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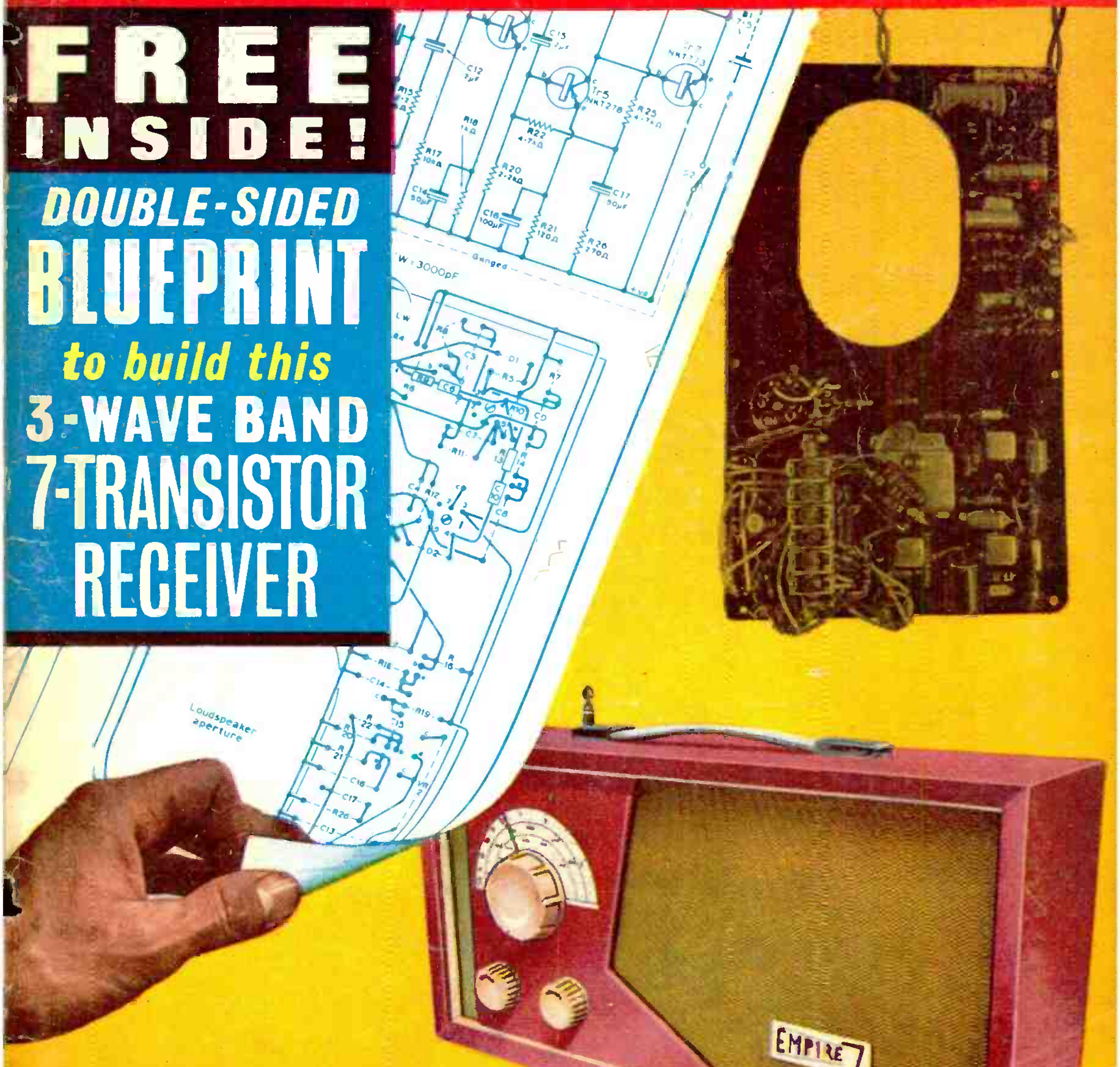

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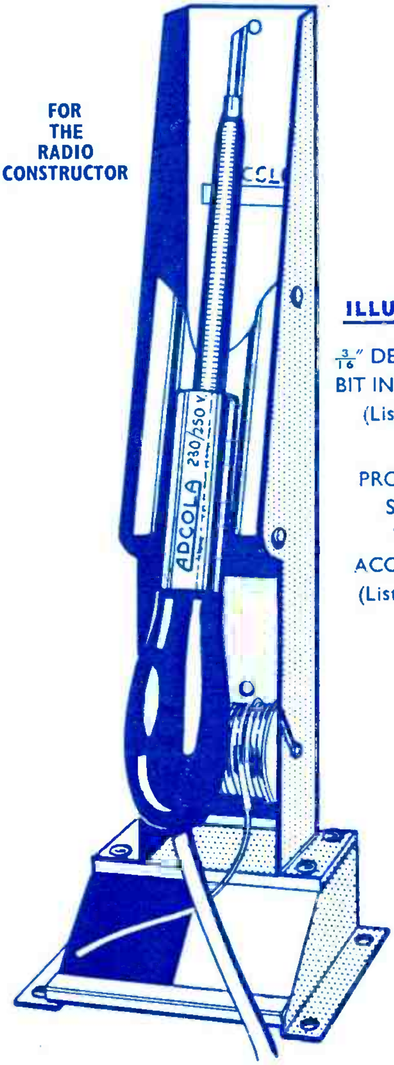

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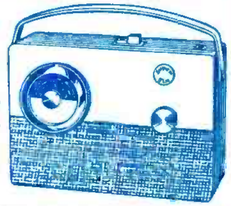
SUPER 6
LONG & MEDIUM WAVE TRANSISTOR RADIO



A quality radio available as a kit or ready built. The sparkling performance and superb finish of the completed receiver give you value equivalent to a £12.12.0 commercial model. ★ All new parts. ★ 6 transistors and diode. ★ 350mW output. ★ Superhet circuit, Ferrite rod aerial. ★ Weymouth Radio printed circuit board. ★ Component positions and references printed on back of board. ★ Nicely styled wooden cabinet, 11 x $7\frac{1}{2}$ x $3\frac{1}{2}$in. ★ Vinyl covered in various colours. ★ 6 x 4in. speaker giving good bass and treble response. ★ Full instruction booklet 2/-. Free with kit. ★ I.F. frequency 470 kc/s. ★ Lining up service if required. ★ All parts supplied separately. Write for list. S.A.E. please. ★ 9v. battery required. VT9 or P.P.9 (3/9 with kit).

COMPLETE KIT ONLY £4.17.6
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Volume and Tone Controls. In order, value; with or without mains switch; spindle length from fixing face; body dia.; price. A—2Mlog, SP, $2\frac{1}{2}$, $1\frac{1}{8}$, 3/-; B—2Mlog, NO, $2\frac{1}{2}$, $1\frac{1}{8}$, 2/-; C—1Mlog, DP, 1, 1, 3/-; D—1Mlog, NO, $\frac{6}{8}$, 1, 2/-; E—500Klog, DP, $1\frac{1}{4}$, $1\frac{1}{8}$, 3/-; F—500Klin, NO, 1, 1, 2/-; G—100Klin, DP, $2\frac{1}{2}$, $1\frac{1}{8}$, 3/-; H—100Klog, DP, $\frac{7}{8}$, $1\frac{1}{8}$, 3/-; J—100Klin, NO, $\frac{1}{2}$, $1\frac{1}{8}$, 2/-; K—50Klin, DP, $2\frac{1}{2}$, $1\frac{1}{8}$, 3/-; L—5Klog, DP, $\frac{3}{4}$, $1\frac{1}{8}$, 3/-; M—1Klin, NO, $2\frac{1}{2}$, $1\frac{3}{4}$, wirewound, 2/-; N—150lin NO, $1\frac{3}{4}$, 1, wirewound, 2/-; post 9d. (1); 1/- (2 or more). Parcel 1 of each, 13 controls, 25/-, post paid.

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SAVBIT ALLOY
saves wear on soldering iron bits

The world-famous copper loaded alloy containing 5 cores of non-corrosive flux, that saves the soldering iron bit. Ersin Multicore Solder is also available in high tin quality alloys. 60/40 in 22 s.w.g. for printed circuits, transistors, etc.

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Contains approximately 30 feet of 18 s.w.g. SAVBIT. It is also supplied in 14 s.w.g. and 16 s.w.g. Obtainable from radio and electrical stores.

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Easy to find in the tool box—simple to use. Virtually a third hand for tricky soldering jobs. 12 feet 5-core 18 s.w.g. ERSIN MULTICORE SAVBIT alloy in a continuous coil used direct from free-standing dispenser.

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Strips insulation without nicking wire, cuts wire cleanly, adjustable to most thicknesses. Splits extruded plastic twin flex.

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MULTI-METERS CABY M1. Sensitivity 2,000 ohms per volt. A.C. and D.C., 54/-. **A.10.** Basic Meter sensitivity 155 micro-amps A.C. and D.C. ranges £4.11.6. **B.40.** Sensitivity up to 10,000 ohms per volt A.C. and D.C., £6.2.6. 30,000 ohms per volt, with overload buzzer, £8.19.6. Other types in stock from 39/9.

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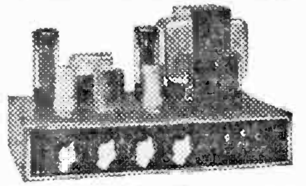
Ex. GOVT. SMOOTHING CHOKES, 200 mA, 3-5 H, 50 ohms. Parmeko 8/9; 150mA, 10 H, 50 ohms 9/9; 120mA, 12 H, 100 ohms, 8/9; 100mA, 10 H, 100 ohms, 6/9; 60 mA, 5-10 H, 250 ohms, 2/11.

TANNOY RE-ENTRANT LOUD-SPEAKERS. For outdoor or Factory use. 8 ohms, 8 watts. Only **25/9**

HI-FI 10 WATT AMPLIFIER
Brand New Complete Units **£7.19.6** Carr. 5/6
Manufacturer's discontinued Model. Push-pull output. Latest high efficiency valves. Dual separately controlled Inputs for 'Mike' and gram. Separate Bass and Treble Controls. High Sensitivity. Output for 3 or 15 ohm speaker. Guaranteed tested and in perfect working order.

R.S.C. 30-WATT ULTRA LINEAR
A10 HIGH FIDELITY AMPLIFIER



A highly sensitive Push-Pull high output unit with self-contained Pre-amp. Tone Control Stages. Certified performance figures compare equally with most expensive amplifiers available. Hum level 70 dB down. Frequency response ±3 dB 30-20,000 c/s. A specially designed sectionally wound ultra linear output transformer is used with 807 output valves. All components are chosen for reliability. Six valves are used EF86, EF86, ECC83, 807, 807, GZ34. Separate Bass and Treble Controls are provided. Minimum input required for full output is only 12 millivolts so that **ANY KIND OF MICROPHONE OR PICK-UP IS SUITABLE.** The unit is designed for **CLUBS, SCHOOLS, THEATRES, DANCE HALLS, or OUTDOOR FUNCTIONS,** etc. For use with Electronic **ORGAN; BASS, LEAD OR RHYTHM GUITAR, STRING BASS,** etc. For standard or long-playing records. **OUTPUT SOCKET PROVIDES** L.T. and H.T. for **RADIO FEEDER UNIT.** An extra input with associated vol. control is provided so that two separate inputs such as Gram and "Mike" can be mixed. Amplifier operates on 200-250v. 50 c/s. A.C. Mains and has output for 3 and 15 ohm speakers. Complete Kit of parts with fully punched chassis and point-to-point wiring diagrams and instructions. If required perforated cover with carrying handles can be supplied for 19/9. The amplifier can be supplied, factory built with EL34 output valves and 12 months' guarantee, for 14 gns.

11 Gns. Carr. 10/-

Send S.A.E. for leaflet.
TERMS: DEPOSIT 34/6 and 9 monthly payments of **33/6. (Total 16 gns).**
Suitable microphones and speakers available at competitive prices.

FANE HEAVY DUTY HI-FI SPEAKERS

12in. 15 ohms. Cast chassis. Exceptionally robust 2in. diam. Voice Coil Assemblies.
122/10 20watt,5gns. 122/10A 20watt, 6gns.
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122/17 25watt,£11.17.6 122/17A25watt£12.17.6

15in. 15 ohms. Cast chassis, Exceptionally robust 2in. diam. Voice Coil Assemblies.
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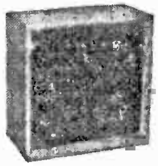
"A" indicates dual cone type. 30-17,000 c.p.s. Send S.A.E. for leaflets and terms

R.S.C. GRAM. AMPLIFIER KIT. 3 watts output. Negative feedback. Controls Vol., Tone and Switch. Mains operation 200-250v. A.C. Fully isolated chassis. Circuit, etc., supplied. Only 39/9. Carr. 3/9.

GL3A MINIATURE 2-3 WATT GRAM AMPLIFIER. For use with any single or auto-change unit. Output for 2/3 ohm speaker. For 200-250v. A.C. mains. Size 11½ x 2½ x 2½in. Controls: Vol. and Tone with Switch. Only 59/6.

12 in. 10 WATT HIGH QUALITY LOUDSPEAKER

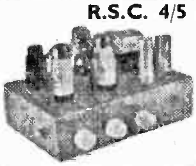


In walnut veneered cabinet. Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only **£4.19.6** Carr. 5/-
Terms: Deposit 11/3 and 9 monthly payments of 11/3. (Total £5.12.6)

12" 20 WATT HI-FI LOUDSPEAKERS IN CABINETS. Size 18 x 18 x10in. Finish as above. Only £7.19.6. Terms: Deposit 17/9 and 9 monthly payments of 17/9 (Total £8.17.6). Carr. 8/6.

LINEAR TREMOLO/PRE-AMP. UNIT
Designed for introducing the Tremolo effect to any amplifier which is fitted with a reserve power supply point for smoothed H.T. and 6.3v. A.C. L.T. The unit plugs into power supply point and any input socket or amplifier. Controls are Speed (frequency of interruptions). Depth (for heavy or light effect). Volume and Switch. Three sockets are for two inputs and Foot Switch. ONLY **4 Gns.**

R.S.C. 4/5 WATT A5 HIGH-GAIN AMPLIFIER



A highly-sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest High-fidelity Pick-up heads in addition to all other types of pick-ups and practically all "mikes". Separate Bass and Treble Controls are provided. These give full long-playing record equalisation. Hum level is negligible being 71 dB down. 15 dB of Negative feedback is used. H.T. of 300 v. 25 mA and L.T. of 6.3 v. 1.5a. is available for the supply of a Radio Feeder Unit, or Tape-Deck, pre-amplifier For A.C. mains input of 200-230-250 v. 50 c/s. Output for 2-3 ohms speaker. Chassis is not live. Kit is complete in every detail and includes fully punched chassis (with baseplate) with Gold Hammer finish and point-to-point wiring diagrams and instructions. Exceptional value or assembled ready for use 25/- extra, plus 3/6 carr., deposit 22/6 and 5 monthly payments of 22/6 (Total £6.15.0) for assembled unit. **£4.15.0**

JASON FMT1

V.H.F./F.M. RADIO TUNER DESIGN of parts including valves, tuning dial, escutcheon, etc. Total cost **£6.19.6**

SUPERHET FEEDER UNIT. Design of a high quality Radio Tuner (specially suitable for use with our Amplifiers). Delayed A.V./C. Controls are Tuning, W/Ch. and Vol. Only 250v. 15mA. H.T. and L.T. of 6.3v. 1 amp. required from amplifier. Size approx. 9 x 6 x 7in. high. Simple alignment procedure. Point-to-point wiring diagrams, instructions and priced parts list with illustrations, 2/6. Total building costs £5.5.0. S.A.E. for leaflet.

TRANSISTORISED SOUND MIXER

Enables mixing of up to 4 inputs, i.e., mic., tape, gram., tuner, etc., into single output.

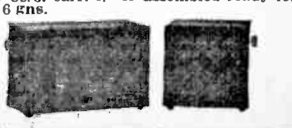
Compact and completely self-contained, uses standard 9 volt battery. Four standard jack inputs.

PRICE **49/6**

R.S.C. G5 AMPLIFIER
for Guitar, 'Mike', Gram or Radio

5 watt high quality output. Incorporating high flux 12in. 10 watt 12,000 line loudspkr. Sensitivity 30 m.v. High impedance jack input. Handsome strongly made cabinet (size 14 x 14 x 7in. approx.) finished in complementary shades of Rexine/Tygan. 200-250v. A.C. mains. Suitable for Lead or Rhythm Guitar in home or small club, etc. £9.19.6. Or DEPOSIT 22/3 and 9 monthly payments of 22/3 (Total £11.2.6). Carr. 7/6.

R.S.C. BABY ALARM or INTER-COMM KIT. Complete set of parts with diagrams, etc. Housed in two polished walnut finished cabinets of pleasing design. High sensitivity For 200-250v. A.C. mains. Fully isolated. Controllable at both units. An intercomm. of this class would normally cost £20-30. Only 89/6. carr. 5/- or assembled ready for use. 6 gns.



R.S.C. (MANCHESTER) LTD

R.S.C. G100 100 WATT AMPLIFIER

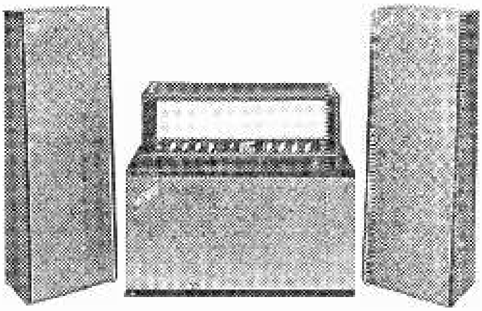
TERRIFIC *POWER OUTPUT FOR ALL PURPOSES!*

For ELECTRIC ORGAN, LEAD, RHYTHM and BASS GUITAR and any other musical instrument. FOR VOCALIST, Gram, RADIO and Tape etc.

★ Incorporating SIX 12in. PLUS TWO 15in. HEAVY DUTY LOUDSPEAKERS. Total Rating, 140 watts.
★ Housed in 4 substantial Wood Cabinets of pleasing design and covered in contrasting shades of Rexine and Vynair with 'gold' trimmings.
★ 4 Jack Inputs in TWO CHANNELS with 4 Independent Volume Controls.
★ Separate Bass and Treble Controls on each channel.
★ For standard 200-250v. A.C. mains operation.

Fantastic Value at only 89½ Gns. Carr. 30/-
Or Deposit £10.14.2 and 52 weekly payments of 35/- (Total 97½ Gns.)

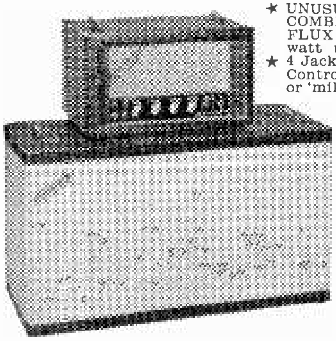
Send S.A.E. for full descriptive leaflet, or visit one of our many branches and hear this fabulous amplifier



ALL INTEREST CHARGES REFUNDED IF SETTLEMENT MADE WITHIN 6 MONTHS

R.S.C. BASS-REGENT 50 WATT AMPLIFIER

AN EXCEPTIONALLY POWERFUL HIGH QUALITY ALL-PURPOSE UNIT
For lead, rhythm, bass guitar and all other musical instruments
For vocalist, gram, radio, tape and general public address



★ UNUSUALLY POWERFUL LOUDSPEAKER COMBINATION consisting of a FANE HIGH FLUX 15in. 30 watt unit PLUS A FANE 12in. 20 watt unit with extended frequency response.
★ 4 Jack Socket Inputs and two independent Vol. Controls for simultaneous use of up to 4 pick-ups or 'mikes'.
★ Separate cabinets fully covered in contrasting tones of Rexine/Vynair with 'gold' trimming, for speakers and amplifiers.
★ Separate Bass and Treble Controls giving 'boost' and 'cut'.

Send S.A.E. for leaflet. Or call at one of our many branches and compare the Bass Regent with units at more than three times the cost. Carr. 17/6.

47 Gns. Cash Price — Or Deposit £5.11.0 and 12 monthly payments of £4. (Total 51 Gns.)

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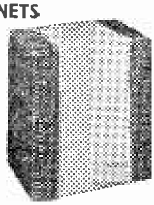
HEAVY DUTY LOUDSPEAKERS IN SUBSTANTIAL CABINETS

TYPE BG1



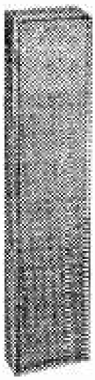
Two Tone Rexine/Vynair covered. Suitable for Bass Guitar. Speaker Unit 15in. High Flux, 15 ohms. 30 watts. Cabinet size approx. 24 x 21 x 13in. Only **19½ Gns.**
Or Deposit 51/9 and 9 monthly payments of 44/5. (Total 21¼ Gns.)

R.S.C. BASS/20 AMPLIFIER

SUITABLE FOR BASS GUITAR

A highly efficient unit incorporating massive 15in. high flux loudspeaker specially constructed to withstand heaviest load conditions. Rating 25 watts. Individual bass and treble controls give ample "Boost" and "Cut". Two jack socket inputs separately controlled. Cabinet is of substantial construction and attractively finished in two contrasting tones of Rexine and Vynair. Size approx. 24 x 21 x 13in. Carr. 17/6
Send S.A.E. for leaflet **29½ Gns.** Or deposit £3.4.6 & 12 monthly payments of 51/6. (Total 32¼ Gns.)

R.S.C. COLUMN SPEAKERS

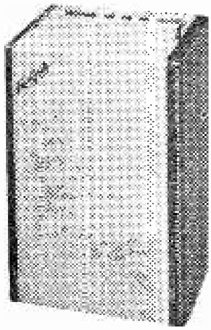


Covered in two-tone Rexine/Vynair. Ideal for vocalists and Public Address. Normally supplied for 15 ohm matching but can be supplied for 100v. line for 35/- extra.
Type C58, 15-20 watts. Fitted five 8in. high flux speakers. Overall size approx. 42 x 10 x 5in. **12½ Gns** Carr. 10/-.
Or deposit of 29/- and 9 monthly payments 29/- (Total £14.10.0).
Type C412. 40 watts. Fitted four 12in. 12,000 line 10 watt speakers. Overall size 52 x 13 x 7in. approx. **19½ Gns** Carr. 15/-.
Or Deposit of 51/9 and 9 monthly payments of 44/5 (Total 21¼ Gns.)

R.S.C. BASS-MAJOR 30 WATT AMPLIFIER

A MULTI-PURPOSE HIGH FIDELITY HIGH OUTPUT UNIT FOR VOCAL AND INSTRUMENTAL GROUPS

Eminently suitable for lead, rhythm, bass guitar and all other musical instruments

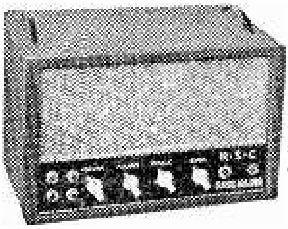


★ Incorporating two 12in. 25 watt Heavy Duty. High Flux Fane Loudspeakers, one with dual cone for high frequencies.
★ Robust wood cabinet with exceptionally attractive covering of Rexine/Vynair with gold trimmings.
★ Four Jack Socket Inputs and two independent Volume Controls for simultaneous connection of up to four Pick-ups or "Mikes".
★ Separate Bass and Treble Controls.
SUPERIOR TO UNITS AT TWICE THE COST.

39½ Gns. Carr. 17/6 — Send S.A.E. for leaflet or call for demonstration at any branch.

Terms: Deposit £4.3.0 and 12 monthly payments of £3.8.4 (Total 43 Gns.)

