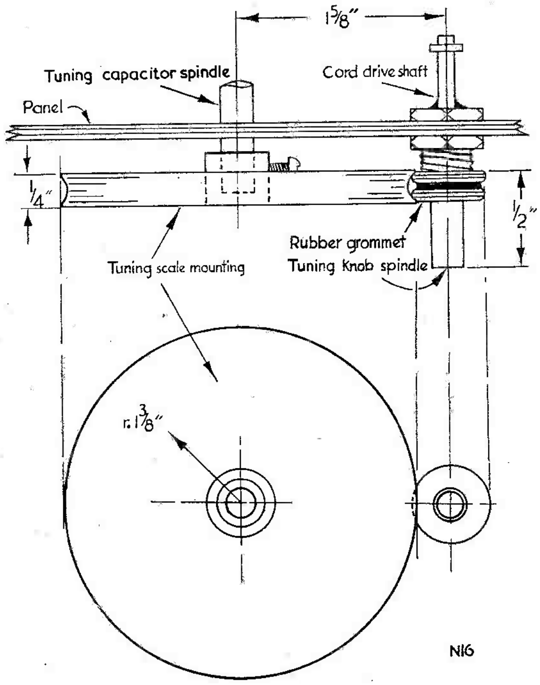


Fig. 16. Details of the reduction drive and scale

Location	Voltage	Meter Range Set
Junction black lead, T_1 and R_{15}	320	1,000V
Junction C_{17}, R_{15} ..	220	250V
Cathodes, V_3, V_4 (pins 3)	11	50V
Pin 3, V_1	1.2	10V
Pin 8, V_1	1.4	10V

If all is well a record may be played experimentally. The units may then be switched off and placed in the cabinet.

The Tuner

The tuner can, if preferred, be set up independently of the other apparatus, the output being temporarily injected into the pick-up sockets of a standard broadcast receiver. The output can even be heard in headphones. Usual superhet alignment techniques are adopted, the intermediate frequency transformers being trimmed to 465 kc/s. Coil pack trimmers are adjusted at the high frequency end of the tuning scale and dust cores at the low frequency end. The tuner *can* be aligned fairly well without a signal generator but this tends to become a tedious process when a consequently doubtful intermediate freouency is in use. (Pre-aligned i.f. transformers are, however, usually obtainable.)

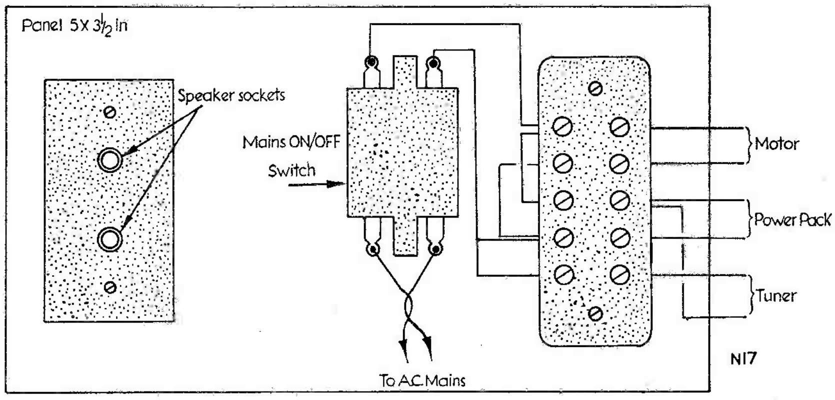


Fig. 17. Layout of the distribution panel

If coil trimmers refuse to peak properly at either maximum or minimum settings the main tuning capacitor should be reset to very slightly greater or less capacitance as required, and a fresh attempt made. Improved quality of output is likely to result if the cores associated with the i.f. transformer secondaries are very slightly detuned on completion of alignment. The a.g.c. operation can be checked by tuning to a strong signal and then momentarily short circuiting C_{10} to chassis, whereupon volume should increase as bias is reduced.