30W. HIGH QUALITY AMPLIFIER



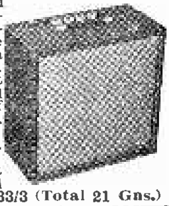
A Four Input, two volume control Hi-Fi unit with separate Bass and Treble "Cut" and "Boost" controls. Designed for vocal or Instrumental groups. For Bass, Lead or Rhythm Guitar. Six Mullard or Brimar latest type valves. Housed in strong Rexine covered cabinet with twin chrome carrying handles. Attractive black and gold perspex fascia plate. For 200-250v. A.C. mains. Output for 3 or 15 ohm speakers. Send S.A.E. for leaflet.

16½ GNS. Carr. 10/- or Deposit 2 Gns. and 9 monthly payments of 38/6 (Total 18¼ Gns.)

R.S.C. G15 15 WATT AMPLIFIER

for Lead or Rhythm Guitar, 'Mike', Gram, or Radio

High-fidelity push-pull output. Separate bass and treble "Cut" and "Boost" controls. Twin separately controlled inputs so that two instruments or "mike" and pick-ups can be used at the same time. Loudspeaker is a heavy duty high flux 12in. 20 watt model with cast chassis. Cabinet is covered in contrasting shades of Rexine/Vynair. Size App. 18 x 18 x 8in.

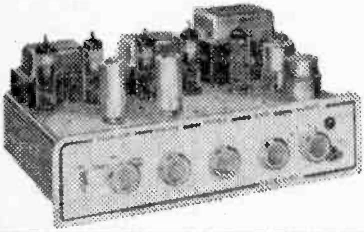


Only **19 Gns.** Carr. 10/-
Send S.A.E. for leaflet
Or DEPOSIT 2 Gns. and 12 monthly payments of 33/3 (Total 21 Gns.)

R.S.C. STEREO 20/HIGH FIDELITY AMPLIFIER

PROVIDING 10/14 WATTS ULTRA LINEAR PUSH-PULL OUTPUT ON EACH CHANNEL

SUITABLE for "MIKE", GRAM., RADIO OR TAPE. INTENDED FOR THE HOME OR STUDIO BUT SUITABLE FOR LARGE HALLS OR CLUBS



Features include:
- ★ **Four-position tone and compensation input Selector switch.**
- ★ Stereo/Mono switch so that peak monaural output of 25 watts can be obtained.
- ★ Separate Bass "Lift" and "Cut" and treble "Lift" and "Cut" controls.
- ★ Neon panel indicator.
- ★ Handsome Perspex Frontplate. **13 Gns.**

Send S.A.E. for illustrated leaflet. Carr. 10/-. Complete set of parts with point to point wiring diagrams and instructions, or Factory assembled, tested and supplied with our usual 12 months' guarantee for 18 gns, or DEPOSIT 2 gns. and nine monthly payments of 41/6 (Total £20.1.6).

Based on a current Mullard design and employing valves ECC83. ECC83. ECL86. ECL86 ECL86. ECL86 EZ81. Output transformers are high quality sectionally wound to required specification. Output matchings for 3 and 15 ohm speakers on each channel.

FREQUENCY RESPONSE ± 2dB. 30-20,000 c.p.s.

HUM LEVEL 65dB down.

SENSITIVITY: 15 millivolts maximum.

HARMONIC DISTORTION (each channel) 0.2%.

For operation on 200/250v. A.C. Mains.

AUDIOTRINE HI-FI TAPE RECORDER KIT $25\frac{1}{2}$ GNS. Carr. 17/6

REALISM AT INCREDIBLY LOW COST. CAN BE ASSEMBLED IN AN HOUR

Incorporating the latest Collaro Studio Tape Transcriptor. The Audiotrine High Quality Tape Amplifier with negative feedback equalisation for each of 3 speeds. High Flux P.M. Speaker, empty Tape Spool, a Reel of Best Quality Tape and a Handsome Portable Carrying Cabinet tastefully covered in two contrasting shades of Rexine and Vynair, size 14½ x 15 x 8½in. high and circuit. Total cost if purchased individually approximately £40. Performance equal to units in the £60-£80 class. S.A.E. for leaflets. **TERMS.** Deposit £3 and 12 monthly payments of 44/-. (Total 28 Gns).

ONLY 3 PAIRS OF SOLDERED JOINTS PLUS MAINS

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W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS HF1012. 10 watts rating. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. £4.12.0. Please state whether 3 ohm or 15 ohm required.

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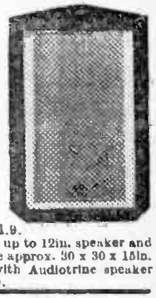

AUDIOTRINE CORNER CONSOLE CABINETS. Strongly made. Beautiful polished walnut veneered finish. Pleasing design. **JUNIOR MODEL.** To take up to 8in. speaker. Size approx. 20x11x8in. 49/9. **STANDARD MODEL.** To take up to 10in. speaker. Size 27 x 18 x 18in. £4.11.9. **SENIOR MODEL.** To take up to 12in. speaker and with Tweeter cut-out. Size approx. 30 x 30 x 15in. (Recommended for use with Audiotrine speaker system.) 7 gns. or terms.

HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

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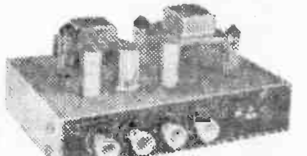

Two input sockets with associated controls allow mixing of "mike" and gram., as in A10 High sensitivity. Includes 5 valves, ECC83, ECC83, EL84, EL84, EZ81. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condensors of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut". Frequency response ±3 dB 30-20,000 c/s. Six negative feedback loops. Hum level 60 dB down. ONLY 23 millivolts INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs for **STANDARD or LONG PLAYING RECORDS. For MUSICAL INSTRUMENTS** such as **STRING BASS, LEAD OR RHYTHM GUITARS,** etc. **OUTPUT SOCKET** with plug provides 300v. 30mA, and 6.3v. 1.5a. For supply of a **RADIO FEEDER UNIT.** Size approx. 12 x 9 x 7in. For A.C. mains 200-250v. 50 c.p.s. Output for 3 and 15 ohms speaker. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. Only **8 Gns.** Carr. 10/-. (Or factory built 51/6 extra).

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LINEAR TAPE PRE-AMPLIFIER. Type LP/1. Switched Negative feedback Equalisation, Positions for Record 1in., 3¾in., 7½in. and Playback. EM84 Recording Level Indicator. Designed primarily as the link between a Collaro Tape Transcriptor and a High fidelity amplifier, but suitable for almost any Tape Deck. S.A.E. for leaflet. **Only $9\frac{1}{2}$ Gns.**

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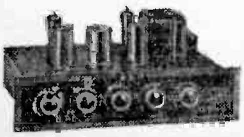

A complete set of parts for the construction of a stereophonic amplifier giving 5 watts high quality output on each channel (total 10 watts). Sensitivity is 50 millivolts. Suitable for all crystal stereo heads. Ganged Bass and Treble Control give equal variation for "lift" and "cut". Provision is made for use as straight (monaural) 10-watt amplifier. Valve line-up ECC83, ECC83, EL84, EL84, EZ81. Outputs for 2-3 ohm speakers. Point-to-Point wiring diagrams and instructions supplied. Send S.A.E. for leaflet. **8 Gns.** Full constructional details and price list 2/6. Carr. 10/-.

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6/12 v. 2a.	6/11	250 v. 50 mA	3/11
6/12 v. 3a.	9/9	250 v. 60 mA	4/11
6/12 v. 4a.	12/3	250 v. 80 mA	5/11
6/12 v. 6a.	15/3	250 v. 250 mA	11/9
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Consisting of Mains Trans., Metal Rectifier. Double electrolytic smoothing choke chassis and circuit For 200-250v. A.C. mains. Output 250v., 60mA, 6.3v., 2a. **19/11**

CHARGER AMMETERS 0-1·5 a., 0-4 a., 0-7 a., each. **8/9**

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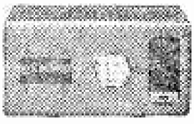
Guaranteed 12 months

All for A.C Mains 200-250v., 50c/s



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BATTERY CHARGER KITS Consisting of Mains Transformer F.W. Bridge. Metal Rectifier. well ventilated steel case, Fuses, Fuse-holders, Grommets, panels, Heavy Duty Clips, circuit. Carr. 3/6 extra.

6v. or 12v. 1 amp.	22/9
As above with Ammeter	28/9
6v. or 12v. 2 amps.	25/9
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350-0-350v. 80mA, 6.3v. 2a, 0-5-6.3v. 2a	19/9
250-0-250v. 100mA, 6.3v. 2a, 6.3v. 1a	21/9
250-0-250v. 100mA, 6.3v. 3.5a, C.T.	19/9
250-0-250v. 100mA, 6.3v. 4a, 0-5-6.3v. 3a	27/9
300-0-300v. 130mA, 6.3v. 4a, 6.3v. 1a, for Mullard 510 Amplifier	33/9
300-0-300v. 100mA, 6.3v. 4a, 0-5-6.3v. 3a	27/9
350-0-350v. 100mA, 6.3v. 4a, 0-5-6.3v. 3a	27/9
350-0-350v. 150mA, 6.3v. 4a, 0-5-6.3v. 3a	35/9

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250-0-250v. 100mA, 6.3v. 4a, 0-5-6.3v. 3a	28/9
300-0-300v. 100mA, 6.3v. 4a, 5v. 3a	28/9
300-0-300v. 130mA, 6.3v. 4a, C.T. 6.3v. 1a, for Mullard Amplifier	35/9
350-0-350v. 100mA, 6.3v. 4a, 0-5-6.3v. 3a	28/9
350-0-350v. 150mA, 6.3v. 4a, 0-5-6.3v. 3a	37/9

FULLY SHROUDED (continued)—

425-0-425v. 200mA, 6.3v. 4a, C.T. 5v. 3a	57/9
425-0-425v. 200mA, 6.3v. 4a, C.T., 6.3v. 4a, C.T., 5v. 3a	59/9
450-0-450v. 250mA, 6.3v. 4a, C.T. 5v. 3a	69/9

OUTPUT TRANSFORMERS

Midget Battery Pentode 66:1 for 3S4, etc.	4/6
Small Pentode, 5,000Ω to 3Ω	4/6
Small Pentode, 7/8,000Ω to 3Ω	4/6
Standard Pentode 5,000Ω to 3Ω	5/9
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Push-Pull 8 watts, EL84, or 6V6 to 3Ω or matched to 15Ω	9/9
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Following types for 3 and 15Ω speakers	
Push-Pull 10-12 watts 6V6 or EL84	18/9
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50 c/s. 250v. 60mA, 6.3v. 2a.	11/9
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Both above size 2¼ x 2¼ x 2¼in.

FILAMENT TRANSFORMERS All with 200-250v. 50 c/s primaries 6.3v. 1.5a. 5/9; 6.3v. 2a, 7/6; 12v. 1a, 7/11; 6.3v. 3a, 8/11; 6.3v. 6a, 17/6; 12v. 1.5a, twice 17/6.

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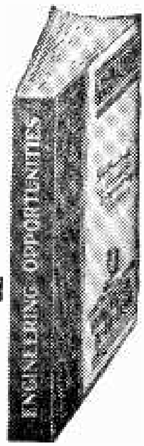

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Packard Bell Pre-Amp. Contains a relay push-pull input and output transformers and many useful spares. Less valves 6/6 each + 2/6 post and insurance.
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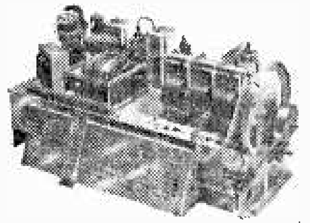
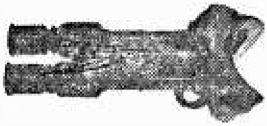
7 VALVE 5 WAVE SUPERHET



Famous maker—has H.F. Stage and many special features — covers Medium and 4 Short bands to 11 metres—offered for less than the value of the coil pack alone. 12 volt model, 32/6; no power pack model, 27/6. Unused but a little dusty, all less scale and drive—also less valves but there are standard octal types 6K7, 6K8, 6K7, 6Q7, 6V6, 5V4 available, price 20/- the set. DON'T MISS THIS! Carriage and insurance, 7/6.

INFRA-RED BINOCULARS



These if fed from a high voltage source will enable objects to be seen in the dark, providing the objects are in the rays of an infra-red beam. Each eye tube contains a complete optical lens system as well as the infra-red cell. These optical systems can be used as lens for TV camera—light cell etc. (details supplied). The binoculars form part of the army night driving (Tabby) equipment. They are unused and believed to be in good working order, but sold without a guarantee. Price £2.17.6 plus 10/- carriage and insurance. Handbook 2/6.

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Designed to operate transistor sets and amplifiers. Adjustable output 6v—9 to 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1-PP3-PP4-P6-PP7-PP9 and others. Kit comprises: mains transformer-rectifier, smoothing and load resistor 5000 and 500 mfd condensers, zener diode and instructions. Real snip at only 14/6 plus 2/6 post.

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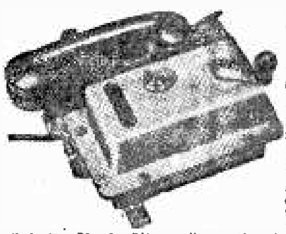
Garrard Auto-Slim Record Changer

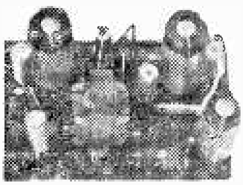
One of the nicest record changers that this famous company make—Automatic selection of records which may be mixed—may also be played manually. Finger tip adjustment of Stylus pressure. Fitted with mono head—but pickup wired for stereo—suitable 200/250 A.C. mains—cabinet space required 14¾ x 12¼in. with 4¼in. above and 2¼in. below. DON'T MISS THIS SPECIAL SNIP only £5.15.0 (post and insurance, 6/6).

EX-ROYAL NAVY SOUND-POWERED TELEPHONE



These require no batteries and will go for long periods without attention. Complete with generator and sounder which gives a high-pitched note easily heard above any other noise. Also fitted with an indicator lamp which in quiet situations can be used instead of the sounder or, where several telephones are used together, will indicate which one is being called. Size 7¾ x 9 x 7¼in., wall mounting, designed for ship's use but equally suitable for home, office, warehouse, factory, garage, etc. In good order but soiled. Price 29/6 each, plus 6/6 carriage.

750 mW TRANSISTOR AMPLIFIER

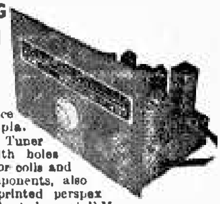


4 transistors including two in push-pull input for crystal or magnetic microphone or pick-up—feed back loops—sensitivity 5 m/v..

Price 19/6

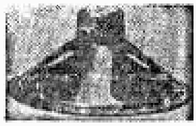
Post and insurance 2/6.
35 ohm Speaker, 12/6 extra.

MAKING AN FM TUNER



Available at present is a very nice cadmium-plated F.M. Tuner chassis with holes punched for coils and other components, also a nicely printed perspex front, calibrated usual F.M. frequencies. Real bargain 6/6 + 2/- or with two-gang tuning condenser 10/- + 2/- postage

Speaker Bargains



12in. High-fidelity loudspeaker. High flux permanent magnet type with either 3 ohm or 15 ohm speech coil. Will handle up to 10 watts. Brand new by famous maker. Price 27/6 + 3/6 post and insurance.

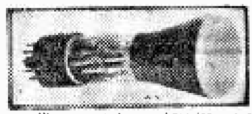
Hi-Fi Speakers

Hi-Fi Speakers—E.M.I. Ceramic magnet 12,000 lines, size: 13 x 8in. (roughly equivalent to 12in. round speaker). Bass frequency 40-50 c/s. Handles up to 10 watts. Price 33/6 plus 5/- carriage and ins. State whether 15 ohm or 3 ohm.

TRANSISTOR SET CASE

Very modern cream cabinet, size 5¼ x 3 x 1½in. with chrome handle, tuning knob and scale. Price 4/6 plus 1/6 postage.

Building a 'Scope



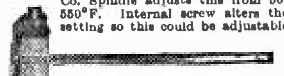
3in. oscilloscope tube. American made type No. 3PF7, 6.3 v. 0.6 amp. heater electrostatic deflection, brand new and guaranteed with circuit diagram of 'scope, 15/- each. Plus 2/6 post and insurance.

Simmerstat Heater Regulator

Suitable to control elements, heaters, soldering irons and boiling rings up to 2,500 watts. Complete adjustable, normal price 35/- each, special snip price 12/6, plus 1/6 postage and insurance.

THERMOSTATS

Type 'A' 15 amp. for controlling room heaters, greenhouse, airing cupboard. Has spindle for pointer knob, quickly adjustable from 30-80°F. 9/6 plus 1/- post. Suitable box for wall mounting, 5/-. P. & P. 1/-.
Type 'B' 15 amp. This is a 17in. long rod type made by the famous Sunvic Co. Spindle adjusts this from 50-550°F. Internal screw alters the setting so this could be adjustable



over 30° to 1,000°F. Suitable for controlling furnace, over kiln, immersion heater or to make flamestat or fire alarm. 8/6 plus 2/6 post and insurance.
Type 'C' is a small porcelain thermostat as fitted to electric blankets etc. 1½ amp. setting adjustable by screw through side, 3/6, P. and P. 6d.
Type 'D'. We call this the Ice-stat as it cuts in and out at around freezing point, 2-3 amps. Has many uses, one of which would be to keep the loft pipes from freezing, if a length of our heater wire (16 yds. 10/-) is wound around the pipes, 7/6. P. & P. 1/-.
Type 'E'. This is a standard refrigerator thermostat. Spindle adjustments over normal refrigerator temperatures, 7/6 plus 1/- post.

ELECTRONICS (CROYDON) LTD

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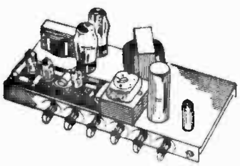
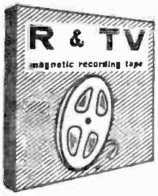


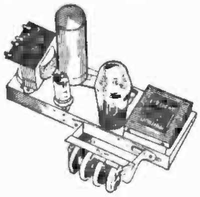
6 VALVE 15 WATT PUSH-PULL AMPLIFIER, 15 x 7 x 1½in. A.C. Mains 200-250 volts. 4 inputs with controls for same and bass and treble lift controls. Tapped for 3 and 15 ohm speakers. Extra H.T. and L.T. for F.M. Tuner supplies etc. Built and tested. 7 gns. P. & P. 12/6.



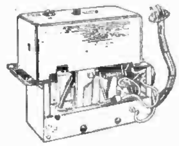
FIRST QUALITY PVC TAPE

P. & P. on each 1/6. 4 or more post free.

5¾in.	Std.	850ft.	9/-
7in.	Std.	1200ft.	11/6
3in.	L.P.	240ft.	4/-
5¾in.	L.P.	1200ft.	11/6
7in.	L.P.	1300ft.	18/6
5in.	D.P.	850ft.	10/6
3in.	T.P.	600ft.	8/-
5in.	T.P.	1800ft.	20/6
7in.	T.P.	3600ft.	37/6



3 TO 4 WATT AMPLIFIER KIT comprising chassis 8¾ x 2¼ x 1in. Double wound mains transformer, output transformer, volume and tone controls, resistors, condensers, etc. Valves 6V6, ECC81 and metal rectifier. Circuit 1/6 free with kit. 29/6 plus 4/- P. & P.



CHANNEL TUNER I.F. 16-19 Mc/s. Continuously tunable from 174-216 Mc/s. Valves required—PCF80 and PCC84 (in series). Cover BBC and ITA ranges. Also Police, Fire and Taxis etc. Brand new by famous maker, 10/-. P. & P. 3/-.

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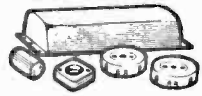
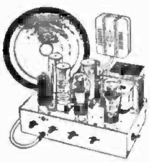


40W FLUORESCENT LIGHT KIT incorporating G.E.C. Choke size 8½ x 1½ x 1¼, 2 bi-pin holders, starter and starter holder. 11/6, P. & P. 3/6. Similar to above: 80W Fluorescent Light Kit incorporating G.E.C. Choke size 11½ x 1½ x 1¼, 2 bi-pin holders, starter and starter holder. 17/6, P. & P. 4/6.

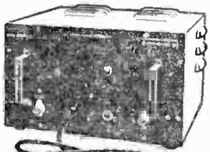
SILICON RECTIFIERS, 250 v. P.I.V 750 mA. Six for 7/6 post paid

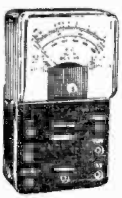
SIGNAL GENERATORS: Cash £7.5.0. P. & P. 6/6. Coverage 100 Kc/s to 100 Mc/s on fundamentals and 100 Mc/s to 200 Mc/s on harmonics. Case 10 x 6½ x 5¼in. Three miniature valves and Metal Rectifier. A.C. mains 200/250v. Internal modulation of 400 c.p.s. to a depth of 30 per cent. Modulated or unmodulated R.F. output continuously variable 100 millivolts. C.W. and mod. switch, variable A.F. output. Magic eye as output indicator. Accuracy plus or minus 2 per cent.



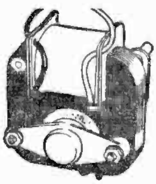
8-WATT PUSH-PULL 5 VALVE AMPLIFIER. A.C. mains 200-250v. Size 10½ x 6½ x 2¼in. 5 valves. For use with all makes and types of pick-ups and mike. Negative feed back. Two input, mike and gram. and controls for same. Separate controls for Bass and Treble lift. Response flat from 40 cycles to 15 Kc/s. 2dB down to 20 Kc/s Output 8 watts at 5 per cent total distortion. Note level 40 dB down all hum. Output transformer tapped for 3 and 15 ohms speech coils. For use with Std. or L.P. records, musical instruments such as guitars, etc. Suitable for small halls, £3.19.6. P. & P. 7/-. **Crystal mike to suit, 15/-. P. & P. 2/-. 8in. P.M. Speaker to suit, 12/6, P. & P. 2/-.**

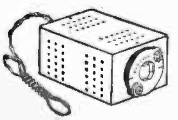
FIXED FREQUENCY SIGNAL GENERATOR. Crystal control in metal case, size 10 x 6 x 6in. Incorporating two FC13 valves, mains transformer, metal rectifier choke, indicator, lamp, crystal and numerous components. Modulated and unmodulated output socket. Originally used for I.T.V. frequencies. Brand new, 39/6, plus 6/- P. & P. A.C. mains 200-250 volts.





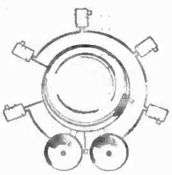
POCKET MULTI-METER. Size 3½ x 2¼ x 1¼in. Meter size 2¼ x 1¼in. Sensitivity 1,000 O.P.V. on both A.C. and D.C. A.C. and D.C. volts. 0-15, 0-150, 0-1,000. D.C. current 0-150 mA. Resistance 0-100K Ω. Complete with test prods, battery and full instructions, 39/6, P. & P. 2/6. FREE GIFT for limited period only. 30 watt Electric Soldering Iron value 15/- to every purchaser of the Pocket Multi-Meter.





POWER SUPPLY KIT in metal case, size 3½ x 2¼ x 2in. Incorporating mains transformer, rectifier and condensers. 230/250 AC mains. Output: 9v 100mA. Price 10/6 plus 2/6 P. & P.

A.C. MAINS MOTOR. Can be used for a variety of purposes, silent running satisfactory in every way. 230/250 v. A.C., 9/6, P. & P. 2/-.



RINGO BURGLAR ALARM SYSTEM. A.C. mains, 200/240 volt. Fire salvage slightly tarnished. List price 7 gns. Our price, complete with double gong bell five micro switches and full instructions. 49/6. P. & P. 4/-.

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A compact V.H.F. Transceiver that can be held in the hand. Size approx. 12 x 3¼ x 2¼in. Range up to 3 miles under favourable conditions. Utilises 3 miniature valves and self-contained standard batteries. Easy to operate, economical to run. Ideal for authorised fixed or mobile operation. British manufacture. Limited number in stock. Price 12 gns. per pair, post free.

CRYSTAL SET

A wonderful educational set for all children. Provides hours of amusement while following the easy step by step instructions. It is powered entirely by wireless waves eliminating the expense of batteries. No soldering required. Receives all main stations. Price 19/11. P. & P. 2/6.

19 SET TRANS/REC MAINS POWER PACK

Operate your 19 set receiver straight off the mains. Ready built power unit complete with modification and fitting instructions. Price 49/6. P. & P. 3/6. Please state Mk. II or III.

TRANCEIVER No. 38 A.F.V.

This lightweight Trans/Rec. has a transmitting range of 3 to 5 miles. Frequency coverage 7.4 to 9 mc/s. Operates from 12 and 120 volt supplies. Large clearly numbered tuning control with tuning lock. Price £4 per pair post free.

Handy Power Pack. Housed in compact metal case. 200/250V mains input. Output 250V D.C. 60mA fully smoothed, 6.3V at 2 amps. Can be used for powering almost any preamp or radio tuner. Price 39/6. P. & P. 2/6.

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M.A.T. Transistors. M.A.T. 100, 7/9; M.A.T. 120, 7/9; M.A.T. 121, 8/6. Ferrite slab aerials suitable for Transistor sets. 3/-. P. & P. 6d.

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Matched Mullard Transistors. One OC81D driver. Two OC81 output stage matched pair. Price 9/11 the set. P. & P. 1/-.

American Signal Generator V.H.F. Model. A well made instrument with a built-in crystal master oscillator. Exceptionally fine slow motion tuning with easily read scale. Stepped output and adjustable amplitude. Ideal for 2 metres and V.H.F. calibration. Price 49/6, P. & P. 5/-.

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A high quality 30-watt amplifier developed for use in large halls and clubs, etc. Ideal for bass lead or rhythm guitars, schools, dance halls, theatres and public address. Suitable for any type of mike or pick-up.
Valve line-up: two EF86; one ECC83; one GZ34; two EL34.
Four separate inputs are provided with two volume controls. Bass and Treble controls are incorporated. Amplifier operates on standard 50 c/s mains. 3 ohm and 15 ohm speakers may be used.
Perforated cover with carrying handles can be provided if required.

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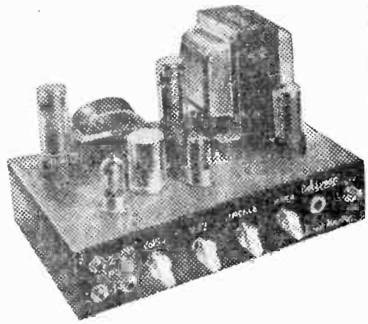
Customers are invited to see and hear this amplifier at our shop premises in Lambert's Arcade. Send S.A.E. for illustrated leaflet. Or deposit of £1.16.0 and twelve monthly payments of £1.9.2. Total H.P. price £19.6.0. Carr. 15s. to be sent with order.

16 GNS



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As used by the Armed Forces. These sound powered earpieces will work up to a distance of 1 mile without the use of batteries. Beautifully made. Ideal for use in the house, office or garden. Complete with connecting cable 17/6. P & P. 2/6.

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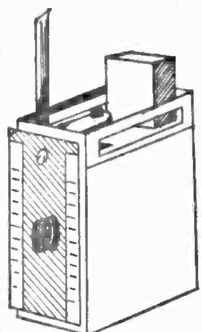
In Robust Rexine Covered Cabinets.

(a) Suitable for base and lead guitars. Incorporating two 12in. high flux 25 watt 15ohm loudspeakers, providing excellent frequency response. Cabinet size approx. 28 x 20 x 10 in. Rating 50 watts. Fitted with carrying handles.

Price 27 gns. or H.P. terms available. Deposit £2.17.0 and 12 monthly payments of £2.6.9. Total H.P. price £30.18.0. Carriage 15/- to be sent with order.

VEHICLE RADIO-TELEPHONE



Originally used by the Armed forces for field communication. This compact little unit can be powered by a car battery, and two 60V or 90V H.T. batteries. Communication is possible up to a distance of 3 miles in favourable terrain, and on testing the receiver we were able to receive many Continental and Maritime stations. Battery drain is less than ½ of an amp. Output stage de-commissioned to conform with regulations. Full wiring instructions provided. Price **5 Gns.** each, carriage free. 2 for £10, carr. free

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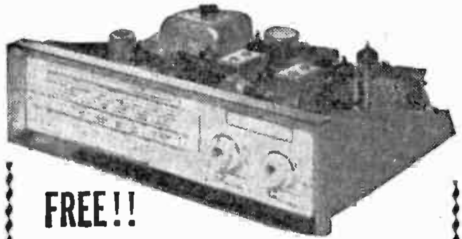
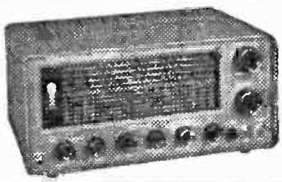
Full Med um, Long and VHF Coverage.

3 watts per channel output, 3 ohm output impedance. Internal aerial for A.M. Provision for Multiplex adaptor. Pick up and Tape input sockets. A.C. Mains 200/250 volts.



FREE!!

Two 10 x 6in. matching speakers supplied free if the following items are purchased together. CHASSIS 19 GNS. and GARRARD Autoslim with stereo plug in head £8.7.0. (or any unit above £8.7.0.) Carr. 15/- extra.



NEW LOW PRICE COMMUNICATION RECEIVERS

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Starflight 90 Watt Transmitter
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Send S.A.E. for fully descriptive brochure.

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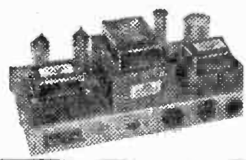
DOUBLE FEATURE PRE-AMPLIFIER

Inputs for microphone, crystal or magnetic pick-ups, tuner unit and in addition offers full facilities for tape recording and high fidelity replay. This unique feature means that should you wish to include tape in your hi-fi system at a later date all that is required is a suitable tape deck. Push-button switching for 3 tape speeds equalised.
KIT OF PARTS 11 GNS.
BUILT AND TESTED 18 GNS. (Carr. and Ins. 5/-)

JL10 POWER AMPLIFIER



Incorporates the latest diode/pentode ECL86 valves in push-pull PARTRIDGE ultra linear output transformer, PARTRIDGE mains transformer and smoothing choke. 10 watts power output, surplus power output, surplus power available for tuner.
KIT OF PARTS 9½ GNS.
BUILT AND TESTED 12 GNS.
(Carr. and Ins. 7/6).
Prices if both units purchased together:
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5in.	600ft.	Standard Acetate		8/6
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5in.	1,200ft.	Double Play	Mylar	15/-
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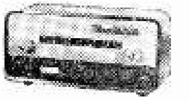

HI-FI F.M. TUNER. Tuning range 88-108 Mc/s. Tuning unit (FMT-4U) with 10.7 Mc/s. I.F. output (**£2.15.0** inc. P.T.) I.F. Amp. (FMA-4U) complete with cabinet and valves. (**£13.3.0**). Total kit **£15.18.0.** Assembly can be arranged.

"OXFORD" DE-LUXE TWO WAVEBAND TRANSISTOR PORTABLE. Model UXR-2. The ideal domestic, car, or personal portable receiver. 10 Semi-conductors. Send for full details. **£14.18.0** Kit (inc. P.T.). Assembly can be arranged.

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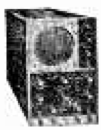
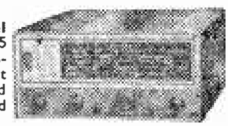
6W DE LUXE AMPLIFIER. Model S-33H. An inexpensive Stereo-Mono amplifier, with high sensitivity. Suitable for Decca Deram Cartridge. Kit **£15.17.6.** Assembled **£21.7.6**
6 TRANSISTOR PORTABLE. Model UXR-1. Prealigned I.F. transformers. Printed circuit, 7 x 4in. high flux speaker. Real hide case. Very easy to build .... Kit **£12.11.0** incl. P.T.
SHORTWAVE TRANSISTOR PORTABLE. Model RSW-1. Two short bands, trawler and medium wave Kit **£19.17.6** incl. P.T.

5W HI-FI MONO AMPLIFIER. Model MA-5. A low-priced well designed amplifier. Printed circuit construction makes it easy to build. Kit **£10.19.6.** Assembled **£15.10.0**
"COTSWOLD" HI-FI SPEAKER SYSTEMS. MFS or Standard. Range 30-20,000 c/s. Kit **£23.4.0.** Assembled **£30.15.0**
MONO CONTROL UNIT. Model UMC-1. Ideal for use with MA-12 or similar amplifier. Kit **£8,12.6.** Assembled **£13.12.6**
HI-FI EQUIPMENT CABINETS. Large range, in kit form or assembled and finished, incl. record housing range, available to meet various needs. Details on request. From **£7.15.0** to **£44.2.0**



5in. OSCILLOSCOPE. Model 10-12U. Wide band amplifiers essential for T.V. servicing, F.M. alignment etc. T/B covers 10 c/s-500 kc/s in 5 ranges. Kit **£32.12.6.** Assembled **£41.10.0.** The ideal low-priced 'scope.



COMMUNICATIONS TYPE RECEIVER. Model RG-1. Freq. cov: 600 kc/s.-1.5 Mc/s; 1.7 Mc/s.-32 Mc/s. A two-speed tuning drive. R.F. "Front end" supplied assembled and aligned. Kit **£39.16.0.** Assembled **£53.0.0.**

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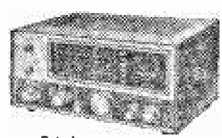
All models available assembled. Deferred terms available over £10. Free delivery U.K.

PA AMPLIFIER. Model PA-1. 50W output. For vocal and instrumental groups, guitars, etc. 4 inputs 2 speakers, Tremolo. Send for full details. Kit **£54.15.0.** Legs optional extra **17/6** set. **Assembled £74.0.0.**

50W POWER AMPLIFIER. Model MA-50. Ideal for PA work etc. Kit **£19.18.0.** Assembled **£27.18.0.** Suitable Control Unit, model UMC-1.



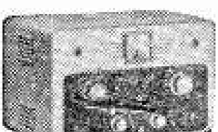
RA-1

AMATEUR BANDS RECEIVER. Model RA-1. Covers the amateur bands from 160 to 10m. Special features incl.: half lattice filter; 8 valves; Tuning meter; tuned RF amplifier stage. Kit **£39.6.6.** Assembled **£52.10.0.**

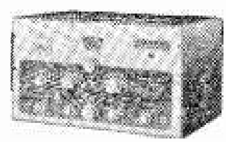
Q MULTIPLIER. Model QPM-1. For 450/470 kc/s. I.F. Kit **£8.10.0.** Assembled **£12.14.0.** QPM-16 for 1.6 Mc/s I.F. same prices.

2½in. PORTABLE SERVICE OSCILLOSCOPE. Model OS-1. An ideal light, compact 'scope for servicing and general work. Printed circuit construction. Kit **£22.18.0.** Assembled **£30.8.0**
"MOHICAN" TRANSISTOR GEN-COVERAGE RECEIVER. Model GC-1U. An excellent portable for the short wave listener .... Kit **£37.17.6.** Assembled **£45.17.6**
VALVE VOLTMETER. Model V-7A. Measures up to 1,500 v. (D.C. and r.m.s.) and 4,000 pk-to-pk. Res. 0.1Ω to 1,000 MΩ. **Kit £13.18.6.** Assembled **£19.18.6.**

LATEST AMERICAN SINGLE-SIDE-BAND AMATEUR EQUIPMENT. Now available from Gloucester. Please send for details.
MULTIMETER. Model MM-1U. Ranges: 0-1.5 v. to 1,500 v. A.C. and D.C. 0-150μA—15A D.C. 0.2Ω to 20MΩ 4½ in. 50μA meter .... Kit **£12.18.0.** Assembled **£18.11.6**
R.F. SIGNAL GENERATOR. Model RF-1U. Up to 100 Mc/s. fundamental, 200 Mc/s. on harmonics. Up to 100 mV output all bands .... Kit **£13.8.0.** Assembled **£19.18.0**



TELEVISION ALIGNMENT GENERATOR. Model HFW-1. Accurate alignment of TV receivers achieved in minimum time at low cost. Covers 3.6 to 220 Mc/s. fundamentals. Kit **£34.18.0.** Assembled **£44.10.0**



DX-100U

AMATEUR TRANSMITTER Model DX-40U. Self-contained. 80-10 m. Power input 75 w. CW., 60 w. peak C.C. phone. Output **40** w. to aerial Prov. for VFO Kit **£33.19.0.** Assembled **£45.8.0**

AMATEUR TRANSMITTER. Model DX-100U. Covers all amateur bands. 160-10 m. 150 w. D.C. input, self contained with power supply Modulator. VFO Kit **£79.10.0.** Assembled **£104.15.0**

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Complete- die punch Allen screw and key.

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⅝in.	14/6	1⅛in.	18/-	2in.	34/3
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Size 1½in. dia. x ⅜in. 1in. dia. x 7/16in. 7/6
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TSL QUALITY STICK MIKE 25/-
TELEPHONE TAPE MIKE 10/6
GUITAR CONTACT MIKE 15/6
MOVING COIL MIKE, high or low impedance, 90/-. FLOOR STAND, 57/-
TANNOY Carbon Hand Mike 5/6
TRANSISTOR 4 CHANNEL MIXER with 4 separate input-output controls 59/6

FULL WAVE BRIDGE SELENIUM RECTIFIERS: 2, 6 or 12 v., 1½ amp., 8/9; 2 a., 11/3; 4 a., 17/6. **CHARGER TRANSFORMERS.** Tapped input 200/250 v. for charging at 2, 6 or 12 v., 1½ amps., 15/6; 2 amps, 17/6; 4 amps., 22/6. Circuit included.

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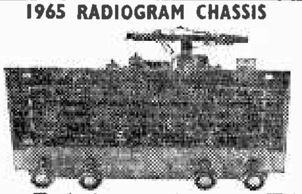
Size 1½in. sq. Precision Jewelled 2%

1 mA	..	27/6	50µA	..	39/6
5 mA	..	27/6	500µA	..	32/6
300V	..	27/6	"S" Meter		35/-

VALVE HOLDERS. Int. Oct. or Mazda Oct., 6d. B7G, B8A, B8G, B9A, 9d.; B7G with can 1/6. B9A with can 1/9. Ceramic EF50, B7G, B9A, 1/-. Valve plugs B7G, B9A. Inst. Oct. 2/3.

1965 RADIOGRAM CHASSIS



Three Wavebands. Long, Med., Short. Five Valves ECH81. EF89, EBC81. EL84, EZ80. 12-months guarantee. A.C. 200/250 v. Ferrite Aerial. 5 watts, 3 ohm. 13½in. x 7in. high x 5in. deep. Dial size 13 x 4in., horizontal working. Aligned, calibrated. Chassis isolated from mains.

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Matched speakers 8in. 17/6; 10in. 25/-; 12in. 30/-.

ARMSTRONG RADIOGRAM CHASSIS VHF-FM and Medium Wave model 127M £26.10.0 or Stereo £37.10.0

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TUBULAR		TUBULAR		CAN TYPES	
1/350V	2/-	100/25V	2/-	8/600V	9/-
2/350V	2/3	250/25V	2/6	16/600V	12/-
4/350V	2/3	500/12V	3/-	16+16/500V	7/6
8/450V	2/3	1,000/12V	3/-	32+32/350V	5/6
16/450V	3/-	8+8/450V	3/6	32+32/450V	6/-
32/450V	3/9	8+16/450V	3/6	50+50/350V	7/-
25/25V	1/9	16+16/450V	4/3	64+120/350V	11/6
50/50V	2/-	32+32/350V	4/6	100+200/275V	12/6

PAPER CONDENSERS. 0.001mfd., 7 kV., 6/6; 20 kV., 10/6; Tubular 500 v. 0.001 to 0.05, 9d. 0.1, 1/-; 0.25, 1/6; 0.1/350 v., 9d.; 0.5/350 v., 1/9; 0.01/2,000 v., 2/6; .05/2,000 v., 3/6.
CERAMIC. 500 v. 1 pF. to 0.01 mfd., 9d. Pulse 100 pF etc., 12 kV., 2/6.
SILVER MICA. Close tolerance (plus or minus 1 pF), 2.2 to 47 pF., 1/-; ditto 1% 50 to 815 pF., 1/-; 1,000 to 5,000 pF., 1/9.
TWIN GANG. "0-0" 208 pF. +176 pF., 10/6; 365 pF. miniature, 10/-; 500 pF. standard with trimmers, 9/6; midget, 7/6; midget with trimmers, 9/-; 500 pF. slow motion, standard, 9/-; small 3-gang 500 pF., 17/6. Single "0" 365 pF., 7/6 **SHORT WAVE.** Single 10 pF., 25 pF., 50 pF., 75 pF., 100 pF., 160 pF., 5/6 each. Can be ganged together Couplers 9d. each.
TUNING AND REACTION. 100 pF., 300 pF., 500 pF., 3/6 each, solid dielectric. **TRIMMERS** Compression ceramic. 30, 50, 70 pF., 9d.; 100 pF., 150 pF., 1/3; 205 pF., 1/6; 600 pF., 750 pF., 1/9. Trimmer with knob 1000 pF., 2/-.

MAINS TRANSFORMERS *Postage 2/- each*
STANDARD 250-0-250. 80mA. 6.3 v. 3.5 a. tapped 4 v. 4 a. Rectifier 6.3 v. 1 a., 5 v. 2 a. or 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. 300-0-300, 70 mA. 6.3 v. 4 a. .. 19/6
STD. 250-0-250, 65 mA, 6.3 v. 3.5 a. .. 17/6
HEATER TRANS., 6.3 v., 1½ a. 7/6; 4 a... 10/6
Ditto, tapped 1.4, 2, 3, 4, 5, 6.3 v., 1½ a... 8/6
GENERAL PURPOSE LOW VOLTAGE 2 amp. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24, 30 v. 22/6
AUTO TRANSFORMERS. 150 w. .. 22/6
0, 115, 200, 230, 240 v. 500 w. 82/6
MULLARD "510" Mains Transformer .. 38/6

SURPLUS 2-VALVE GRAM. AMPLIFIERS. Valves: UY85 Rectifier and UCL82 Triode/Pentode giving 3½ watts output. Overall size 5in. high x 5½in. x 2in. deep. Each amplifier New and Tested supplied complete with valves, 3 ohm output transformer, tone and volume on/off controls. **ONLY 37/6.** P.P. 2/6. Completely ready for use 200/250v. A.C.

TELESCOPIC CHROME AERIALS, 12 to 33in., 6/6. **TRIPLEXERS** Bands I, II, III, 12/6, **COAX PLUGS** 1/-. **LEAD SOCKETS,** 2/-; **PANEL SOCKETS,** 1/-. **OUTLET BOXES** (Surface or flush), 4/- each. **BALANCED TWIN FEEDER** yd., 6d., 80 or 300 ohms **TWIN SCREENED** per yd., 1/-, 80 ohms only.

THE "INSTANT" BULK TAPE ERASER AND RECORD HEAD DEMAGNETIZER. 200/250 v. A.C. 35/-

TRANSISTOR MAINS ELIMINATORS 29/6
PP1-6v., PP9-9v. Doubles. 42/6 PP1+PP1, PP9+PP9, PP11 (4½—4½)

WEYRAD P50 COILS
Ferrite aerial 12/6: Osc. P50/1AC 5/4; 1st and 2nd I.F. P50/2CC 5/7 each; 3rd I.F. P50/3CC 6/-. Spare Cores 6d.; Driver Trans —LFDT4 9/6; Printed Circuit 9/6; 35 ohm Speakers, 5in. 17/6; 6 x 4in. 21/-; J.B. Tuning Gang 10/6; Booklet 2/-.

NEW MULLARD TRANSISTORS
OC71, 6/-; OC72, 7/6; OC81D, 7/6; OC81, 7/6; AF115, 10/6; AF114, 11/-; OC44, 8/-; OC45, 8/-; OC171, 9/-; OC170, 8/6; AF117, 9/6; OA81, 3/-; OC26, 12/6; Holders, 1/3. Sub. Min. Condensers 0.1 mFd., 30 v. 1/3; 1, 2, 4, 5, 8, 16, 25, 30, 50, 100 mFd., 15 volt, 2/6.

Volume Controls
Linear or Log Tracks Long spindles. Midget 5 K ohms to 2 Meg. L.S., 3/-. D.P. 4/6.
Stereo L/S 10/6; DP. 14/-. 1m log+1m. A/log. 7/6

80 ohm CABLE COAX
Semi-air spaced ¼in. 40 yds. 17/6 60 yds. 25/- **6d. yd.**
Ideal 625 lines. U.H.F. Low loss 5dB 100ft. 500 Mc/s **1/6yd.**

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25 WATT 5 Gns. 12" GUITAR HEAVY DUTY

15 OHM VOICE COILS
Response 30-10,000 cps.
Bass Resonance 80 cps.
Genuine Musical Instrument Loudspeaker.

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BAKERS 12in. STANDARD 20w. 7 gns. More powerful magnet 14,000 lines special suspension. 40-14,500 cps. Recommended.

BAKERS 15in. AUDITORIUM 35w., 18 gns.

LOUDSPEAKERS, P.M. 3 OHM FAMOUS MAKES. 2½in., 3in., 4in., 5in., 7 x 4in., 15/6 each; 8in., 17/6; 6½in., 16/6; 10in., 30/-; 12in., 30/- (15 ohms 35/-); 10 x 6in., 22/6; 8 x 5in., 21/-; 9 x 6in., 21/-.
WAVE-CHANGE SWITCHES, 3/6 each.
2 p. 2-way or 2 p. 6-way; 3 p. 4-way or 1 p. 12-way; 4 p. 2-way or 4 p. 3-way, 6/6; 8 p. 4-way, 2 wafer. Wavechanger "MAKITS" available; 1 p. 12-way, 2 p. 6-way, 3 p. 4-way, 4 p. 3-way, 6 p. 2-way, Kit prices 1 wafer 3/6; 2 wafer 12/6; 3 wafer 16/-. Extra wafers 3/6 each, extra long shafts 2/- extra.
TOGGLE SWITCHES, s.p. 2/-; d.p., 3/6; d.p.d.t., 4/-.

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Transistor Audio Amplifier Manual 6/-
Shortwave Transistor Receivers .. 5/-
Beginners' Modern Transistor Sets, 7/6
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High Fidelity Speaker Enclosure 5/-
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Mullard Amplifier Manual 3/6
Radio Valve Guide, Books 1, 2, 3, 4 or 5 .. .. .. 5/- each
Practical Radio Inside Out 3/6
Valve Equivalents at a Glance .. 3/6
Transistor Controlled Models .. 7/6
International Radio Stations .. 2/6

JACKS Standard open-circuit 2/6, closed circuit 4/6 Grundig type 3-pin 1/3; Grundig Lead Type 3/6 Phono Plugs 1/-. Socket 1/-. Banana Plugs 1/- **JACK PLUGS.** Screened 3/-. Grundig 3-pin 3/6 **BULGIN NON-REV PLUGS and SOCKETS** P74, 2-pin 4/3; P73 3-pin 4/6; P194 6-pin 6/6; P466 12/6
RESISTORS Preferred values, 10 ohms to 10 meg. ¼ w., ½ w., 1 w., 20% 4d.; 1½ w., 8d.; 2 w., 1/-. **HIGH STABILITY** ½ w., 1%, 2/-. Preferred values 10 ohms to 10 meg. Ditto 5%, 10 ohms to 22 meg., 9d.