Finally, all control knobs can be fitted correctly and the units finalised. In the prototype four engraved knobs are used for the amplifier controls, viz., "Radio/Gram", "Treble", "Bass", and "Volume", these being set so that the lettering is upright when in the positions normally used with increased boost or increased volume occurring if the appropriate knob is turned clockwise. This allows the controls to be reset to their original positions with reasonable accuracy.

The Loudspeaker

It is scarcely necessary to mention that a good unit or units is essential and that these should be capable of handling the frequency range and output without stress. A good enclosure is desirable and this is likely to vary in shape and type somewhat with differing environments. That used with the prototype is not dissimilar to one described in an earlier issue of this journal[3] but with a 10in unit fitted. Four legs to match those fitted to the equipment cabinet then give the completed Family Radiogram a look of distinction.

Components List (Fig. 17)

Panel (dimensions 5 x 3½ x ⅛in), hardboard, plywood, etc.
Speaker socket strip
5-way connection block
On/off toggle switch, 2-pole

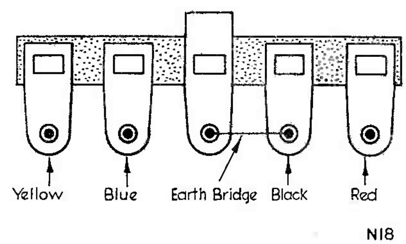


Fig. 18. The tagstrip fitted to the UA8 autochanger

[3] "A Small Bass Reflex Enclosure", by M. J. Pitcher, B.Sc., *The Radio Constructor*, August 1961.

New Compact Microwave Generator

The M-O Valve Co. Ltd. has started production of a compact microwave generator embodying a new focusing principle. The valve, Type OPX1, is an electrostatically-focused backward wave oscillator which has been named the Ophitron.*

The mechanical problems inherent in the design of oscillators for microwave frequencies are such that particular difficulties arise in altering the operational frequency by variation of mechanical dimensions. The backward wave oscillator principle overcomes this difficulty by variation of an electrical potential and, in the Ophitron, this principle is combined with electrostatic focusing of the electron beam, resulting in a device which is extremely compact and robust, has good low noise performance and which operates within a wide frequency range variable by single knob control. The device is about 9in long and ¾in in diameter and weighs only 12oz.

The Ophitron system has been designed for simple operation. A single stamped-out periodic structure and two flat focusing plates form the propagating path for the r.f. wave and set up the periodic electrostatic field which focuses the electron beam. The electrostatic focusing principle also assists in reducing ion noise.

The Ophitron at present being produced operates over a frequency range of 8.5 to 12.5 kMc/s with variation of the supply voltage from 600V to 2kV and gives a power of tens of milliwatts.

The Ophitron can be used wherever a wide electronic tuning range X-band low power oscillator is required. Because of its small size and light weight it has a clear advantage over the magnetically focused backward wave oscillator and its wide electronic tuning range gives it an advantage over reflex klystrons. More specifically, it can be used in wide frequency coverage receivers, as a test source for laboratory use, in test equipment for military use, and in place of reflex klystrons in a number of applications.

* After the Greek: a serpent, the word being suggested by the undulating path of the electron stream flowing along the structure Registered Trade Mark.

RADIO topics

By RECORDER

ONE OF THE MINOR IRRITANTS IN the life of the service engineer must surely be dust. I refer, of course, to that fine soft dust which finds its way into the works of radio and television sets and which rests, like a thick velvety pall, over all the resistors, capacitors and valves. Apart from the fact that such dust combines with the lubricants used for variable capacitor and potentiometer spindles to form what Smithy the Serviceman described as "Black Jam" in last year's August issue, it does not seem to interfere too much with the working of electronic equipment. Nevertheless, it is a nuisance, and it makes what should be a clean job unnecessarily unpleasant. Also, it gets into the air and on to the clothes.