5 watt	WIRE-WOUND RESISTORS 10 ohms—6,800 ohms	1/6
10 watt		1/9
15 watt		2/-

10 K., 15 K., 25 K., 10 w. 3/-
MAINS DROPPERS Midget. With sliders. 0.3a. 1 K., 0.2a., 1.2 K., 0.15a., 1.5 K., 0.1a., 2 K., 6/- each. Line Cord 100 ohms ft. 3-way, 1/- ft.
Wirewound Ext. Speaker Controls 10Ω 3/-; 25Ω 6/6.
WIRE-WOUND POTS 3 WATT Pre-set Min., TV Types. All values 10 ohms to 25 K., 3/- each. 30K., 4/-. (Carbon 30K to 2 meg., 3/-).
WIRE-WOUND 4 WATTS Pots. Long Spindle. Value 50 ohms to 50 K., 6/6; 100 K., 7/6.
SPEAKER FRET Tygan various colours, 52in. wide from 10/- ft.; 26in. wide from 5/- ft. Samples S.A.E.
EXPANDED METAL Gold 12 x 12., 6/-.

ARDENTE TRANSISTOR TRANSFORMERS
D3035 7.3 CT.1 Push-pull to 3 ohms output 11/-
D3034 1.5:1 C.T. Push-pull Driver 11/-
D3058 11.5:1 Output to 3 ohms, etc. 11/-
D239 4.5:1 Driver: D240, 8.5:1 Driver 11/6
TRANSISTOR POTS 5 K Switched VC1545 5/3
SUB-MIN EARPIECE Xtal or magnetic 7/6
SUB-MIN JACK AND PLUG 2.5 or 3.5 mm., 3/6 pr.

B.T.H. TAPE MOTORS 115 v. A.C. 28 w. 12/6 pair. for 200/250 v. (in series).

Blank Aluminium Chassis. 18 s.w.g. 4 sides, riveted corners, lattice fixing holes, 2½in. sides, 7 x 4in., 5/6; 9 x 7in. 6/6; 11 x 7in., 7/6; 13 x 9in., 9/6; 14 x 11in. 12/6; 15 x 14in., 15/-; 11 x 3in. 6/6.

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PRACTICAL WIRELESS

MAY 1965
VOL 41 NO 699

SPRING, SPRING, SPRING

IT is said that in the Spring, a young man's fancy turns lightly to all sorts of frivolous things. But what of the amateur radio enthusiast? Where do his electronic fancies lie in these early months of the year?

It was once fondly imagined that the epitome of radio work was to spend a dark Winter's evening huddled up round an oil stove wearing a set of headphones. This was never really true, for the real enthusiast cares little about seasons, except perhaps for such aspects as their effect on F-layer propagation.

We agree that there may be less bench work during the Summer months, and maybe some slight slackening off in ham radio activities. (Then there is always the lady of the house who has the temerity to uproot occupants of radio dens for the frivolity of Spring cleaning. Sacrilege!) But radio fans like to follow the sun (or the rain) and there has always been a large Summer activity.

We would say, then, that this Spring, many P.W. readers will be fancying mobile operation or Field Days with the club. Others may be thinking of radio control of models. (Some will digress from radio, of course, and for those who find themselves more afloat than on dry land our July issue contains an article on building a marine radiobeacon direction finder.)

Thus, in divers ways, many shack-bound enthusiasts will again stumble out into the great open spaces, shading their eyes from the unaccustomed sunlight. So too, alas, will the Daleks of the Decibels—the gruesome plague bearers of transistor portables, vainly attempting to get ten watts output from a pair of OC81's and a three-inch speaker. Not to condemn all users of transistor portables, of course—only the moronic tone-deaf. However, this is to digress ourselves.

CONTENTS

All correspondence intended for the Editor should be addressed to: The Editor, "Practical Wireless", George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Phone: TEMple Bar 4363. Telegrams: Newnes Rand London. Subscription rates, including postage: 29s. per year to any part of the world. **THE JUNE ISSUE WILL BE PUBLISHED ON MAY 6TH.**

PCR2 Transformers

I AM building an s.s.b. receiver which is to employ three of the i.f. transformers taken from an old PCR2 receiver.

After drilling the chassis, I found one of the iron dust slugs to be faulty, and the other two missing! These slugs appear different to any I have seen before and the more modern ones which are available cannot readily be adapted. Likewise, I shudder at the thought of changing the chassis to accept a different type of unit. I have made up the rest of the chain with trimmer-tuned transformers and, in any case, have no more slug-tuned transformers in my junk box.

Is it possible that some reader will have these transformers lying idle and be kind enough to spare three of the slugs, or, better still, three complete transformers? I shall, of course, cover all expenses.

G. H. Scholey,
G3CDR.

157 Dartford Road,
Dartford,
Kent.

Mr. Scholey and other readers may be interested to know that in next month's issue of P.W. we will be publishing an article describing several useful modifications to this interesting ex-government receiver.—Editor.

Science Museum Party

THE Roding Boys' Society is arranging a conducted tour round the Radio and Electronic Gallery of the Science Museum, with an afternoon lecture which will be chosen to cover an electronic subject. I would be delighted if any of your young readers who live in, or who are visiting London would like to join in.

We are fixing a provisional date as Saturday, April 24th, and meeting at 10 o'clock in the morning at South Kensington Underground Station.

If lads who intend to come along drop me a card, we will have a rough idea as to how big the party will be, as well as knowing in advance something about our companions for the day.

Ken Smith,
G3JIX. 82 Granville Road,
Walthamstow, E.17.

NEWS AND...

R.S.G.B. CONVENTION

The Eleventh International V.H.F./U.H.F. Convention organised by the Radio Society of Great Britain, will be held at the Kingsley Hotel in London, on Saturday, April 10th.

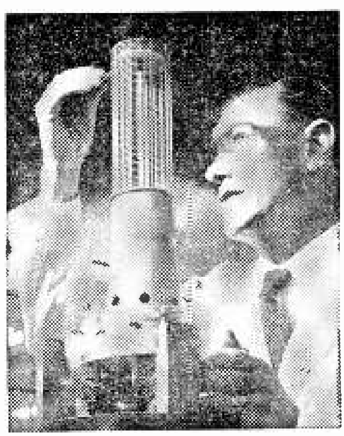
The Convention will open with a trade show in the morning, followed by a programme of lectures in the afternoon. A dinner in the evening will end the Convention, when Mr. C. G. Phillips, Chief Telecommunications Engineer of the Ministry of Aviation, will be among special guests.

QUADRUPLE-PLAY TAPE AT AUDIO FAIR

At this year's Audio Fair, soon to be held at the Russell Hotel in London, Kodak will be demonstrating their P.400 quadruple-play tape. This demonstration, to be illustrated by colour slides, will emphasise the superior low-speed performance obtainable from what Kodak's claim to be the world's first quadruple-play tape.

Other Kodak tapes will be seen and heard at their stand, including the P.300 triple-play tape.

A DELICATE TOUCH



This STC technician's task (left) is a delicate one. He is lining up the cage grid of a powerful radio broadcast valve which has been manufactured at the Paignton works of Standard Telephones and Cables Limited.

From this same plant—Devon's biggest industrial unit—STC ship tubes, capacitors and thin-film circuits to the markets of Australia, South Africa, Brazil, India, the USA and many European countries.

TINY, TINY CAPACITORS

Solid electrolyte tantalum capacitors from a new range recently introduced by Plessey-UK Limited are small, very small; smaller than a lighter flint in some cases.

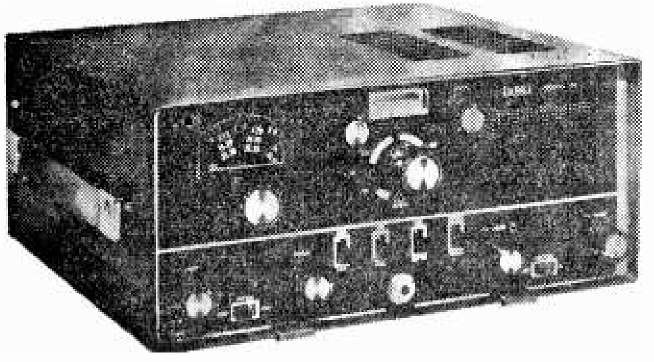
Designated type 'M', the capacitors are available in values ranging from 0·047μF to 10μF, with working voltages of from 50V to 1·5V. Produced at the Dielectric and Magnetic Division at Towcester, Northants, the capacitors are expected to find application in many domestic circuits—hearing aids, paging systems, electric wrist-watches—where miniaturization is essential.

..COMMENT

TRANSISTOR TRANSCEIVER FROM US

A new transistorized transceiver (shown below) made by Sideband Engineers, a unit of the Raytheon Company of the USA, offers the amateur single sideband communications on 80, 40, 20 and 15m. The receiver's circuit of 23 transistors, 18 diodes, a zener diode, a varactor diode and only three valves, ensures cool operation with less battery drain when run mobile. The basic receiver (model SB-34) uses a built-in power supply for either 117V a.c. or 12V d.c. and has a sensitivity of 1μV for 10dB signal-to-noise ratio.

Several advanced tuning devices are included for convenient dial calibration, quick frequency shift, smooth vernier adjustments, etc. Full specifications of the SB-34 are available from Cossor Communications Co. Ltd., The Pinnacles, Elizabeth Way, Harlow, Essex.



14-YEAR-OLD GIRL GETS LICENCE

Fourteen-year-old Elizabeth Allen of Westport, New Zealand, is likely to put every 'pirate' operator in the world to shame, for only two days after her 14th birthday, she received her amateur radio transmitting licence and callsign. This makes Elizabeth the youngest licensed amateur of either sex in her own country, which must be an embarrassing fact for young male aspirants in many countries, but especially so for those in New Zealand.

In fact it was the volume of letters published in P.W. for and against the R.A.E. that prompted reader Robert Turnbull of New Zealand to send the Editor the newspaper account of Elizabeth's achievement.

Apparently amateur radio runs in the Allen family as both Elizabeth's parents are licensed hams. Now she is continuing the line by building her own transceiver, soon to be on the air under the callsign ZL3AA1.

NEW STYLE PORTABLE

The latest medium and long wave portable from Roberts Radio Co. Ltd. (Molesey Avenue, West Molesey, Surrey) employs new cabinet styling in teak and black 'Rexine'. The 7-transistor circuit incorporates a 1W transformerless output stage, driving a 7in. x 4in. loudspeaker. The new receiver, model R404, joins the R300 and R500 in the Roberts range of portables at a retail price of 17 guineas.

more News and Comment on page 52

Amazing Change

I RECENTLY acquired most of the copies of P.W. dating from about 1950-59. I expected them to be somewhat different from ones which I have been getting for the last few years, but I was totally unprepared for the amazing change in the articles and general style. The old issues were completely uninteresting, dealing mainly with clumsy valve medium wave receivers and other dull projects. Modern P.W. articles offer a vast variety of general electronics as opposed to radio.

Also, in earlier issues, advertisements appeared offering transistors at 25s. or more, which I can now obtain for less than 1s.

All these things combined with the huge purchase tax on radio equipment of about 1950, brings me to the conclusion that although I spend a considerable amount of my time on radio and electronics, and intend to take it up as a profession, had I been born 10 years earlier, I doubt if I would ever have considered spending my time on radio.

L. Ruddock.
Co. Fermanagh,
N. Ireland.

We would disagree with Mr. Ruddock's point of view that bygone issues of P.W. were uninteresting, as for the radio enthusiasts of the time P.W. brought them data and designs which, unlike transistor circuits of today, were hard to come by. However, thanks for the compliment. — Editor.

P.W. and P.T. Issues

I SHALL be going abroad at the end of May or June, and I am willing to offer my issues of P.W. and P.T. of the last four years and certain issues of Radio Constructor, to other readers of your magazine.

I must stress, however, that *ample postage* and a *stamped addressed envelope* must be sent with requests for copies. First come will be first served and postage will be returned if the copy is not available.

4200894 Sac. White, R. W.
Fire Section,
R.A.F. Ballykelly,
Limavady,
Co. Derry, N. Ireland.

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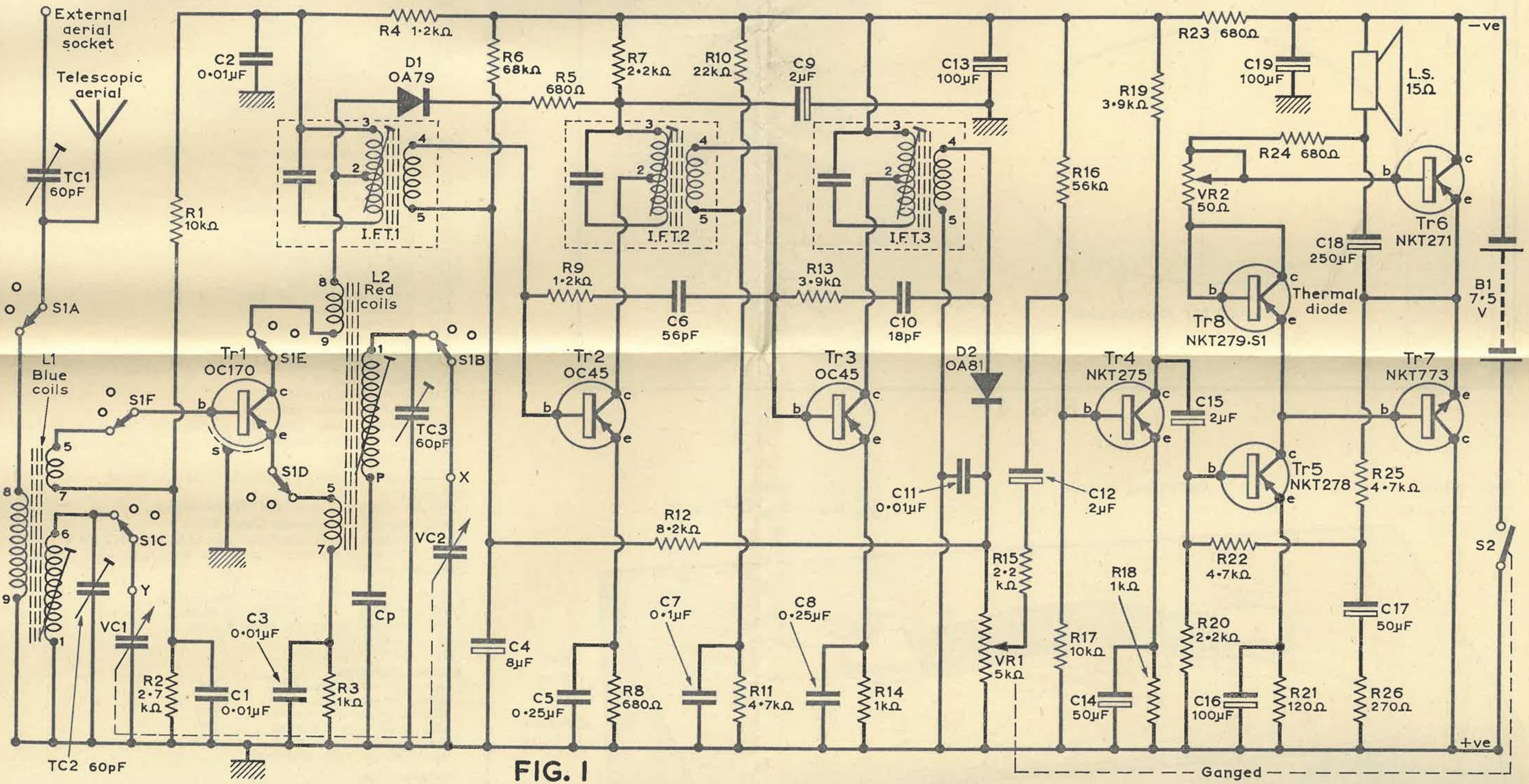


FIG. 1

Pin P..... L.W.=6, M.W.=2, S.W.=4

Cp...... L.W.=110pF, M.W.=350pF, S.W.=3000pF

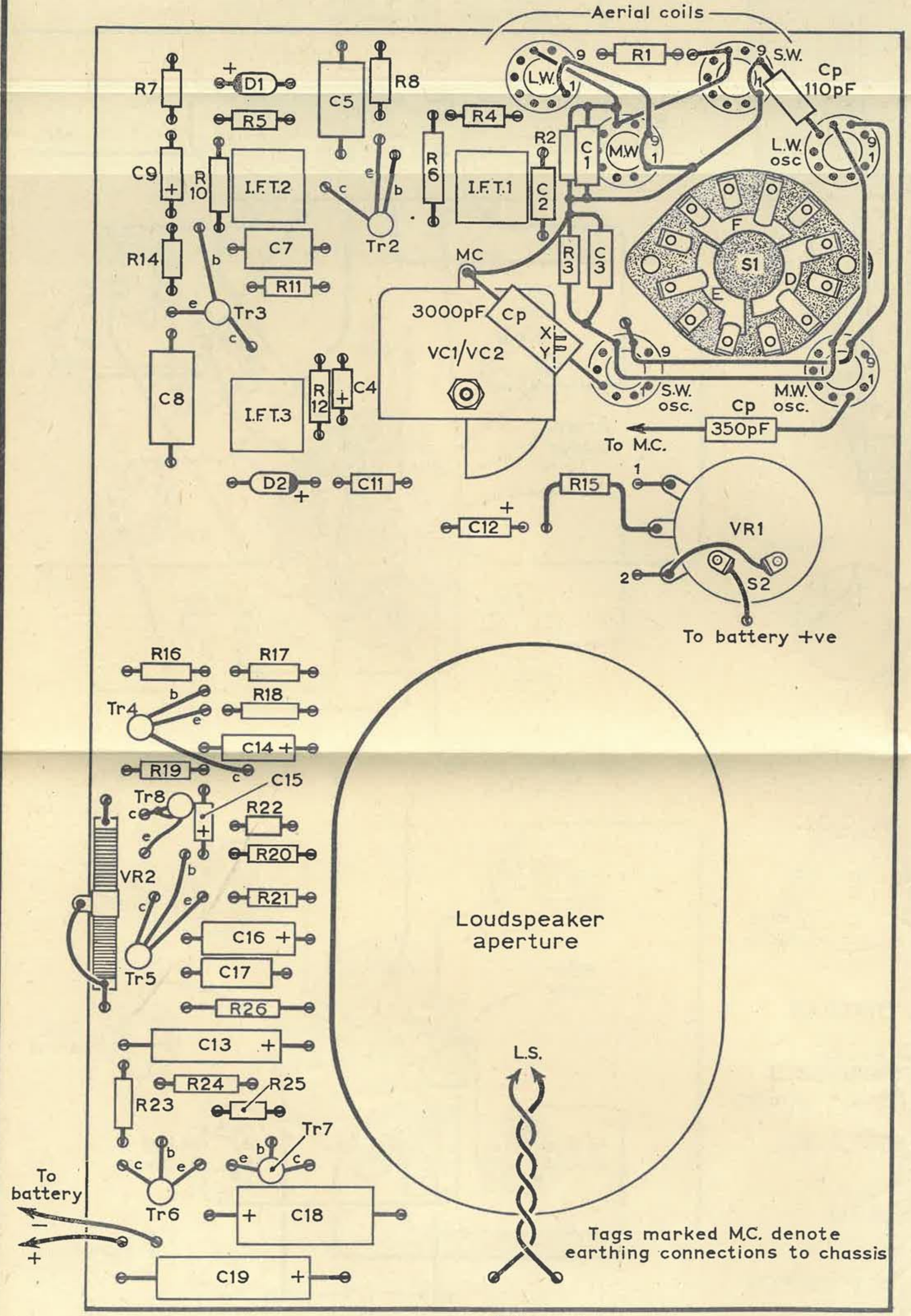


FIG. 2

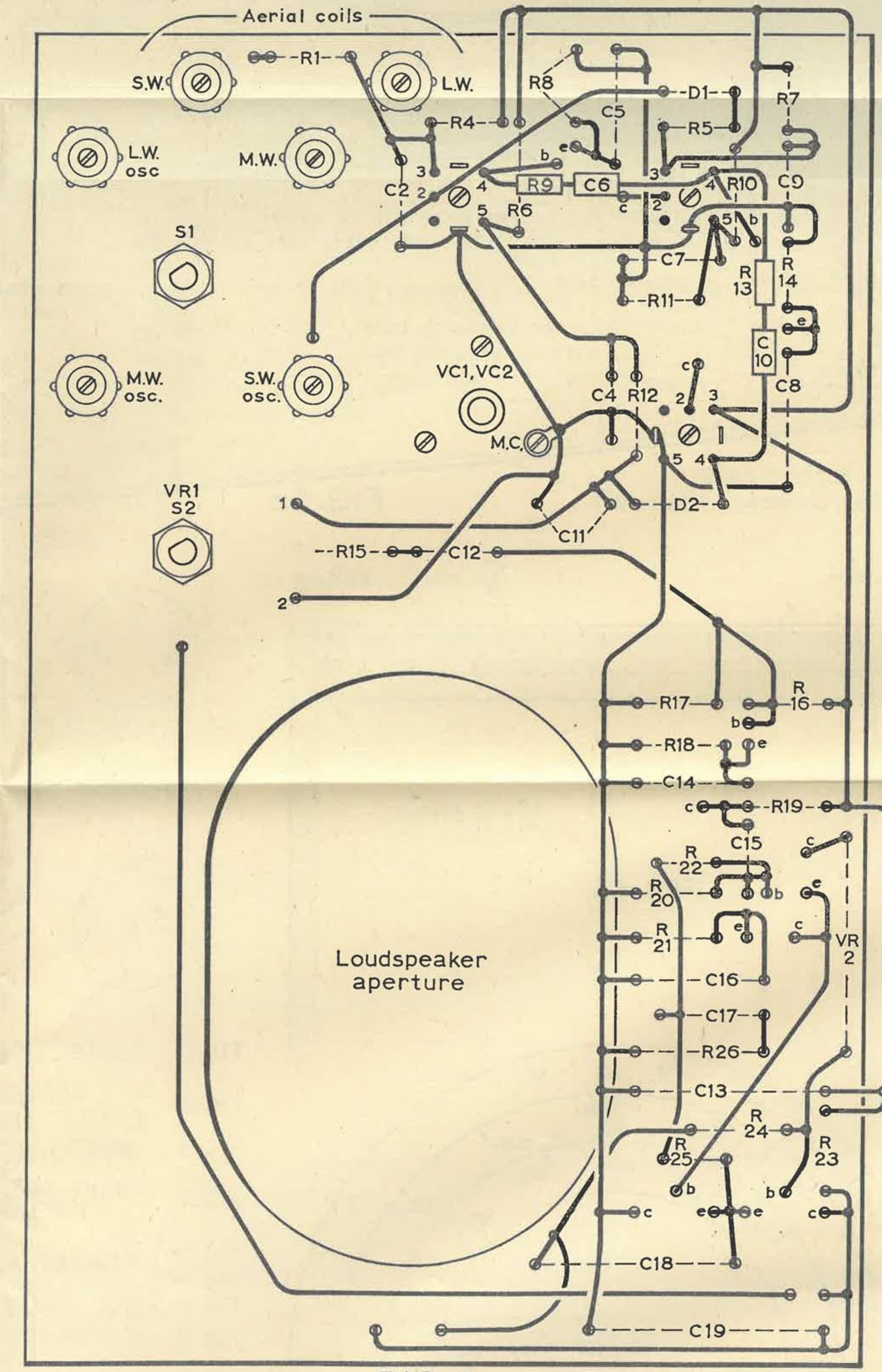


FIG. 3

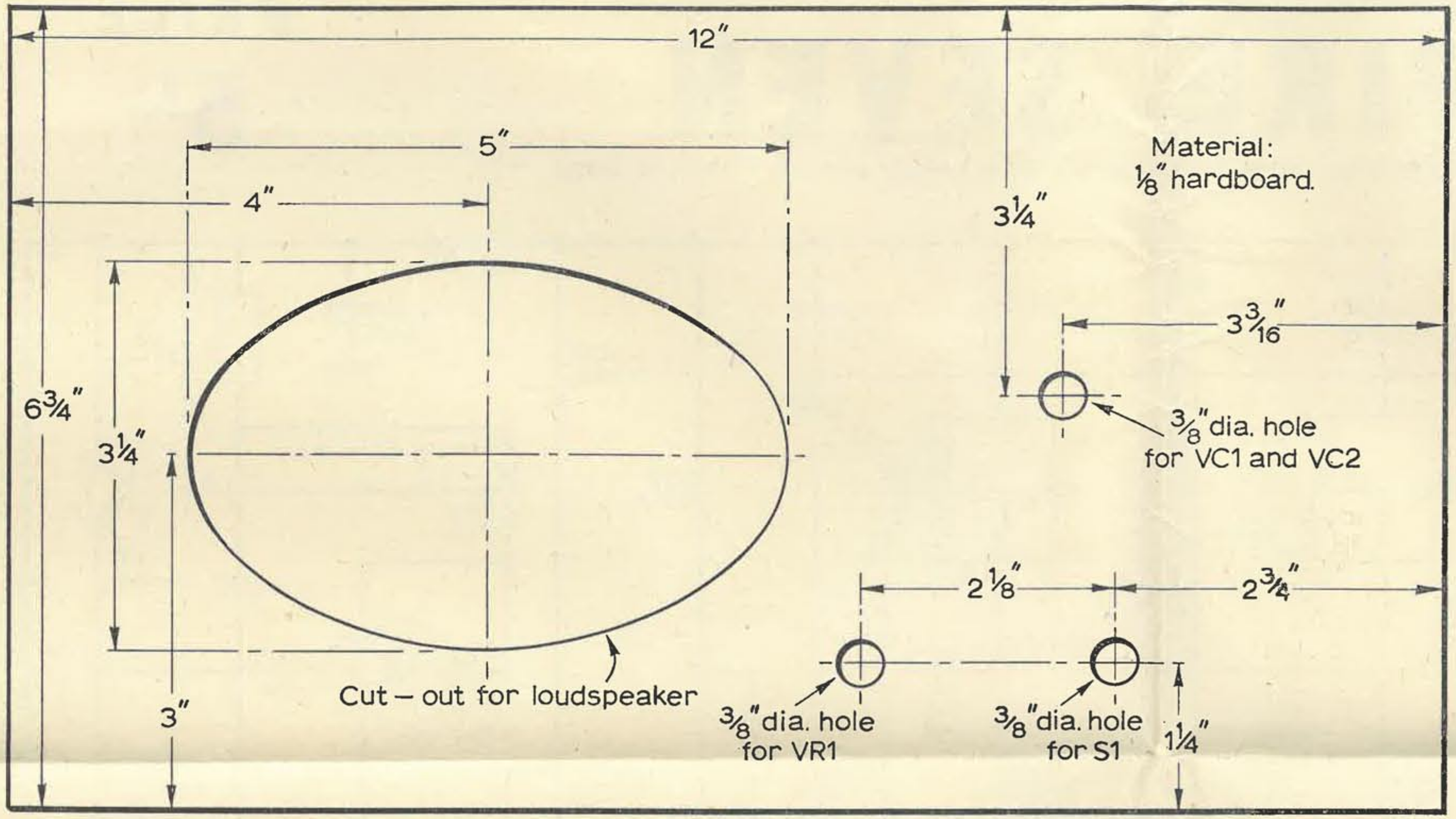
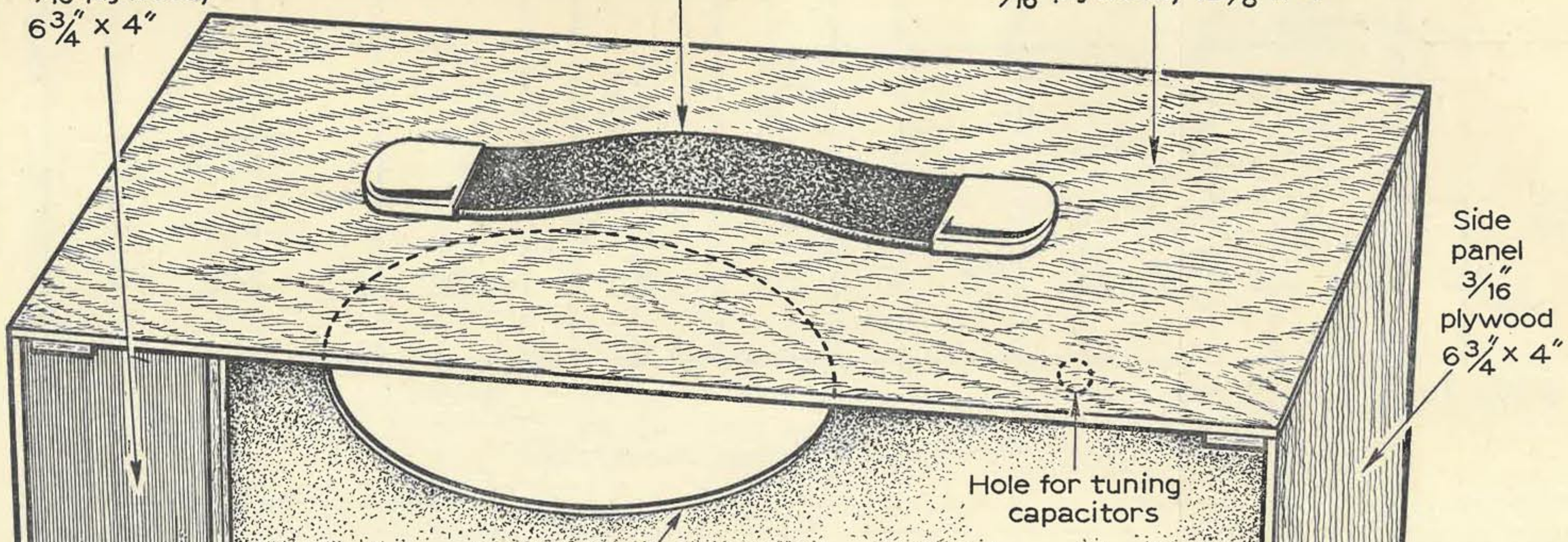


FIG. 4



COMPONENTS LIST

Resistors:

R1	10kΩ	R14	1kΩ
R2	2·7kΩ	R15	2·2kΩ
R3	1kΩ	R16	56kΩ
R4	1·2kΩ	R17	10kΩ
R5	680Ω	R18	1kΩ
R6	68kΩ	R19	3·9kΩ
R7	2·2kΩ	R20	2·2kΩ
R8	680Ω	R21	120Ω
R9	1·2kΩ	R22	4·7kΩ
R10	22kΩ	R23	680Ω
R11	4·7kΩ	R24	680Ω
R12	8·2kΩ	R25	4·7kΩ
R13	3·9kΩ	R26	270Ω

All 10% ½W miniature carbon
VR1 5kΩ log. potentiometer, with switch, S2
VR2 50Ω variable 'slider' resistor, w.w. (Home Radio)

Capacitors:

C1 0·01μF miniature paper 150V
C2 0·01μF miniature paper 150V
C3 0·01μF miniature paper 150V
C4 8μF electrolytic 6V
C5 0·25μF miniature paper 150V
C6 56pF silver mica 2%
C7 0·1μF miniature paper 150V
C8 0·25μF miniature paper 150V
C9 2μF electrolytic 6V
C10 18pF silver mica 2%
C11 0·01μF miniature paper 150V
C12 2μF electrolytic 6V
C13 100μF electrolytic 12V
C14 50μF electrolytic 6V
C15 2μF electrolytic 6V
C16 100μF electrolytic 6V
C17 50μF electrolytic 6V
C18 250μF electrolytic 15V
C19 100μF electrolytic 12V
CP Coil-set padder: 110pF for l.w.; 350pF for m.w.; 3,000 pF for s.w.
VC1, VC2 365-365pF slow-motion twin-gang variable (Jackson 02)
TC1 60 pF trimmer
TC 2, 3, Bank of six 60pF compression trimmers (Denco)

Inductors:

IFT1, 2 470kc/s i.f. transformers (Denco IFT13)
IFT3 470kc/s i.f. transformer (Denco IFT14)
L1 Transistor aerial coils (Denco Blue coils ranges 1, 2 and 4)
L2 Transistor oscillator coils (Denco Red coils, ranges 1, 2 and 4)

Semiconductors:

Tr1 OC170 Tr2 OC45 Tr3 OC45
Tr4 NKT275 Tr6 NKT271
Tr5 NKT278 Tr7 NKT773
Tr8 NKT279. S1 thermal diode } Newmarket matched set
D1 OA79 or GD9
D2 OA70, OA81 or GD9

Cabinet Materials:

$\frac{3}{16}$in. 3-ply wood 12⅜in. x 4in. ... 2 off
$\frac{3}{16}$in. 3-ply wood 6¾in. x 4in. ... 2 off
12in. x 6¾in. hardboard panels ... 2 off
12in. length ¼-round beading ... 2 off
7in. length ¼-round beading ... 2 off
4ft. length ¼in. x ¼in. stripwood

Miscellaneous:

S1 3-way, 6-pole, 2-wafer rotary switch
S2 On/off switch on VR1
15Ω 4in. x 7in. loudspeaker. Telescopic aerial.
6½in. x 10½in. piece of paxolin. Battery plug.
Aerial socket. Flex, knobs, etc.

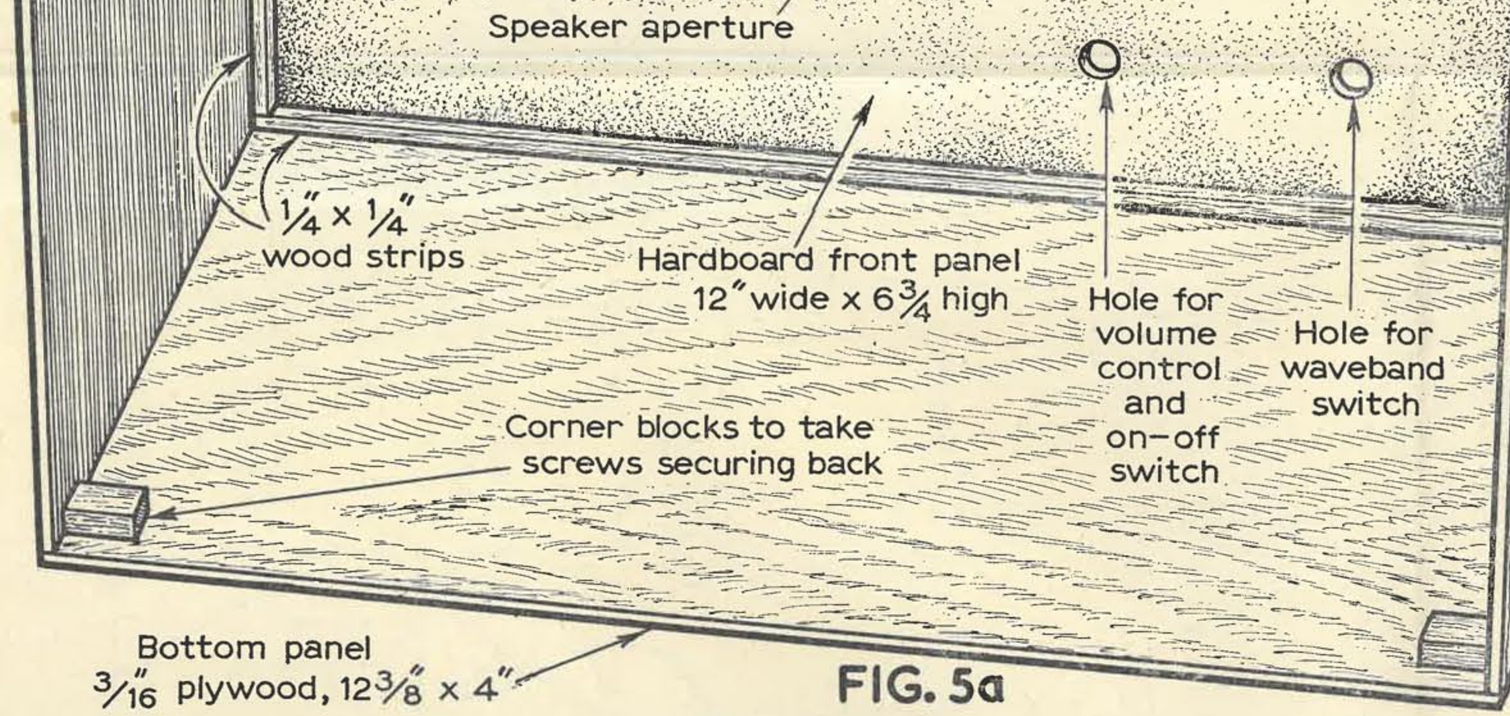


FIG. 5a

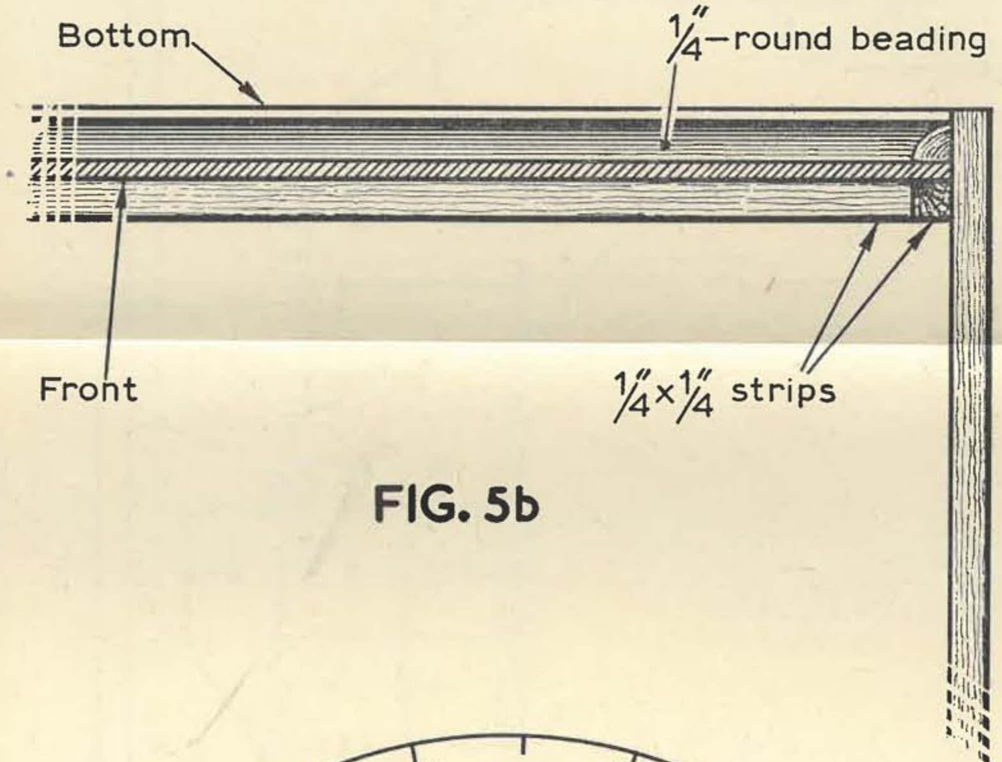
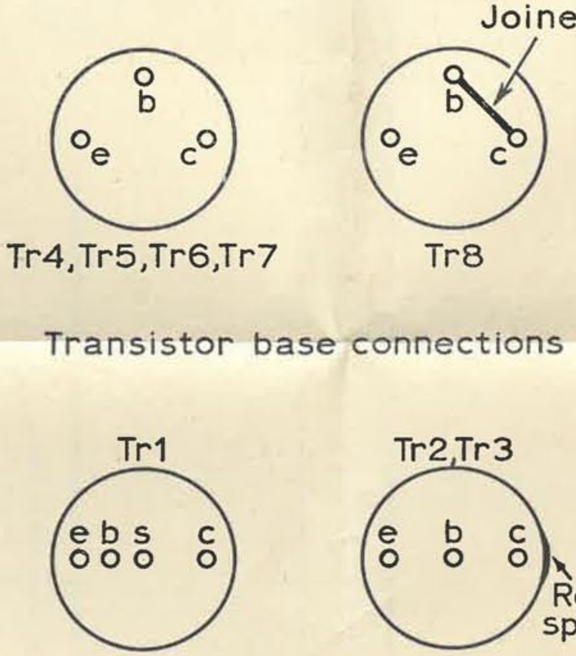


FIG. 5b



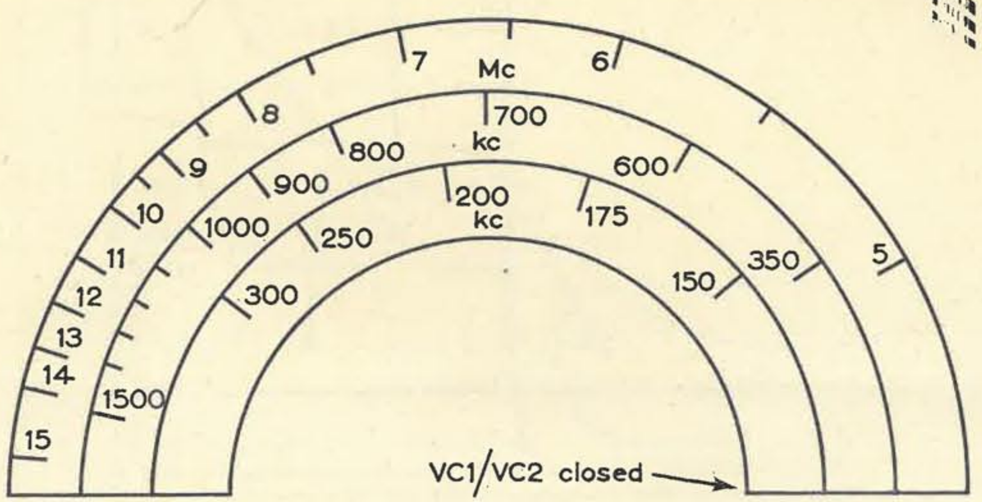


FIG. 6

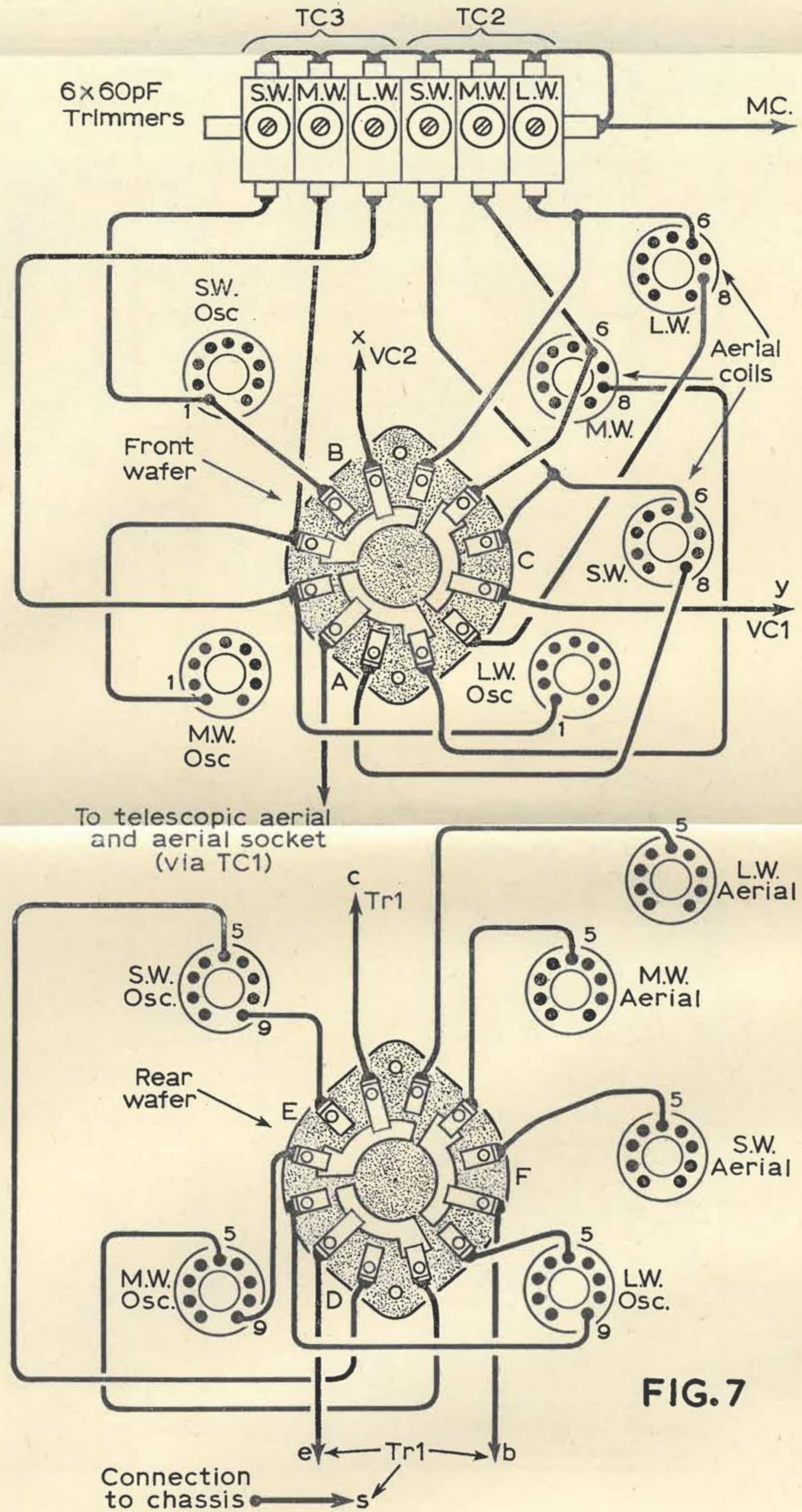
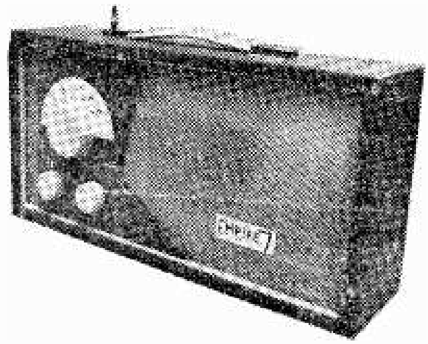


FIG. 7

FIG. 1	THEORETICAL DIAGRAM
FIG. 2	ABOVE CHASSIS LAYOUT OF COMPONENTS
FIG. 3	UNDERSIDE CHASSIS WIRING
FIG. 4	FRONT PANEL DRILLING LAYOUT
FIG. 5a, FIG 5b	CABINET ASSEMBLY
FIG 6	DIAL CALIBRATION
FIG 7	(S1) WAVECHANGE SWITCH WIRING

COVER SUBJECT



The EMPIRE 7

by F. G. Rayer

This month's Blueprint design—a 7-transistor portable receiver covering long, medium and short wave-bands.

THIS receiver uses ten semiconductors in all, and covers long, medium and short wavebands. It should be of particular interest to constructors who want short-wave coverage of the most popular frequencies in addition to reception on the normal long and medium bands. Good reception is obtained with the telescopic aerial which is fitted. An external aerial may be connected instead when wanted. This is useful if the receiver is taken in a car as screening by the vehicle then usually makes the external aerial essential.

The whole receiver is self-contained and of similar size to that of popular non-miniature transistor portables.

The receiver circuit is shown in Fig. 1 and a few details on this should be helpful. Each waveband uses its own aerial and oscillator coils (coils for one band only appear in Fig. 1). This has the advantage that each band can be dealt with separately when trimming. A three-way switch selects the required pair of coils and there are six coils in all. The three "blue" coded coils are for aerial tuning, while the three "red" coils are for oscillator. Each coil has its own trimmer, a small six-bank trimmer strip being used for this purpose.