All else being equal, the thickness of dust on a chassis should vary directly as the time between servicing. Other factors can, however, have considerable effect on the thickness of the deposit, the most important being the use or otherwise of a vacuum cleaner in the same room. If a vacuum cleaner is regularly employed, the dust found on a radio or television chassis is normally very much less.

Television Repair

Recently, I undertook a repair on an early 12-channel television receiver and encountered quite a few interesting points about dust. The set must have rested undisturbed for many years because the chassis was covered with the thickest layer of dust I have ever seen. When switched on, valve heaters could be vaguely discerned through the gloom like street lamps in a fog. As the fault could have been caused by the surface dirt I left this undisturbed during initial tests. These didn't help me but, before I started cleaning things up, I noticed an interesting point which I shall recount later.

Tidying up was a relatively quick process, most of the dirt on the surface of the chassis passing quite easily into a vacuum cleaner. A final flick-around with a cloth made things fairly presentable.

The fault was pretty straightforward. Every ten to twenty seconds the picture would suddenly dim and open out, or "bloom"; after which it would take a further second or so to return to its normal brightness and size. The initial dimming was accompanied by an audible, but not visible, spark from some point in the chassis. Since low e.h.t. causes both dimming and "blooming", it was reasonably certain that the snag was the result of a spark in the line output stage, either in the line output valve circuit or the e.h.t. circuit. The spark could then give a sudden drop in e.h.t., a subsequent delay occurring before e.h.t. built up again to its previous level. As it was more likely that the e.h.t. voltage would cause an audible spark than the voltages associated with the line output valve (and because it was easier to look into the e.h.t. circuit anyway!) I carefully cleaned up the associated components, hoping that I was similarly removing any spark discharge path that existed. This did not clear the snag but it did show a visible spark occurring inside the EY51 e.h.t. rectifier. The spark had previously been hidden under the grime which covered this valve, and a new EY51 put the set back into proper working order.

A final touch, due to dust again, was to clean the face of the tube with cotton wool plus a little water and detergent. A minor process, but it made the cowboys and Indians brighter than they had been for many a long moon.

An interesting fact resulting from the general clean-up of the chassis was that a spot appeared on the screen shortly after switching off. Such a spot is, of course, the result of a still-hot cathode emitting electrons to the screen, the e.h.t. voltage for the final anode remaining stored in the reservoir capacitor formed by the tube inner and outer graphite coatings. With this receiver the effect hadn't been seen for years! Despite the fact that my cleaning efforts hadn't removed the e.h.t. spark, there must have still been a pretty heavy discharge path through the grime. A discharge path whose resistance, incidentally, was quite low enough to discharge the tube reservoir capacitance almost immediately after the set was switched off.

The interesting point I referred to earlier, and which occurred when the set was in its original dusty state, was mainly discernible around the deflector coils. These carry a pulse voltage of several kV during flyback, and the dust between an adjacent chassis point and the coils had formed into short "hairs" following the lines of electrostatic force between the two conductors; in the same way as iron filings follow lines of magnetic force. Each time the spark occurred the "hairs" wavered, drooping slightly then returning to their original position.

So, if you want to *see* lines of electrostatic force suspended in mid-air, collect some really fine dust. It may be as effective for this purpose as iron filings are for magnetic fields.

Remote Volume Control

It is always a little fascinating to learn about what goes on behind the scenes in Court circles. You may recall that, during Queen Juliana's recent silver wedding celebrations, Amsterdam was invaded, for the Royal wassail, by sovereigns from all over the world.

Part of the festivities included a banquet at the Amstel Hotel where, according to Paul Tanfield in the *Daily Mail*, the Court Chamberlain had a special assignment. It was his function to press a button connected to the orchestra pit in accordance with signs made to him by Queen Juliana. Three long presses on the button meant "Stop"; three short presses—"Start"; short and long presses alternately—"Play louder"; three short then three long presses —"Play softer".

I've been trying to make up my mind since as to whether this isn't the most expensive, or most inexpensive, remote volume control system I've ever heard about.