When wiring up it will be noted that all the aerial coils have the same pin connections, so connections are duplicated for each band. With the oscillator coils pins 1, 5, 7, 8 and 9 are also the same for each coil. However, the padding capacitor pin P is different on each coil. This is pin 6 for long waves, pin 2 for medium waves and pin 4 for short waves. The padder capacitor CP also has to be different for each coil—110pF for l.w., 350pF for m.w. and 3,000pF for s.w.

Transistor Tr1 is an OC170 and functions as a self-oscillating mixer. Diode D1 is a clamp diode greatly increasing the automatic volume control efficiency with powerful signals. Bias for this diode is obtained from the voltage drop in R7. When signal levels exceed the bias voltage the diode conducts, reducing gain and preventing overloading on strong signals.

Tr2 and Tr3 are intermediate frequency amplifiers fed by the 465kc/s transformers i.f.t.1, i.f.t.2. C6 and R9 neutralise feedback over Tr2, while C10 and R13 provide neutralising for Tr3. This is to avoid instability (oscillation) in the i.f. amplifier.

Diode D2 provides demodulation and automatic volume control at lower signal levels. When a strong signal is received a positive voltage is developed across VR1 and applied to Tr2 base through R12 and i.f.t.1 secondary. When this bias increases, the gain of Tr2 is reduced. This helps to maintain a more stable output from the loudspeaker with changes in signal strength due to fading.

The audio output is taken from the slider of VR1 to the first audio amplifier Tr4. The amplified output is taken through C15 to the driver transistor Tr5.

Push-pull output is provided but no transformer is necessary because Tr6 and Tr7 are a matched pnp and npn output pair, driving the 15Ω speaker direct. This type of circuit has a low current consumption and gives very good reproduction. The thermal diode Tr8 is a diode-connected thermal transistor to stabilise working conditions and it is used in conjunction with the miniature pre-set slider potentiometer VR2 so that operating conditions can be set to optimum when first using the receiver. Transistors Tr4, Tr5, Tr6, Tr7 and the thermal diode Tr8 may be obtained in a matched set. This assures that operating conditions in this part of the receiver will be correct.

The capacitor C18 feeds the speaker, which is a 7 x 4in. or similar oval unit (a circular speaker can be used equally well if to hand). Feedback to Tr5 base is through R22 and R25.

COMPONENT TOLERANCES

Most transistors have the base voltage set by two resistors as a potential divider. For example, R1 and R2 for Tr1 or R10 and R11 for Tr3, etc. Proper working conditions will be obtained for transistors of the type given if 10% tolerance resistors are fitted. All such resistors have a silver band in addition to the colour coding showing the value. Emitter bias is also used (R3 for Tr1, R8 for Tr2, etc.) and this further helps stabilise working conditions.

With bypass capacitors the values are not very important but should not generally be smaller than shown. There will be no change in results if near values or larger capacitors, already to hand, are fitted. Other capacitors, notably C3, C6, C10 and all padders, should be of the value indicated.

SECTIONAL TEST

The receiver may be built completely before testing. Alternatively, part may be tested when wired.

Initially, coils for one waveband only may be connected. Coils for the other ranges can then be added after satisfactory results are obtained on the first range. This greatly reduces chances of errors in connecting the wavechange switch.

When Tr1, Tr2 and Tr3 stages are wired up to R15, this section of the receiver may be tested by wiring medium impedance phones from R15 to positive line and connecting a 6V battery across C13 (observe polarity). The first three stages should draw 2-3mA. The i.f.t.s and coils may be roughly aligned for good phone reception.

If the a.v.c. circuit from D2 is in order, battery current will drop slightly when a strong signal is tuned in.

The clamp diode circuit can be checked by temporarily leaving D1 and R5 disconnected. If a strong signal is tuned in, volume should fall considerably when D1 and R5 are joined. But joining D1 and R5 should make no difference to the volume of a weak signal.

When the first stages are found to work correctly the audio amplifier from C12 may be wired.

CONSTRUCTION: PANEL

The receiver is built on a $10\frac{1}{2}$ x $6\frac{1}{4}$in. paxolin panel which has a cut-out to clear the loudspeaker magnet. It is best to drill all large holes first, checking that components fit as this proceeds. Many small holes, for resistors and other small items, can also be made, using a $\frac{1}{16}$in. drill.

If any small holes are missed these can be drilled after wiring has begun. But at this stage care is needed so that fragments of paxolin do not get into the wavechange switch or elsewhere.

The gang capacitor has an integral reduction drive and it is secured with three 4BA bolts. These bolts must be very short or have extra washers or nuts under their heads so that they only project the thickness of the capacitor frame. A soldering tag under one bolt is an earth return (MC) connecting point.

The coils fit in holes and are held with a finger nut which should not be tightened with too much force. All coils have nine pins as shown in Fig. 2.

REAR OF PANEL

Fig. 2 shows components on the panel. The wire ends of resistors and capacitors are bent to pass through the holes and are then spread to keep these items in position. All the electrolytic capacitors (2μF to 250μF) have positive and negative ends which are placed as shown. It is best to leave the transistors and coils until last.

VR2 has a short piece of thin flex soldered from its slider to one outer tag. The i.f. transformers are held by spreading the tags which are attached to the screening cans.

The easiest method of construction is to insert a number of components then turn the panel over and connect them. It is suggested that the outline of each part is marked with coloured pencil as it is inserted. Each connection is marked in the same way when it is soldered. This takes only very little time and shows at once what remains uncompleted. If it is done systematically there is no likelihood that a connection will be overlooked or some other error made.

PANEL WIRING

All connections on the front of the panel are shown in Fig. 3. Some 26s.w.g. tinned copper wire with 1mm sleeving can be used throughout. Joints should be soldered quickly and the iron removed as lengthy heating is unnecessary and may damage parts.

One tag of each i.f. transformer screening can is joined to the earth line which returns to the tag MC. This tag is held by a bolt fixing the ganged capacitor. The i.f. transformers have five tags with wide spacing between tags 4 and 5, so connections will be correct if the pins are located as in Fig. 3. A $\frac{1}{4}$in. hole is needed under each transformer so that the core can be adjusted.

The neutralising components R9 and C6 are soldered together and taken directly from pin 4 of the first i.f.t. to pin 4 of the second i.f.t. C10 and R13 are similarly joined between pin 4 of the second i.f.t. and pin 4 of the final i.f.t.

The diodes D1 and D2 have positive and negative ends which are placed as in Fig. 2. Leave the wires at least $\frac{1}{2}$in. long and solder quickly to avoid damage from excessive heat.

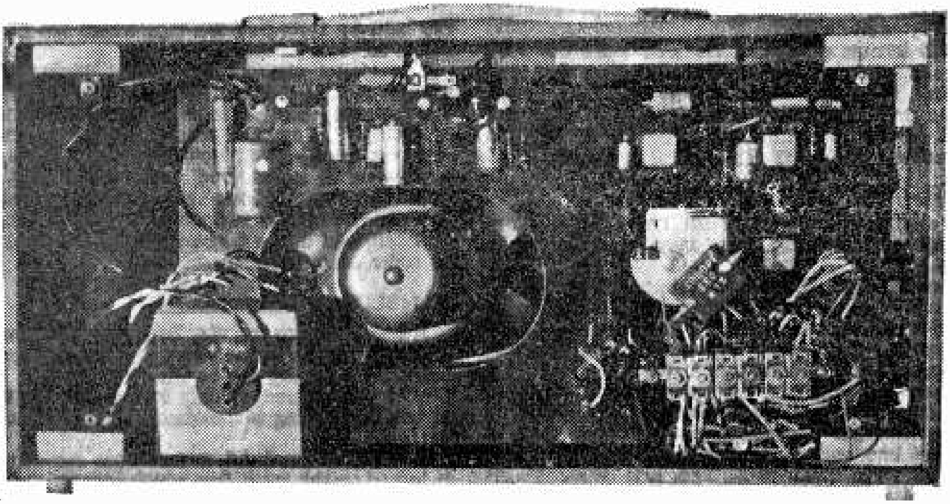
Battery leads are anchored in holes near the top of the panel. Thin black flex is used for negative and red flex for positive as it is most important that polarity is correct. With the 7·5V type of battery a two-pin plug is required and the large pin is positive. The receiver may be run from a 9V battery if preferred.

Tr1 is best left until coils are wired. Tr2 and Tr3 both have a red spot to identify the collector. A piece of sleeving about $\frac{3}{4}$in. long can be placed on each centre lead (base) and the wires are then threaded through in the positions shown in Fig. 2. The panel is turned over and the leads cut and soldered. Tr2 emitter goes to C5 and R8. Tr3 emitter is taken to C8 and R14. Each base wire goes to pin 4 of the adjacent i.f.t. Each collector is soldered to pin 2 of the next i.f.t. There is no need to cut any of the transistor leads very short.

All transistor wires may, however, be left almost full length, sleeving being placed on connections as required. There is little danger of damaging the transistors from excessive heat if the wires are long and the connections are soldered quickly.

Tr4 base goes to R16 and R17. Emitter goes to C14 negative and R18, with collector to R19 and C15 negative.

Tr5 base is taken to R20 and R22, with emitter to R21 and C16 negative. Tr5 collector goes to the base of Tr7 and emitter of the thermal diode Tr8. Base and collector wires of the thermal diode are joined by the maker, so this item has



A look into the back of the completed receiver. This view shows clearly how the cut-out on the panel fits round the loudspeaker cone. At the bottom-right of the panel can be seen the bank of six trimmers which is mounted on bolts, above the wave-change switch.

only two long leads. The lead marked C goes to VR2.

When soldering in Tr7 note that this is of npn type. The arrow still indicates emitter though pointing away from the base. Collector goes to positive line. Tr6 collector goes to negative, with base to R24 and VR2. Tr6 and Tr7 emitters are joined and go to positive on C18 and R25.

SETTING VR2

This is pre-set to allow best possible working. Initially move the slider so that no resistance is in circuit (fully towards R19 in Fig. 2). The slider is then moved along until the output transistors take 1·5mA to 2mA with no signal tuned in.

This adjustment will not normally be made until the receiver is ready to test and the speaker must be connected. The setting of VR2 is not critical.

COIL CONNECTIONS

Fig. 2 shows coil connections, excluding those to the switch. The oscillator coils are red and the aerial coils blue. Insert each coil with pins 1 to 9 as shown. Pins 7 on the three oscillator coils are then joined. R3 and C3 are soldered to pin 7 of the short wave coil and to a lead which passes to the gang capacitor frame tag. These leads and connections to switch and coils should be short and direct.

Pins 7 on the aerial coils are also joined and go to C1 and R2. Pins 1 and 9 on each aerial coil are joined and returned to the earth line MC at the capacitor.

Each oscillator coil has a different padder capacitor and the connection is to a different pin. This is shown in Fig. 2. The 3,000pF s.w. coil padder goes from pin 4 to MC. Leads should be quite short. The m.w. padder is 350pF and from pin 2 to an earth return point. The l.w. coil requires a 110pF padder from pin 6 to a convenient earth return.

Note that a lead goes from pin 7 of the s.w. aerial coil to R1, which is fixed to the panel.

SWITCH CONNECTIONS

These are shown in Fig. 7 and the front wafer (that nearest the paxolin panel) is best wired first. In Fig. 7 the front wafer is shown in the upper sketch and in the m.w. position.

Leave a few inches of connecting wire projecting from pin 6 of each aerial coil and from pin 1 of each oscillator coil circuit. These leads are later taken to the trimmers.

The rear wafer is wired last. Tr1 is first soldered to the contacts. This transistor is placed over the centre of the switch so that leads are quite short. Emitter, base, screen and collector leads are marked E, B, S and C in Fig. 7, the space coming between S and C wires.

The screen wire (S) is soldered to the earth return to MC on the gang capacitor.

TRIMMERS

The six-bank trimmers (TC2/TC3) are mounted about 1¼in. from the panel, using two 6BA or 4BA bolts 2in. long. Extra nuts are required on the bolts or spacing sleeves. A soldering tag is held under each nut and connected to MC at the gang capacitor. The earthed tags should be those which come from the top plates of the trimmers.

The projecting leads are then cut to length, covered with sleeving and soldered to the trimmers as in Fig. 7.

METER TEST

A meter may be included in one battery lead when first testing the receiver. This should show about 10mA with no signal or with low volume if a 7·5V supply is used. Current will be slightly higher with a 9V battery. With good volume, current will rise to about 20-30mA, this depending solely on the volume chosen.

If a high current is found the set should be switched off and a check made for short-circuits or wrong connections.

BAND COVERAGE

The coils are intended to give bands approximately as follows:

Long waves.—150-400kc/s or 2,000-750m.

Medium waves.—515-1,545kc/s or 580-194m.

Short waves.—5-15Mc/s or 60-20m.

These coverages are with a twin-gang 315pF capacitor. The gang capacitor listed has a maximum value of 365pF and is chosen because of its small size and reduction drive. This means that band coverage at the low frequency end of each band is slightly increased.

I.F. ALIGNMENT

If no signal generator is available tune in any station and rotate the i.f. transformer cores for best volume. A completely insulated tool, such as can be made from a plastic knitting needle, should be used for all adjustments.

If a signal generator is available set it to give a 465kc/s modulated output. Inject this at the base of Tr3 and adjust i.f.t.3 core. Then inject at the base of Tr2 and set i.f.t.2 core for best response. Finally apply the signal at the base of Tr1 and adjust i.f.t.1 core.

An accurate indication of output can be obtained by having a meter in one battery lead and adjusting VR1 so that current rises to some 20mA or so as adjustments are peaked for best results. This is more accurate than adjustments by ear.

When the i.f.t.s have been aligned they do not need any further attention and should be left alone.

COIL ALIGNMENT

Each range is treated separately and it is probably best to do the m.w. range first. Adjustments are most easily carried out in two steps: (1) Band coverage, (2) tracking.

(1) If a signal generator can be used couple it to the aerial socket of the receiver through a 400Ω resistor or place a lead from the generator near the receiver aerial. Open the gang capacitor, set the generator to 1,545kc/s and adjust the m.w. trimmer TC3 until the signal is tuned in. Then set the gang capacitor 10° from closed, tune the generator to 515kc/s and adjust the m.w. oscillator coil core until the signal is tuned in. Check at the h.f. end of the band, readjusting the trimmer slightly if necessary.

(2) Tune the generator to 1,390kc/s, tune in the signal with the receiver tuning knob and adjust the m.w. aerial circuit trimmer TC2 for best reception. Then adjust the generator to 566kc/s, again tune in the signal with the receiver and adjust the m.w. aerial coil core for best results. Repeat as before, since one adjustment is modified to some extent by the other.

For l.w. alignment adjust coverage for 150-400kc/s and track at 165kc/s and 370kc/s. The trimmers are l.w. TC3 and l.w. TC2.

For the s.w. band adjust coverage for 5-15Mc/s and track at 5.5Mc/s and 13·5Mc/s. The trimmers are s.w. TC3 and s.w. TC2.

When making adjustments to the s.w. band it will be found that aerial trimming slightly modifies the oscillator tuning, so the receiver control knob should be adjusted to keep the signal in tune.

If alignment is carried out by ear first choose strong stations near the ends of the band to allow approximate adjustments. Adjust the trimmers at the h.f. end of the band (capacitor nearly open) and the coil cores at the l.f. end (tuning capacitor nearly closed). Afterwards find weak stations and repeat the adjustments until no further improvement is obtained.

When aligning do not use a long aerial as this makes adjustments difficult. Accurate tuning points will more easily be found with the aerial only slightly extended. Final alignment is with the aerial fully erected.

On the s.w. band, reception is possible with the aerial circuit tuned above the oscillator frequency. This is the second channel or image frequency and is not required. It will not be encountered if the oscillator circuit trimmer (s.w. TC3) is opened and the aerial circuit trimmer (s.w. TC2) is screwed down in advance. Also begin with the s.w. oscillator coil core somewhat unscrewed so that adjustment is approached from the high-frequency position. When adjustment is correct (oscillator on the h.f. side of the aerial frequency) image frequency reception of the signal generator or a strong station will arise at 930kc/s (2 x 465kc/s) points higher in frequency than the correct tuning point and at reduced volume.

CABINET FIXING

The receiver requires a cabinet a little larger than 10½ x 6½in. inside to give clearance and 3in. deep internally. Ready-made cabinets may be adapted. If necessary new holes can be cut for the control spindles and old holes may be obscured with a fingerplate of coloured plastic or paxolin or other material.

The loudspeaker should be screwed to a baffle board which has an aperture to match the speaker cone. This board is then screwed inside the cabinet. Proper reproduction is not to be expected until the speaker is in its cabinet.

Strips or blocks of wood are glued and screwed inside the cabinet so that the paxolin panel can rest against them.

The tuning capacitor spindle is in two sections and the pointer is attached to the rear part. A standard ¼in. diameter hole knob fits the front part of the spindle.

The telescopic aerial may be screwed to the outside of the case or it may be fixed inside and drawn up through a hole. The aerial lead goes to one fixing screw.

A socket for an external aerial can be added at the back or anywhere convenient. To maintain reasonable selectivity in the aerial tuned circuit the trimmer TC1 is added in series with the socket lead. A fixed capacitor of about 15pF to 25pF may be used here instead. ■

FOR THE BEGINNER

designing a MULTIMETER

by K. Berry

Theory, Design and Construction of Simple Instruments

THIS article is intended to cover the theory and practice of multi-range meter design in its simpler forms.

The basis of this treatment is the moving coil meter. It is not proposed to go into details here regarding the principles of operation and construction of such meters since this may be found in any text-book covering eléctricity and magnetism.

The usual proprietary moving coil meter movement is a low resistance device and is capable of measuring a certain maximum current, this current is known as the full-scale deflection (f.s.d.). A meter movement may be used as it stands to measure the current in a circuit, but more often than not, it will be used with a resistor (known as a "shunt") connected in parallel with it, for measuring currents which are greater than the full-scale deflection, or, alternatively, with a resistor connected in series with it (known as a "multiplier") for measuring voltages. It is the latter use which will be considered first.

Voltage Measurement—D.C.

If a typical moving coil meter, having a full scale deflection of 1mA and a resistance of 100Ω is used as a voltmeter, then the potential across the meter when a current of 1mA is flowing through it will be (by Ohm's Law) $100 \times 0{\cdot}001\text{V} = 0{\cdot}1\text{V}$. That is to say, the meter will read 0—100mV. If now a resistor of 900Ω is connected in series with the meter, and the whole is used as a voltmeter, then when a current of 1mA is flowing, the potential across the meter and resistor will be $(100+900) \times 0{\cdot}001 = 1{,}000 \times 0{\cdot}001 = 1\text{V}$, i.e. the meter will read 0—1V. The combined resistance of the meter and its series resistor (multiplier) is 1,000Ω, and this results in the meter reading 1V full scale.

This can be expressed by saying that the meter has a sensitivity of "1,000Ω per volt", and this is normally written "1,000ΩV". Thus if it is desired to make such a meter read 0—1,000V, the meter must be connected in series with a multiplier whose resistance is such that the combined resistance of the meter and multiplier is $1{,}000 \times 1{,}000 = 1\text{M}\Omega$. Since the meter resistance is 100Ω, the multiplier resistance required is 999,900Ω. This is obviously so near to 1MΩ, that this is the value of multiplier which would be used in practice.

It will be seen therefore, that if a meter is required to read "X" volts at full scale, the value of the multiplier required is simply "X" times "the Ω/V" of the meter concerned. The resistance of the meter itself may be ignored if it is less than 2% of the calculated multiplier resistance. The "Ω/V" of a meter is simply the reciprocal of its full scale deflection in amperes, i.e. f.s.d. = 1mA $= 0{\cdot}001\text{A}$, hence $\Omega/\text{V} = \dfrac{1}{0{\cdot}001} = 1{,}000\Omega/\text{V}$. The number of ohms/volt required for multipliers for some common meters is listed below.

Meter F.S.D.	Ω/V
10mA	100
5mA	200
1mA	1,000
500μA	2,000
100μA	10,000
50μA	20,000

For measurement on radio and electronic equipment, the lowest resistance normally acceptable is 1,000Ω/V, and higher values than this are, in fact, to be preferred.

Current Measurement—D.C.

If a typical moving coil meter having a full-scale deflection of 1mA and a resistance of 100Ω is used as an ammeter it will measure a current of up to 1mA only. If it is desired to measure a current in excess of this, then a resistor must be connected in parallel with the meter to shunt or divert some of the current in the circuit. For example, if this meter is required to measure 10mA full scale, then a resistor must be connected in parallel with it of such a value that 9mA will flow through the

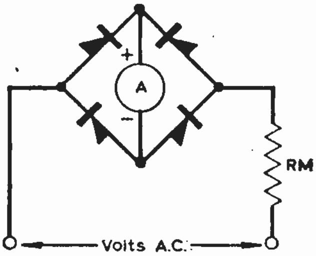


Fig. 1: The basic rectifier voltmeter bridge.

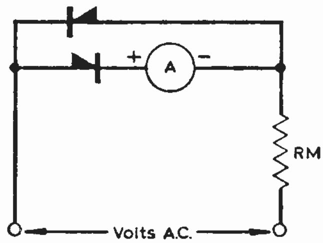


Fig. 2: An alternative half-wave rectifier voltmeter.

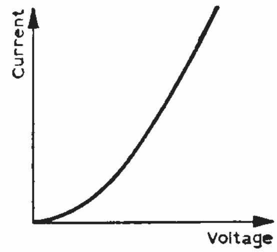


Fig. 3: The characteristic curve for a typical rectifier.

resistor when 1mA flows through the meter, hence the shunt (resistor) must be 1/9th of the meter resistance $= \frac{100}{9} = 11{\cdot}1\Omega$. To read 100mA full scale, the shunt resistor would have to be 1/99th of the meter resistance, i.e. $\frac{100}{99} = 1\Omega$ (approximately).

The value of shunt required is thus giv^n by the following expression:

$$Rs = \frac{\text{meter resistance} \times \text{meter f.s.d.}}{\text{required f.s.d.} - \text{meter f.s.d.}}$$

It will be seen from the two examples quoted above that if the meter f.s.d. is small compared with the required (or shunted) f.s.d., i.e. 1% or less, then the resistance of the shunt is given with sufficient accuracy by the expression:

$$Rs = \frac{\text{meter resistance}}{\text{required f.s.d.}} \times \text{meter f.s.d.}$$

Voltage Measurement—A.C.

A moving coil meter gives a reading which is proportional to the average current flowing through it. Since with alternating current, the average value (over one cycle) is zero, the meter will give no reading when connected to an a.c. supply. To use a moving coil meter to measure a.c. it is necessary to use a rectifier to convert the a.c. into a direct or unidirectional current which can be measured by the meter.

The usual circuit is the bridge rectifier circuit. The meter is directly connected to the d.c. terminals of the bridge, while the a.c. terminals of the bridge are connected to the voltage to be measured via the usual multiplier (Fig. 1).

An alternative circuit uses only two rectifiers instead of the four required for a rectifier bridge. The meter is connected in series with one diode, whilst the other diode is reverse-connected across the meter and diode combination. The whole is connected in series with a multiplier (Fig. 2).

The resistance of the multiplier required for a.c. measurements is different to that required for d.c. measurements. There are two reasons why this should be so.

The first, is that because the meter gives a reading which is proportional to the *average* current flowing, but a.c. voltmeters are normally calibrated in r.m.s. volts. The r.m.s. value of a.c. is $1{\cdot}11 \times$ the average value, or rearranging this:

$$V \text{ average} = \frac{V \text{ r.m.s.}}{1{\cdot}11}$$

Thus to obtain a meter reading in volts r.m.s. it is necessary to reduce the resistance of the multiplier by 1·11. For example, a meter with an f.s.d. of 1mA requires a multiplier of 100kΩ in order that it may read 100V d.c. full scale. The same meter with a rectifier would require a multiplier of $\frac{100}{1{\cdot}11} = 90\text{k}\Omega$ in order that it may read 100V a.c. full scale (r.m.s.) using a bridge rectifier circuit.