PayVision

The Pilkington Committee has not yet, at the time of writing these notes, made its report, and so I cannot be too certain whether a description of the new PayVision Scheme will be topical or otherwise. At any rate, the principles involved are of sufficient interest to warrant passing on the information I have at the present time.

The PayVision system has been designed by Marconi's Wireless Telegraph Company Ltd., and offers a somewhat unusual method of supplying programmes to customers on the "pay-as-you-view" principle. The programmes are brought to the home by coaxial cable, no signals being transmitted over the air. The system can be used with any existing television set and does not affect existing programme reception; instead, it offers three new channels piped along the cable. There is no coin insertion, nor do meter readers have to visit the viewer's home.

The PayVision programmes are coupled to the receiver by way of a small control box which is no larger than the average book. This unit connects to the PayVision cable and to the aerial socket of the existing television receiver. Push-buttons on the control box select the various PayVision channels, whilst a small removable key in the side of the unit allows the desired channel to be switched to the receiver, as well as preventing accidental or unauthorised acceptance of a programme.

To obtain a PayVision programme the viewer first switches his television tuner to an unused channel (which will vary for different parts of the country). He will then receive a Pre-View channel which gives details of forthcoming attractions, together with full programmes for the day in both sound and vision. The Pre-View channel is available at all times and is free of charge. To select one of the three PayVision channels the viewer next presses the appropriate push-button on the control box, and turns the key to buy a programme. No programme can be bought until the key is operated.

Turning the key causes a signal to be passed back through the cable distribution system to the accounting centre, where the data is collected and processed by computing devices into individual subscriber accounts. Viewers receive regular statements, and the central accounting system eliminates the necessity of having coin boxes or meter readers.

An advantage of the central accounting system is that this also provides information on the size of an audience watching a particular channel. The actual receipts for any programme can be assessed immediately.

It is stated that the PayVision system can offer a greater clarity of picture, as the signal is received via closed-circuit techniques; also, there is no need for scrambling and expensive de-coding equipment at the receiver to prevent "pirating". Further, there is no transmission over the crowded space available on the air. The receiver can continue to pick up normal broadcast transmissions in addition to the PayVision programmes and it requires no modification. The PayVision system can be used in any country, and can operate on any line standard (black and white or colour) which is used at the present or which may be adopted. In addition, the system offers, free of charge, two f.m. sound radio channels transmitted over the incoming coaxial cable. These only require a normal v.h.f. set for their reception in the home.

The PayVision unit can be installed in the home at a cost of £5. The average cost of programmes would be 2s. 6d., with some public service and educational programmes free. Typical programmes, for which a charge would be made, could include first run feature films, plays from the West End and Broadway, and entire operas and ballets.

To date, a company—PayVision Programmes Ltd.—has been formed. In the interests of high quality programming, this company has an Advisory Board consisting of prominent members of the entertainment industry and including Larry Adler, Johnny Dankworth and Henry Sherek.

Evergreen Industry

Whilst many members of the public like to relax by watching television, others prefer to listen to the gramophone. And, surprising as it may seem, a high proportion of the latter still listen to the acoustic gramophone!

I am indebted to the E.M.I. house journal, *Eminews*, for this interesting item of information. According to *Eminews*, 320 million acoustic gramophone needles are still used every year throughout the world. By far the largest demand comes from countries without the full benefit of electricity, but there is still, nevertheless, a substantial market in Europe and the U.K.

Although the acoustic needles marketed by E.M.I. Records are produced outside the E.M.I. Group, they still have to conform to very rigid specifications. From every batch of 500,000 needles, 1,000 are given a visual inspection by microscope and 100 are mechanically tested for temper. Needles are also tested by being played through a record on an H.M.V. Model 102 portable gramophone, a machine which was introduced in 1920. After being played through the record, the needle is scrutinised under a "shadowscope" where the flat worn on the tip is measured. The wear should not exceed 0.005in.