The second reason for the difference compared with a d.c. multiplier is the resistance of the rectifier circuit. A further complication is that the impedance of the rectifier elements varies according to the current flowing in them.

A typical rectifier characteristic is shown in Fig. 3. The horizontal (x) axis is the voltage across the rectifier, and the vertical (y) axis is the current flowing through the diode. The shape of the curve at any point is a measure of the rectifier forward resistance at that point. It will be seen that as the current falls to zero, the shape of the curve becomes greater thus indicating a higher resistance.

This changing resistance of the rectifier results in non-linearity of the meter scale. Fortunately this defect can be overcome by certain methods, if this is essential. If the value of the multiplier is high compared with the resistance of the rectifier, then the latter is "swamped" and a linear scale results. This, obviously, only applies on the high voltage ranges. When it is desired to read, say, 10V full scale, a linear scale can be obtained by using a potential transformer, i.e. a voltage step-up transformer. This gives a high voltage output thus enabling a high resistance multiplier to be used. In view of the difficulty of designing and constructing such transformers no details will be given here.

A greater degree of linearity on low voltage ranges can be obtained by using the half-wave rectifier circuit shown earlier in Fig. 2. In practice, if the meter is calibrated at, say, 6·3V on the 10V range, the error over the range 2—8V will be no worse than about 0·5V. i.e. the meter will read 10V when the actual voltage is 9·5. For most purposes this is not a serious complaint, as when measurements of a.c. voltages are made great accuracy is not generally required.

Germanium Diodes

Meter rectifiers are obtainable—these are made specially for this purpose and are usually of the copper oxide type. However, there is no reason why point contact germanium diodes should not be used, in fact the author always uses them himself. Suitable diodes are the Mullard OA70, OA71 or OA81.

It should be noted that the value of multiplier required to measure a particular voltage depends upon whether the bridge or the half-wave rectifier circuit is used. If the latter is used, the multiplier resistance will be about half of that required for use with the former.

The approximate value of multiplier for use with the *bridge* rectifier circuit is given by the expression:

$$R_M = \frac{\text{required f.s.d. (volts)}}{\text{meter f.s.d. (amps)}} \div 1{\cdot}11.$$

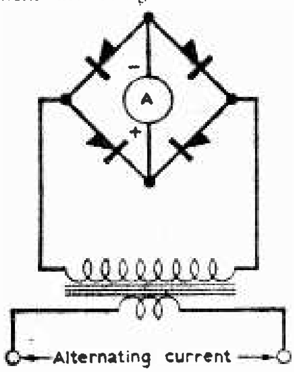


Fig. 4: A rectifier meter connected to a current transformer.

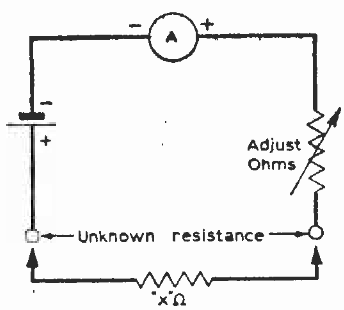


Fig. 5: The basic ohmmeter for resistance measurement.

Current Measurement—A.C.

Whilst measurement of direct current with a moving coil meter is simply a matter of providing the required shunt, measurement of alternating current is not so simple. As was mentioned earlier, the impedance of a rectifier changes with the applied voltage hence the application of a shunt will just result in a variable shunting effect and consequently a non-linear scale. In any case, such a meter would have a voltage drop which would be unduly high for an ammeter.

The solution to this problem is the current transformer. This is in effect a step-up transformer, the large current to be measured is passed through the primary, and results in a small current at a higher voltage in the secondary. This is connected to the rectifier and meter (see Fig. 4).

The design of current transformers is not a simple matter. Considerable care is necessary to ensure that the transformer has a very low iron loss. This is achieved by running the core at a low flux density. In view of the difficulty of designing and constructing current transformers, no further details will be given here.

Resistance Measurement

Precise measurement of resistance is usually made by means of the Wheatstone bridge or its variants. However, in multirange meters, measurement of resistance is affected by more simple (though less accurate) means. The basic movement is connected in series with a dry battery, a fixed resistor, and a variable resistor (Fig. 5). The values of the resistors being chosen so that with the meter terminals short circuited, the meter reads full scale. This therefore is the reading corresponding to zero resistance in the external circuit.

If, for example, a meter with an f.s.d. of 100μA was connected in series with a 1·5V dry cell and suitable resistors the resistance required to give a full-scale reading would be 15kΩ, i.e. when 15kΩ is connected in series with the meter and cell a current of 100μA will flow. If a further (external) resistance of 15kΩ is connected into the circuit the meter will read 50μA. The addition of yet a further 15kΩ external resistance will cause the meter reading to fall to 33⅓μA. In other words, the scale will be non-linear. In proprietary instruments the calculated resistance values will be printed on the scale but when one is making a multi-range meter with a standard meter scaled, say, from 0 to 100 units, it is best *not* to attempt to add a resistance scale by hand as this is a very difficult operation to effect in a neat manner and if done clumsily will completely spoil the appearance of the meter.

In any case the majority of the time, the resistance range of a meter is used just to check that a circuit or component is continuous and no knowledge of the magnitude of the resistance involved is required. In these cases where it is desired to measure the resistance of a component, if the meter reading is noted, a small calculation will give the required answer. For example, if the 100μA meter previously quoted was used (with a 1·5V cell) to measure the resistance of a component and a reading of 36μA was obtained, then the resistance of that component would be

$$\frac{1{\cdot}5}{0{\cdot}000036} - 15{,}000 = 44{,}500 - 15{,}000 = 29{\cdot}5\text{k}\Omega.$$

However, if the prospect of an occasional calculation does not appeal or, alternatively, if one has a steady hand and plenty of confidence, then one can always calibrate the meter with a resistance scale.

Practical Multirange Meters

Having set out the methods by which the various quantities can be measured it is now proposed to consider some practical designs for multirange meters.

When embarking on the construction of a multirange meter for the first time there is a tendency to attempt to cover all the requirements that can possibly be thought of. Whilst this is a good idea in theory, in practice one finishes up with such a formidable design that either one baulks at the prospect of such a labour or else the job is begun but the task proves too much and the project is never completed. Accordingly, three multirange meter designs will be given. The first two are simple designs suitable for a beginner, whilst the last design is more complex and is more suited to the more experienced constructor.

Design No. I

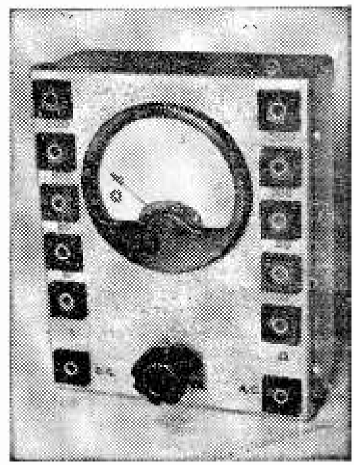
This is a simple multirange meter measuring both a.c. and d.c. voltages up to 500V, also resistance.

No current range is included and in consequence there is no switching. The accuracy on the lowest a.c. range is not high owing to the non-linearity of the rectifier elements as explained earlier. It is, however, a very useful general purpose testmeter and what it lacks in facilities it makes up for in its simplicity.

Specification

Voltage—D.C.	Voltage—A.C.	Resistance
0— 5	0— 10	3,000Ω mid scale
0— 10	0— 50	
0— 50	0—100	
0—100	0—500	
0—500		

The meter used was an ex-Government 2in. round, 500μA meter scaled 0—500. The voltage ranges have been chosen so that the meter reading gives the actual voltage measured or else it is necessary merely to double the scale reading. This is a point worth noting when deciding on meter ranges. An ill-advised choice of full-scale voltage makes a meter more difficult to read. For instance, if a range of 0—20V was included it would be necessary to mentally multiply the meter reading by four and the average person will not find this to be very convenient.



How the prototype of Design No. I looks when constructed and housed in a readily obtainable die-cast box.

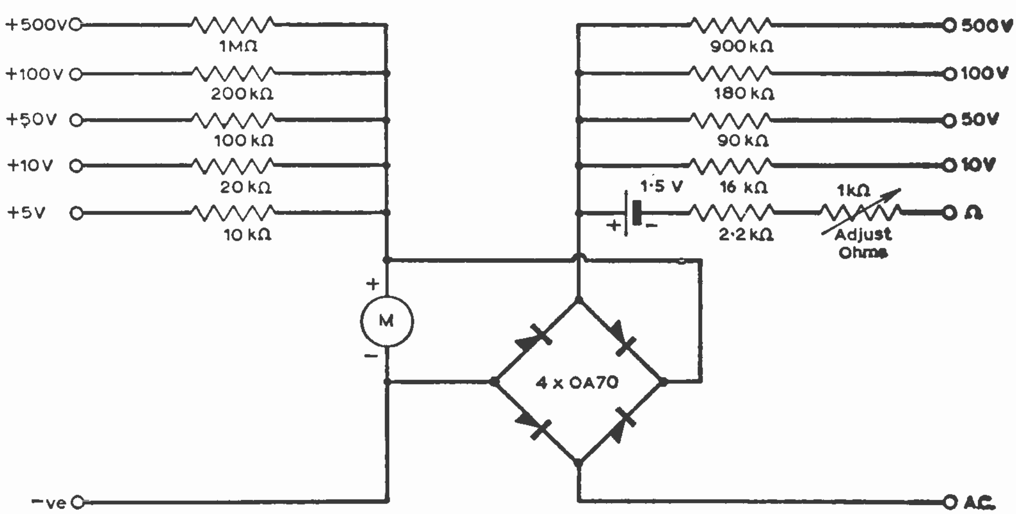


Fig. 6: The circuit of the simple multimeter of Design No. I. This measures a.c. and d.c. voltages and resistance.

No details of construction have been given. the choice is left to the constructor. A meter made to this design is shown in the photograph. Access to the meter circuits is by means of sockets, an arrangement which gives a neat appearance, but terminals could be used if so desired. The circuit is given in Fig. 6.

The accuracy of the meter will depend upon the accuracy of the multipliers. For the d.c. ranges 1% or 5% high-stability resistors would be the most suitable. For the a.c. ranges it will probably be more convenient to use 10% composition resistors as the values required are non-standard and a series or parallel connection of two resistors will probably be needed. The values quoted for the a.c. ranges are only approximate, since the precise value will depend on the particular meter and rectifier used. The exact resistance required can be found easily by the following method:

Connect the meter to a suitable d.c. supply and adjust the supply voltage to 60% of the f.s.d. of the a.c. range to be calibrated. This may be done by using a potentiometer across the supply and measuring the voltage with the already completed d.c. ranges of the meter. If now the meter is connected to read a.c. the multiplier may be chosen so that the meter reads 66·6% of full scale. For example, to calibrate the 10V a.c. range connect the meter to a 6V d.c. supply, measure the exact voltage on the 10V d.c. range, then connect the meter to read 0—10V a.c. The multiplier should then be chosen so that the meter reads 6·66V. This may sound somewhat complicated but it is in fact very easy to do. The choice of a d.c. voltage of 60% of full scale is necessary only on the 10 and 50V ranges. For the 100 and 500V ranges a voltage of between 40% and 90% will do.

COMPONENT LIST FOR DESIGN NO. 1

Multipliers	D.C.	A.C.
5V	10kΩ	—
10V	20kΩ	16kΩ
50V	100kΩ	90kΩ
100V	200Ω	180kΩ
500V	1MΩ	900kΩ

Resistance range

1·5V dry cell,
2.200Ω ¼W resistor,
1kΩ potentiometer.

Miscellaneous

M moving coil meter 0—500μA f.s.d.
4 germanium diodes, type OA70,
12 sockets.

The meter shown in the photograph is housed in a specially made case. A suitable case may be found in the range of "Eddystone" die-cast boxes or, alternatively, a small plastic container sold for use as a sandwich box might be used.

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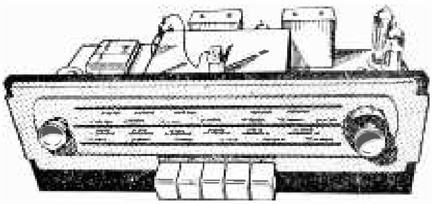

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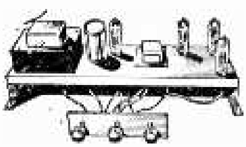

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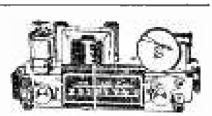

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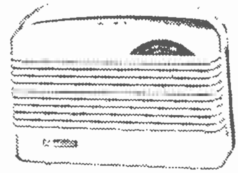

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on the Short Waves

MONTHLY NEWS FOR DX LISTENERS

All times are in G.M.T. All frequencies are in kc/s.

The Broadcast Bands—by John Guttridge

INFORMATION first this month about QSL cards. All verification details (time, date and frequency) continue to be given by *Radio Australia*, A.R.F.S. New York, *Radio Luxembourg*, *Radio Sofia* and *Radio Warsaw*, Sofia and Warsaw having colourful cards according to Wilfred Smith of West Bromwich, who has also obtained a full verification from the Swiss Broadcasting Corporation.

Radio Bucharest, Bucharest, Rumania, has issued six new cards, each carrying a different photograph. Listeners who send in six reports, numbered from 1 to 6 during 1965 will receive the cards in sequence plus a surprise gift at the end of the year. Unfortunately the cards only carry details of date and frequency. The station has English for Europe at 1930—2000 on 7,195/7,225/9,510; 2100—2130 5,990/6,190/7,195 and 2230—2300 on 155/5,990/6,190/7,195.

The Canadian Broadcasting Corporation (P.O. Box 6,000, Montreal) has changed the design on its card. Full verification details are given on its reverse.

Another station giving full details is *Radio Lomé*, Togo. This card is interesting in that apart from the station name it is the same as that issued by *Radio Abidjan*. It gives Radio Lomé's schedule as weekdays 0530—0800, 1200—1400, 1200—2300; Saturdays 0530—0800, 1200—2300, and Sundays 0600—2300. Morning and evening transmissions are on 5,047 and afternoon transmissions are on 7,265.

Radio Sweden, Box 955, Stockholm, Sweden, gives date and frequency only on its card, which includes various facts about Sweden. Information on schedule changes has come both direct from Radio Sweden and from A. Waddelow of Norwich. The main change is the introduction of morning transmissions to Europe (not Sundays) on 9,620. Languages are French 0930, German 1000, Swedish 1030, and English 1100—1130. New frequencies are being used for several other transmissions. Details are English 1230—1300 11,810/15,440, 1445—1515 15,440/9,765, 1615—1645 15,240/11,705, 1400—1430 15,300, 0145—0215 5,990 and 0315—0345 9,705; Swedish 1300—1345 11,810/15,440, 1515—1600 15,240/9,765, 0100—0145 5,990, 0230—0315 9,705; French 2145—2215 6,095. Air Mail report forms are now available from Radio Sweden incidentally.

Good reception of the European English transmissions from *Radio Sofia* is reported by Wilfred Smith. They are aired from 1930—2000 and 2130—2200 on 6,070. This frequency is also used for the English transmissions to North America from 0000—0030 and 0400—0430.

Two Middle-Eastern stations he has heard are the Arabic Home Service of *Radio Baghdad* which was SINPO 33222 between 1930 and 2020 on 7,180 and *Radio Tehran*, Iran. He heard the home service of the latter station at 0800 on 15,125. There is some confusion about this station so readers' observations would be especially welcome.

A recent Swiss Broadcasting Corporation Dx bulletin gave the home service schedule as 1245—1730 on 3,785/7,065/7,165/11,750 and 1730—2030 on 3,785/7,065. The Foreign Service was said to be transmitted from 1730—2130 on 7,165/11,750. A. Waddelow, however, gives the foreign service frequencies as 7,135/11,730, whilst in London I have heard some segments on approximately 7,405. Languages are believed to be Russian 1730, Turkish 1800, Arabic 1830, French 1930, German 2000 and Persian 2030—2130.

Radio Tirana, Albania, is the last station mentioned by Wilfred Smith. He has heard English from 2000—2030 and French from 2030—2100 on 9,390. A parallel frequency is believed to be 7,090.

According to Roy Patrick, of Derby, two of the most persistent North American medium wave stations at his location have been CBA Sackville on 1,070 and WEZE Boston on 1,260.

Several changes have been made by Radio Nederland (P.O. Box 222, Hilversum). Here are some of the affected transmissions, metre bands (e.g. 16m) are given where the exact frequency is not known. If you can discover the correct frequency please let us know. Afrikaans 1530—1630 16m/15,425; Arabic 1430—1550 15,445/11,730; Dutch 0230—0350 31m (Bonaire), 0900—1020 Sunday 21,570/21,480/15,445/16m/6,020, 1800—1920 15,220/25m/6,020, 2100—2220/19m (Bonaire); English (not Sundays) 0400—0450 31m (Bonaire), 1400—1450 16m/15,425/6,020, 2000—2050 25m/9,590/6,020; Spanish 0130—0220 49m (Bonaire), 2230—2320 19m (Bonaire); Happy Station (Sundays) 0600—0720 9,715/49m, 1400—1520 16m/15,425/6,020, 1530—1650 16m/9,590.

Frequency usage *has been revised* by the *Voice of America* for its European English transmissions which can now be heard on 1,196 Munich from 0400—0430, 0500—0730, 1700—1830, 2200—2230; 3,980 Munich 0300—0730, 1400—2330; 5,995 Greenville 0300—0730; 5,995 Tangier 1630—2230; 6,040 Munich 0500—0730; 6,080 Tangier 0300—0730; 7,200 BBC 0300—0730; 7,205 Thessaloniki 1500—2230; 9,540 0300—0730; 9,670 Greenville 2015—2200; 9,740 BBC 0300—0730; 9,740 Tangier

1900—2200; 11,760 1900—2200; 15,205 Greenville 1400—2200; 15,290 Tangier 1400—1630; 15,295 0500—0730; 17,780 Greenville 1400—1830. Many of the V.O.A. Russian service programmes consist of light music and give good U.K. reception. Frequencies are 1,196 0300—0400; 6,020 0300—0500; 6,040 0300—0500, 1500—2100; 6,150 0300—0500; 7,170 0300—0500, 1730—2100; 9,540 1715—2100; 11,710 1500—2100; 15,315 1500—1715.

Extension of its European service to 2400 is the big feature of the latest schedule from *Radio New York Worldwide, New York 19, U.S.A.* Frequency usage to the UK and Europe is now 15,440 1200—2045, 15,220 1245—1600, 17,840 1615—2000, 11,875 2015—2145, 9,525 2100—2400. Transmissions are directed to Africa from 1500—2145 on 17,730 and to the Caribbean from 1200—2400 on 15,440, 1500—2200 on 17,730 and 2200—2400 on 11,855. Radio New York will supply listeners with addresses of stations if wanted and will also try and identify unknown stations if sent a tape recording of the signal. Requests for this help should be sent to the station's "Dxing Worldwide" programme.

The Amateur Bands—by David Gibson G3JDG

THE l.f. bands, particularly Top Band, have been very interesting. Also, ten metres is just beginning to awaken, and as the sunspot cycle starts to build up will again become a good DX band. On February 28th, ZE's and ZS's were coming through.

20 metres keeps open later as the evenings get longer and many reporters noted that it also opens up again late at night when some quite good DX sneaks through. This band still produces some rare ones, at the expense of beauty sleep. A rough guide to the openings is: 0530 to 2000.

On 40, the usual din persists but one can usually hear a VK around 0700 to 0800.

Fifteen is, as usual, spasmodic. One period will produce call signs from all over the globe while the next session will be rewarded with the monotonous noise of frying eggs. Most fruitful times are from around 0800 to 1800 with afternoon peaks.

80 Metres

This is getting more like 40, what with G sideband gatherings, teleprinters, intruders, phantom v.f.o. swishers—and weak DX. Many listeners comment on the noise level; this will get worse as summer comes along. Best time for DX is either around 0600 or from 2300. Early evenings usually produce Europeans only.

Top Band

The last of the Transatlantic tests took place on February 21st. Conditions were much poorer than on previous tests. However, an all-night session using an Eddystone 888A, a 132ft. longwire, and two dozen cups of cocoa, produced the following on C.W:—OH2HK (559), OK1KG, OK2BHX, K2KGD (449), HB9CM, OK2HHX, GI3PDN, OK1AII, PAØPN, W1BB/1 (459), OK1ADM, GW3TJE, W2GGL (349), GM3TMK, OK1AKU, OK1AER, HB9TT (589), OE1KU, VO1FB (459) and numerous G's. The best DX was HP1IE (449) Panama, heard working W1BB/1. As regards 160m in general, a little careful searching can usually produce W1, W2, VO1, 9L1, OH and OK. Top Band is used at certain times by amateur stations sending slow morse and for those who want to learn c.w. Check with your nearest radio club and see if there is a schedule in your area.

Listener's Reports

Thanks to all who have sent along reports again. We can't use them all but the information is still of value. Don't forget to mention time, date, call sign, frequency, RST, or RS report. First this month, a colossal log from A3699 in Elderslie, Scotland. The number after call signs is the time in G.M.T.

1·8Mcys. W1BB/1 0600 (C.W.) DL9KRA1 2359 (SSB).

3·5Mc/s. **CW:** W8ATA 0129, AL4IE 0752, W2KH 0755, **SSB:** W1HKK 2244, W1JAE 2250, W3PHL 2255, UR2CC, OD5AX 0049, KP4BL 0320, W1BU 0628, W5CAI 0705, W5KNV 0709, TF1AC 2355.

7·0Mc/s. **SSB:** YV3KX 0907, VK2AVA 0745.

14Mc/s. **SSB:** 7X3VW 0740, HS1HS 1255, DU1EH 1256, HS1X 1300, YA4A 1315, 7Q7PBD 1732, VP9FR 1855, ZS4F 1859, EL6E 2251, SL3UY 0950, HC5NW 1230, VK7CK 1305, YS1AGM 1307, VK5HY 1317 XE1CE 1322, VK6EZ 1415, W5HWR/VP9 1959. Plus several W6, VE4, 5, 6, 7 between 1600—1900.

21Mc/s. **SSB:** 9K2AU 1134, YA3TNC 1230, KP4AOO/MM 1240, EL6E 1650. **AM:** TN8AA 1119, ZE2JA 1150, 9L1WN 1641, CR4AD 1108. **CW:** CN8CF 1500, W2IYH 1708, K1EPØ 1805, K1YER 1815.

If you still think the bands are quiet then look at the log from **W. L. Clarke** of Yelverton Devon.

3·5Mc/s **SSB:** VE7DU, VE3DJE, VO1B7, W6ITZ/P/4, K1PNE, W8YBZ, (all between 0540—0740).

7·0Mc/s. **SSB:** VK2AKW, VK2AVA 0845. **AM:** SVØWM, W8MAZ/P/VO2, VP4LR, AP2HB (between 1000—1130).

14Mc/s. **SSB:** PY6LP, ZL4BO, LU2DAW, KG1BO 1620, ZS6FT 1915, ZS6ADS 1755, 9Q5RB 1830, 4U1ITU 1240, KV4CX 1245, VU1EN 1330, ET3USA 1335, 5A1PZ 1615, KR6UL, VK2NN, VK3AF, JA1CZE, KP4APS 1130, VK4YG, ZL1SJ, KG6AG, SU5ETO 1545, MP4TBO 1550, ZL3AS, HL9TM, KR6DA, BV1UST 1000, HM2BD 1010, VKØTL, 9K2AN 1330, CR9AR 1425 (Pacific area DX 0830—1130). **AM:** W8MAZ/P/VO2 1100, VP4LR 1120, AP2HB 1135.