Safe Handling Cabinet

With modern manufacturing and research techniques, toxic, inflammable and radio-active materials have to be handled for assembly or measurement in dust-free conditions. However, such materials must be fully screened from the operator if injury is not to occur.

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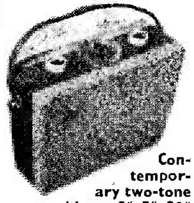

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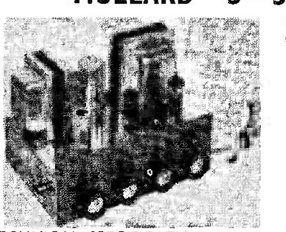

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continued from page 941

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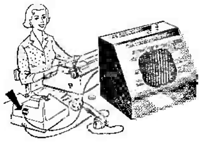

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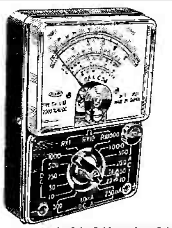

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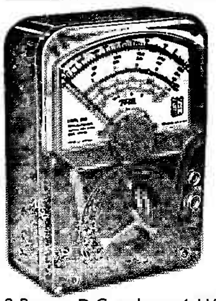

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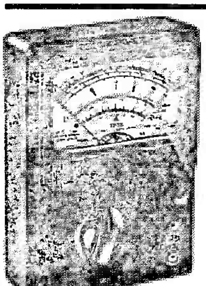

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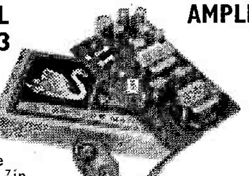
29. 4,000 ohm Lightweight Sensitive Headphones, **12/6.**
30. No. 19 Set Crystal Calibrator with Handbook, **79/6.** P.P. 2/-.
31. ACOS 43-2 High Output 2¼" Xtalmic Insert, **10/6.** P.P. 6d.

4 TRANSISTOR PUSH-PULL AUDIO AMPLIFIER
MODEL PK-543



Size 3 x 1¾ x ⅞in.

A ready-built, miniature 250mW push-pull amplifier incorporating input and output transformers, 4 transistors, 9 volt battery snap cord, speaker and volume connection leads. Ideal for use with record players, intercoms, hearing aids, tape recorders, etc. Complete with full instructions and circuit diagram.

PRICE 52/6 P.P. 1/6.
SUITABLE 2½" SPEAKER, **16/6.**

TRANSISTORS 1st GRADE

AF117	9/6	OC83	6/-	OC139	13/6
AFZ12	35/-	OC84	8/6	OC140	29/-
AC107	14/6	OC75	7/-	OC200	10/6
OC71	5/6	OC35	18/-	OC201	31/-
OC72	7/-	OC44	9/3	OC22	23/-
OC76	7/-	OC45	8/6	OCP71	29/-
OC81	7/-	OC170	9/6	OC41	9/-
OC78	7/-	OC171	10/6	OC42	9/6
AF102	27/6	AF115	10/6	ORP12	15/6

Send for New List of Fully Guaranteed Transistors, Diodes, Zener Diodes, Silicon Rectifiers, etc. All 100% 1st Grade. We stock a semi-conductor device for every need.
SPECIAL REDUCTIONS FOR SETS

TYPE 38, TRANSMITTER RECEIVER

Complete with 5 valves. In new condition. These sets are sold without guarantee but are serviceable.
7.4 to 9 Mc/s. **22/6** P.P. 2/6
Headphones, **7/6** pair. Junction Box, **2/6.** Throat Mike, **4/6.** Aerial Rod, **2/6.**

CRYSTAL MICROPHONES

ACOS 39-1. Stick Microphone with screened cable and stand (list 5 gns.), **32/6.** P.P. 1/6.
ACOS 40. Desk Microphone with screened cable and built-in stand (list 50/-), **15/-.** P.P. 1/6.
ACOS 45. Hand Microphone with screened lead, very sensitive, **25/-.** P.P. 1/6.
100 C. Stick Microphone with muting switch and screened cable, detachable desk stand, cord and neck, **39/6.** P.P. 1/6.
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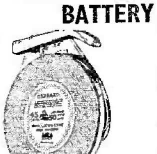
LAPEL. Miniature Mic. With clip. Ideal for recording, **15/-.** P.P. 1/-.

BATTERY ELIMINATOR AND CHARGER

Replaces PP3 or T6003 9 volt batteries to run transistor radios from mains. Also charges to give 5 times normal battery life. Fitted neon indicator and supplied with full details, **29/6.** P.P. 1/6. 'Petit' type **18/6,** P.P. 1/6.

BATTERY RECORD PLAYER



★ 6–7½ volt Garrard turntable with crystal pick-up. Plays 45 r.p.m. Ideal for above amplifier.
65/- P.P. 1/6.
★ **PORTABLE RECORD PLAYER CABINET** for above player and amp., **22/6** for 7" x 4" speaker. P.P. 1/6.

Henry's Radio Ltd

PADdington 1008/9
5 HARROW ROAD LONDON W2
Open Mon. to Sat. 9–6, Thurs. 1 o'clock
Send 1/- stamp for Illustrated Price List

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Redesigned 'Contessa' Mk. III

combined portable and car radio

NOW WITH 600mW **MELLOWTONE** OUTPUT ON MEDIUM AND LONG WAVES
NOW FITTED HORIZONTAL TUNING SCALE WITH ALL STATIONS CLEARLY MARKED
NOW SUPPLIED WITH SIX MULLARD TRANSISTORS AND TWO DIODES
NOW FITTED RECORDING SOCKET AND CAR AERIAL SOCKET
NOW SUPPLIED WITH TWO-TONE BEIGE OR TWO-TONE BLUE CABINET WITH GOLD FITTINGS

GUARANTEED THE VERY BEST OBTAINABLE

● **All parts sold separately** ●

TOTAL COST £10.19.6 P.P. 3/6

OVERALL SIZE $10\frac{3}{4}'' \times 7\frac{3}{4}'' \times 3\frac{5}{8}''$

● **Detailed Leaflet on Request** ●

The New "CONTESSA" 6-Transistor Portable Superhet Radio. Features simple printed circuit construction and fully illustrated building instructions, with all parts clearly marked and identified. Fitted with 8" Ferrite aerial. Double IFTs and the latest in components and design. Full tuning of both Medium and Long Wave bands with unbeatable selectivity and sensitivity. Clearly marked station dial and room-filling "MELLOWTONE" push-pull output are standard features. FULL AFTER-SALES SERVICE AND GUARANTEE

★ ALL THESE EXTRA FEATURES AT NO EXTRA COST ★

— The ideal portable, at home or by the sea —

"TRANSFIVE" PORTABLE RADIO

Medium and Long Wave Portable

$8\frac{1}{2} \times 6\frac{1}{2} \times 3\frac{1}{2}$in.

£6.19.6 P.P. 2/6

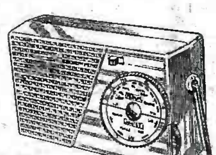
A simple to build 5-Transistor and Diode, Printed Circuit, Medium and Long Wave Portable. Features 5" speaker, Car aerial socket, Mullard transistors and carded components. Building plans free on request. THE IDEAL PORTABLE.
Full after-sales service and guarantee.

"QUINTET" MEDIUM AND LONG WAVE POCKET RADIO

PUSH-PULL SPEAKER OUTPUT

Size $5\frac{1}{4}'' \times 3'' \times 1\frac{3}{4}''$

Red or Blue with Gold trim



Total Cost £5.10.0 P.P. 2/-

A 5-Transistor and Diode medium and Long Wave Printed Circuit loudspeaker Radio. Features Mullard transistors and plainly marked printed circuit with carded components. Excellent results with full station separation guaranteed. Including Radio Luxembourg. Push-pull output up to 200mW. Fitted phone/record socket and car aerial socket.
Full after-sales service and guarantee.

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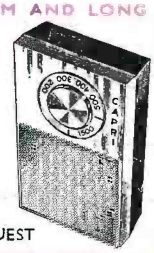
Open Monday to Sat. 9–6. Thurs. 1 o'clock
Send 1/- Stamps for Illustrated Price Lists

"CAPRI" POCKET SIX. 6-TRANSISTOR MEDIUM AND LONG WAVE POCKET SUPERHET RADIO

● SIZE $4\frac{1}{2}'' \times 2\frac{3}{4}'' \times 1\frac{1}{4}''$ REALLY POCKET SIZE ●



The most compact 6-transistor and diode radio with speaker available to the home constructor. Features the latest in miniature components and circuitry. Supplied with Mullard transistors and two-tone moulded cabinets in red/white or blue/white with gold fittings. All components are supplied in packets and clearly identified. A printed circuit is used with fully illustrated building instructions. Push-pull output coupled with a sensitive and selective circuit make the "CAPRI" hard to beat. Fitted Earphone/Record socket.

● FULL AFTER-SALES SERVICE AND GUARANTEE
● ALL PARTS SOLD SEPARATELY—DETAILED LEAFLET ON REQUEST

★ DESIGNED BY EXPERTS FOR THE HOME CONSTRUCTOR ★

TOTAL COST £7.10.0 P.P. 2/- (Battery 2/6)

"CARVERTER"

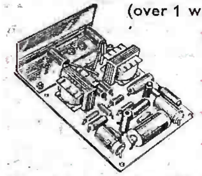
Mobile Transistor Short Wave Converter

As featured in the May edition of *The Radio Constructor*. Just plugs into the aerial socket of your car radio. Crystal controlled—covers amateur and Short Wave broadcast bands from 5 to 16 Mc/s. Supplied complete with long life battery and 39/40 metre band crystal. Send 1/- stamp for full Booklet. **No modifications to car radio at all.**

Total cost with sprayed cabinet, etc. 69/6 P.P. 2/-

750mW 4-TRANSISTOR PUSH-PULL AMPLIFIER

(over 1 watt peak output)



★ Uses OC71/OC81D, 2—OC81
★ ±3dB 70 c/s to 12 kc/s
★ Overall size $4'' \times 2\frac{3}{4}'' \times \frac{3}{4}''$
★ Built on printed circuit

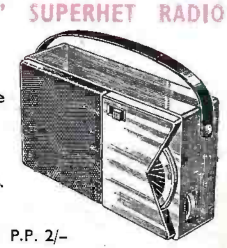
BUILT & TESTED 69/6 P.P. 1/6 OR COMPLETE KIT 62/6 P.P. 1/6

Ideal for Record Player, Intercom., Baby Alarm for Tuners, etc.

3 ohm output, fully guaranteed, 9 volt operated. Descriptive leaflet with uses FREE on request

"PW-6" SUPERHET RADIO

Medium and Long Wave Radio



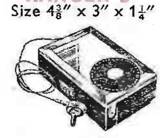
Size $5\frac{3}{4} \times 3\frac{3}{8} \times 2$in.

£8.10.0 P.P. 2/-

Modified version of previously advertised "PW" Superhet. Now with new style Two Tone Cabinet. First grade components and transistors. Printed circuit. Features matched set of 6 Transistors. New $2\frac{1}{2}''$ quality speaker and new illustrated building instructions.

"RANGER 3"

Size $4\frac{3}{8}'' \times 3'' \times 1\frac{1}{4}''$



A Three-Transistor Two Diode Personal Radio for Medium Waves and Amateur top band and shipping. Quality output on personal phone. Fitted air spaced tuner, vol. control. No aerial or earth. **Luxembourg guaranteed.**

69/6 P.P. 1/6

Brand new Stereo Amplifiers ready to use, 79/6, P.P 2/-