21Mc/s. **AM:** ZE8WY, KV4CX, ZE2JA, WØFLM, (St Lucia A.R.C.) 9Q5RB, 9L1WN, ZS1DBV, CR7FC, 5A1TG, CP1LJ, KC4US, VP9FE, CR7AX, CR7IT (all between 1330—1630).

ISWL/GI1362, Worcester, reports 14Mc/s on an 84OC, Codar pre-selector, 20 metre dipole and

—continued on page 70

ARTIFICIAL AERIAL TRANSMITTER LOADS

by G3OGR

MANY transmitter tests are best made with an artificial aerial. This avoids unnecessary radiation (and interference with other transmissions on crowded bands) and may allow output power, p.a. efficiency, or other factors to be checked.

If the same type of socket is used throughout, an aerial tuner, dipole, or artificial aerial load may be connected in a few seconds. The feed impedance of a half-wave dipole is usually about 65 to 75 Ω, so it is convenient to use a length of 65-75Ω co-axial cable as the output lead of the transmitter. This ends with the popular type of co-axial plug, and sockets to match can be fitted to a tuner, artificial load, or feeder to a dipole. If the transmitter has a co-axial output socket, a piece of feeder with two plugs will allow easy connecting up with other circuits.

Lamp Loads

A domestic lamp is quite useful for 1·8 to 28Mc/s. It is suitable as a load for a phone transmitter, or for loading adjustments etc., with a c.w. transmitter. It cannot be used for keying tests with much success because its resistance changes considerably when hot.

A simple base, like that in Fig. 1, and fitted with a socket and lampholder, will prove handy. The lamp wattage may be similar to the d.c. input of the p.a. stage. For top band (10W) a 15W lamp is satisfactory. A 100W lamp will take the output of a 120W transmitter, if a 150W lamp is not to hand. A 100W lamp will actually do for 50W upwards, though a 25W, 40W or 60W lamp is useful for smaller power.

The average pi-output circuit can be loaded directly into the lamp, as described later. If necessary, some indication of output power may be obtained by comparing brilliance with another lamp of the same type, run from the mains. The lamps should be exchanged, to check their brilliance. A photographic exposure meter is also useful for this. P.A. efficiency can be checked at loading points which give 15W, 25W, 40W, 60W and similar outputs. That is, full brilliance with the artificial load lamp, to agree with a similar lamp run from mains supplies.

Resistor Load

A carbon resistor load can be used for 'phone, and a c.w. transmitter when loading or keying. Large resistors which will take the output of a 150W p.a. are obtainable, some being very inexpensive as surplus. For very large outputs, two or more resistors can be used in series or parallel.

Fig. 2 indicates how the load resistor and a r.f. ammeter may be fitted to a base or box. Output power can be found from $I^2 \times R$, so a 350mA meter with 70Ω or similar load will do for a top band or similar low power transmitter. For high power, a 1·5 or 2A meter is satisfactory.

A table of approximate power levels can be glued on the base for easy reference, or the meter may be calibrated in powers. With a 70Ω load, the approximate power for various current readings

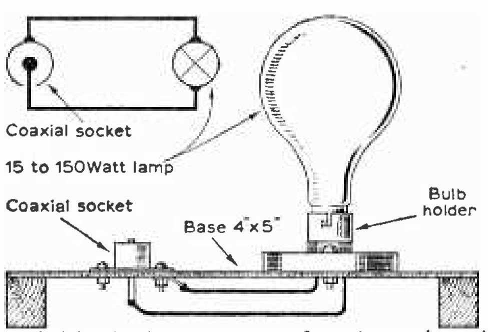
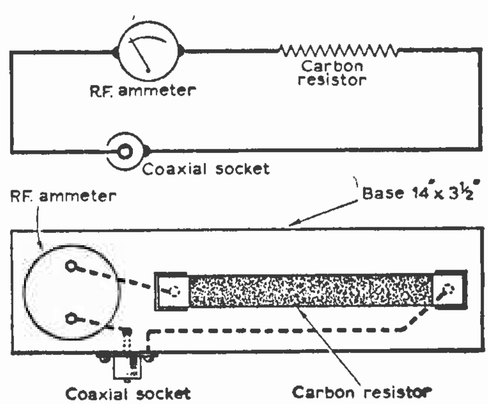


Fig. 1 (above): An arrangement for using a domestic lamp as an r.f. load.

Fig. 2 (right): A carbon resistor load used in conjunction with an r.f. ammeter.



will be as follows:

Current (Amps)	Watts	Current	Watts
0·1A	0·7	0·8	44·8
0·2	2·8	0·9	56·7
0·3	6·3	1	70
0·4	11·2	1·1	92·4
0·5	17·5	1·2	101
0·6	25·2	1·3	118
0·7	34·3	1·4	137

The resistor value and meter can be checked, if high accuracy is wanted. Some error will not influence comparative tests of efficiency. The average r.f. meter is most accurate at about ¼ to ¾ full-scale reading.

Low Power Load

A load for a small transmitter is easily made from several ordinary carbon resistors, wired as in Fig. 3. Six 1W resistors will take the output of the average 10W transmitter. Larger resistors, such as 2W, may be used for more power or the number of resistors can be increased.

When all resistors are of the same value and in parallel, the value of each resistor equals the load multiplied by the number of resistors, e.g. four 2W resistors are to be used, and a 75Ω load is wanted. 75 × 4 = 300. So each of the resistors is 300Ω.

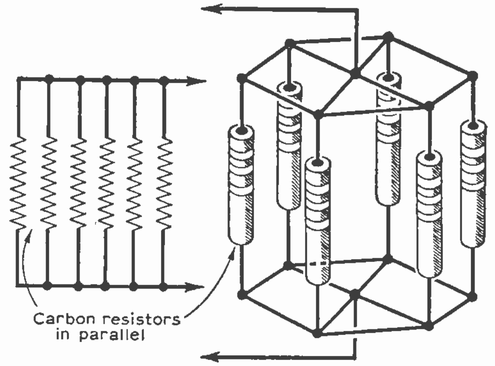


Fig. 3: Several carbon resistors connected as shown form a suitable load for top band or low power transmitters.

Loading with Pi-Output

For those who are just getting started with a transmitter, Fig. 4 shows the usual pi-output circuit. To load the power amplifier into the lamp or resistor, first close VC2 to maximum capacity. If necessary, check p.a. grid current, to see that the stage is being driven correctly. H.T. is then applied to the p.a. and VC1 is rapidly turned until a dip is seen in the anode current meter in the h.t. circuit.

With some valves, the anode dissipation will easily be exceeded if the circuit is not tuned to resonance, and this is why VC1 is quickly tuned. When VC1 is adjusted for minimum h.t. current, this will probably be far too low. So VC2 is opened, VC1 being re-adjusted for minimum h.t. current.

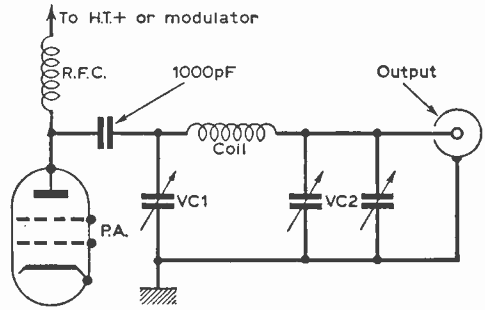
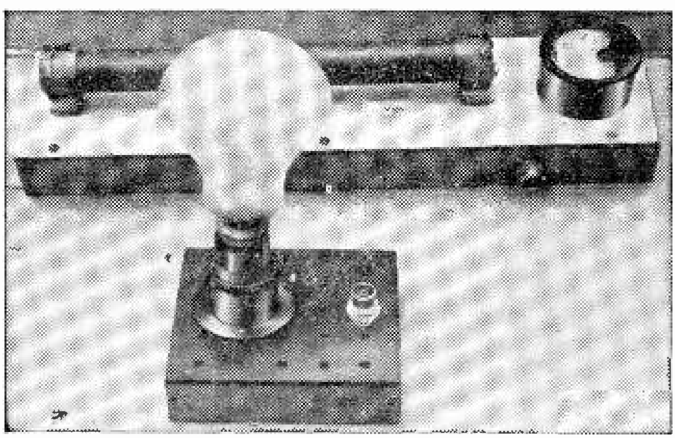


Fig. 4: The usual sort of pi-output circuit used with transmitters.

The h.t. current will now normally be higher. This procedure is repeated until the p.a. draws its full rated h.t. current, with VC1 tuned for *minimum* current. It is convenient to use both hands. VC2 is generally a 2-gang or 3-gang 500pF capacitor.

As loading has progressed, the lamp will have grown much brighter, or the r.f. meter will have increased its reading.



The two loads described in the text and illustrated in Figs. 1 and 2 are shown together in this photograph.

Input and Output

The p.a. input is I × V. For example, if the p.a. draws 100mA at 500V, this is 0·1 × 500=50W input.

Efficiency, as a percentage, is:

$$\frac{\text{Input}}{\text{Output}} \times \frac{100}{1}$$

E.g., output is 30W. In the example, 50/30 × 100 = 60%. Efficiencies of 60% and higher should be anticipated.

When a r.f. meter is present to show output, changes can be made to grid drive, bias, screen grid voltage, etc., in an attempt to secure best efficiency. That

—continued on page 40

GROUNDED INVERTED L ANTENNA

by P. W. Waters, G3OJV

A CHANGE of QTH recently set the writer thinking about the re-erection of the antenna system. Having been used to a half-wave on 160 metres at about 40ft. high, it came as somewhat of a shock to find that at the new QTH the maximum straight run possible would be about 30ft. Even bending the antenna to fit the garden would not allow anything approaching the quarter wave mark on Top Band.

The writer wanted to operate principally on the 160 and 80 metre bands and so a considerable amount of thought was given as to how to accommodate a radiating system for these two bands. If a bent horizontal wire were to be used it would not only have to have several supports in addition to the usual ones at either end, but it would also have to run through several trees. This idea was obviously not practicable.

Thoughts were then turned to a vertical system. This seemed a much sounder idea from the practical aspect. The problem with this method was that the transmitter was located in the top of the house and a considerable length of coaxial cable would have to be run down the side of the house and across the lawn in order to feed the antenna at the base. This would also involve insulating the base and constructing a weather-proof matching network.

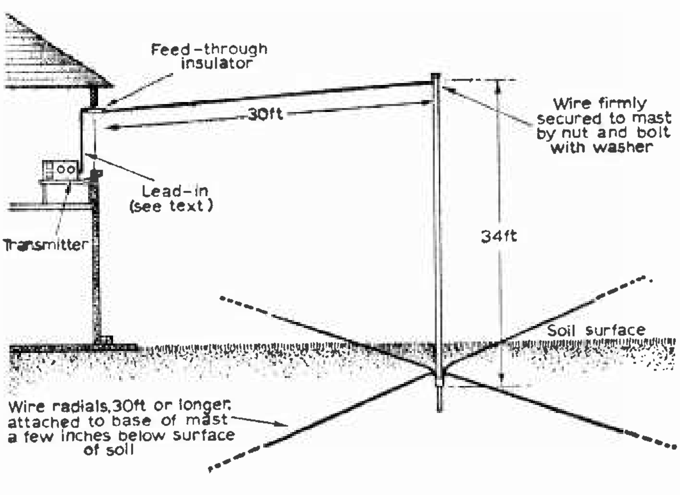


Fig. 1: The antenna arrangement and dimensions, showing the underground system of radial wires.

It then occurred to the writer that it should be possible to feed the antenna from the top and ground the far end. This seemed quite a good idea as well as solving constructional problems. The final antenna is shown in Fig. 1 and has been in use for several months now.

The transmitter is very close to the window only requiring a 2ft. lead in. However, an extra few feet should not effect performance much and a length of 10ft. inside the room was found to leave the performance unaffected.

Due to the higher impedance present at the top of the antenna, coaxial cable cannot be used to feed the system. A 30ft. length of wire has, therefore, been used between the transmitter and the vertical section. The vertical part of the antenna consists of a 34ft. alloy mast which is electrically connected to the far end of the 30ft. wire. The whole. thus forming a 64ft. radiating system. The wire is connected to the top of the mast by means of an alloy nut, bolt, and washer to avoid rusting, and the whole bound with insulating tape.

The mast is supported at the base by means of a sleeve fitted over a piece of gas barrel of slightly smaller diameter driven into the ground. In view of this point being the position of maximum current irrespective of band or frequency it is essential to provide a very good earth connection owing to the heavy losses that can occur at such low impedances. The existing connection is thus not sufficient. While on this point I would like to mention that if several earth spikes are driven into the ground at the base of the mast, a noticeable increase in aerial current will be obtained. Further. the radials were similarly buried to provide an even better earth and in my case they are 30ft long. although the length can be increased if space permits, and may be bent if desired in order to fit the space available. It must be stressed. however, that the better the earth connection the better the results.

The earth spikes are copper rod or tube. and heavy gauge wire is soldered to the top of each spike. These wires, together with the radials, are all connected to the base of the mast by means of a wrap-round, home-made alloy clamp, and bound with insulating tape to protect the connection from the weather. The only point of the system where insulation needs attention is at the feed end where on some bands the aerial is voltage fed and should, therefore, be kept away as much as possible from gutters and walls, etc.

Any reader who requires to know the impedance at the input end for any band can easily calculate it by reference to the base which is always of low impedance. Thus for an odd number of quarter wavelengths the impedance will be high and for even numbers the impedance will be low.

The impedance at the feed point of the antenna will be medium on 160 metres and high on 80 metres.

The current at this point will thus be found to be much higher on 160 metres than on 80 metres and the station aerial tuning unit should be used to match the antenna to the transmitter.

Results have been very encouraging. It has been found possible to work over most of England and Wales on 160 metres c.w. and s.s.b. from the writer's QTH in Essex. On 80 metres coverage of the whole of Europe has been found possible with an input of c.w. of 50W and reports averaging strength 7.

Whilst fantastic results are not claimed for this antenna, it does appear to operate much more efficiently than a horizontal wire of similar length. It is hoped, therefore, that this article will be of interest to people who like the writer suffer from lack of space. ■

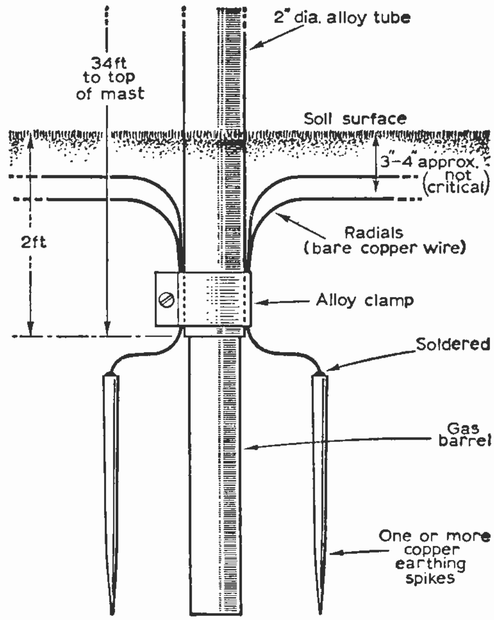


Fig. 2: Details of the base of the mast, buried below ground with all its earthing attachments.

ARTIFICIAL AERIAL TRANSMITTER LOADS

—continued from page 38

is, maximum r.f. output, for a given p.a. d.c. input.

Harmonic Tests Etc.

If the presence of harmonics is to be checked, it is convenient to take the transmitter output to an aerial tuner, or coil. The lamp or other artificial load can be tapped across part of the coil, to secure suitable loading. Harmonics or other unwanted frequencies can then be checked for by placing a wavemeter near the coil. When an end fed aerial is operated through a tuner, the transmitter can be loaded into the 70Ω resistive load. Transmitter tuning can then be left unchanged, aerial tuning or tappings being adjusted to secure the same loading of the transmitter.

When making speech quality tests, or checking modulation with a scope, enough r.f. can be picked up by placing a lead near the lamp or resistor, or by looping an insulated wire round the connection running from the centre of the co-axial socket.

If the transmitter is home built and cannot be loaded into a 70Ω or similar artificial aerial, note the positions of VC1 and VC2 (Fig. 4). If VC1 is fully closed without resonance, the coil needs more turns for that band, or VC1 is too small. But if VC1 has to be fully open, the coil is too large. Many combinations of VC1, coil inductance, and VC2 will permit loading to full anode current. Small values for VC1 are best for the h.f. bands (14, 21 and 28Mc/s). That is, r.f. output is largest with VC1 nearly fully opened, the coil being of

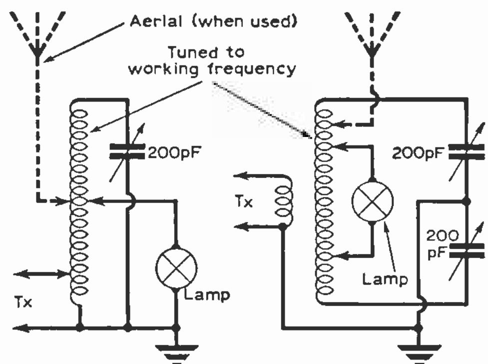


Fig. 5: Two methods of obtaining low impedance loads with high impedance lamps.

sufficient inductance to allow this. The output of a multi-band transmitter can be expected to fall off somewhat on the h.f. bands, compared with 3·5Mc/s.

A domestic lamp used as a load may have too high impedance for some transmitters. If so, this can be overcome by using an aerial tuner similar to that in Fig 5. That is, as required for an end-fed half-wave aerial.

The resistor load can be used to set up a standing-wave indicator for the i.f. bands. With pi-output, standing-wave indicator, and load all of the same value, there should be a steady flow of r.f. into the resistor, and no reflected power. ■

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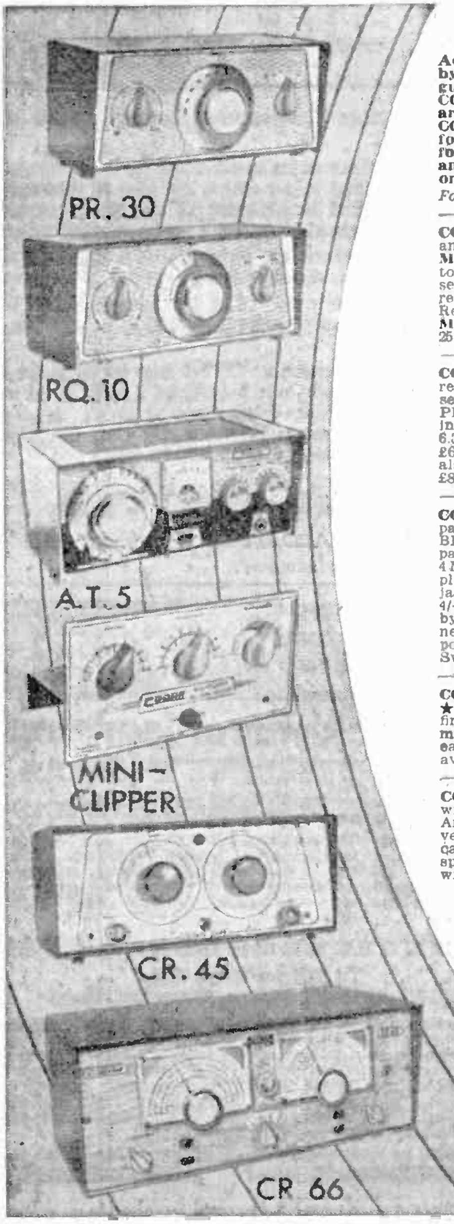

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HIGH-FIDELITY AMPLIFICATION

BY J. D. HASKELL

THE true appreciation of any topic is best tackled with a firm grounding in the basic relevant concepts. To start with, a short list of terms associated with amplifier systems and their performance is given.

Frequency Response

This is usually quoted as a band of frequencies covered within a certain number of decibels (dB for short). A frequency response curve is usually plotted on semi-log. paper. Frequency along the log. scale and decibels along the linear scale Fig. 1. (The definition of a decibel (dB) may be found in a text book on sound.) In general the dB nought point is taken to coincide with the "zero" frequency of 1,000c/s. All scales are referred to this frequency. This is because the quietest sound that the ear can hear is 1,000c/s at a pressure of 0·002 dynes per square cm and this is the standard reference. A good amplifier should have a frequency response of at least 20c/s to 20kc/s ± 1 dB, preferably even wider. It may be argued that the average adult cannot hear beyond about 15kc/s, nevertheless if the total bandwidth is less than that mentioned transient response will suffer and the reproduction will lack attack. The freq. response is usually quoted for an output of 1 watt. This is not necessarily the same at full output. The response at full output is termed *power response* and this is far more important. A good figure for the latter is 30c/s to 15kc/s ± 1dB. A figure of 20c/s to 20kc/s ± 1dB is excellent.

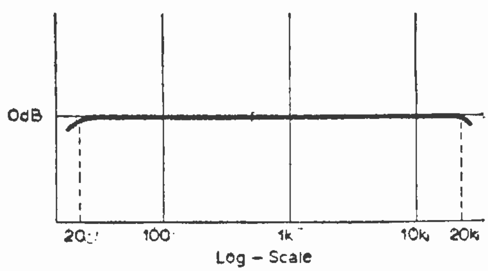
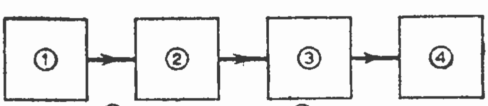


Fig. 1: A frequency response graph. The horizontal scale is measured in cycles per second (c/s).



① Audio generator ② Filter
③ Amplifier under test ④ Wave form analyser

Fig. 2: Illustrating how a wave-form generator is used to test an amplifier for harmonic distortion.

Power Output

With a loudspeaker of average efficiency a low distortion output of 10 to 12W is ample for home listening. Average efficiency is about 7%.

Signal to Noise Ratio

This is simply wanted signal/unwanted signal. Obviously afigure as large as possible is desired here. This figure is quoted in decibels, and a minimum figure of 60dB is required for quality reproduction. Remember that hum and noise are counted as distortion as they are not present in the original signal!

Harmonic and Intermodulation Distortion

Any signal that appears in the output of an amplifier is distortion if not present in the original input signal. The two main types of distortion will be discussed here.

Harmonic

As the title implies harmonic distortion is due to harmonics of the original frequencies being present in the output. This is due to the inherent curvature of valve characteristics, transformer limitations etc. A block diagram in Fig 2 shows how this is measured. A filter removes any harmonics that may be present in the audio

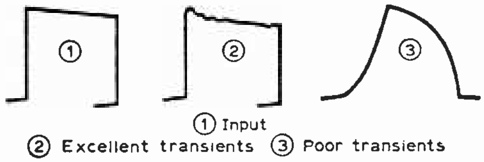


Fig. 3: Investigating transient distortion with square waves.

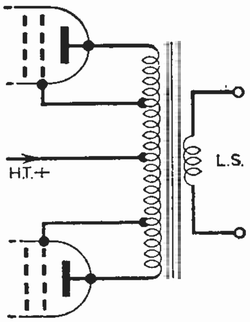


Fig. 4: The "distributed load" output circuit; a variation of the familiar push-pull output stage.

generator. The wave analyser is tuned to harmonics of the applied frequency (usually 400c/s) and the readings are expressed as follows:

D Total

$$= \frac{\sqrt{[(E_2)^2 + (E_3)^2 + (E_4)^2 + \ldots.]}}{\sqrt{[(E_1)^2 + (E_2)^2 + (E_3)^2 + (E_4)^2 + \ldots.]}} \times 100\%$$

where E_1 is the amplitude of the fundamental, and E_2 the amplitude of the second harmonic, etc.

Intermodulation Distortion

Measured by applying a combined high and low frequency to the amplifier (40c/s and 10kc/s). This distortion is due to the two frequencies adding or subtracting, in this case giving 10,040c/s or 9,960c/s. This may occur with any frequencies. The distortion figures for a good quality amplifier are normally of the following order:—Total Harmonic Distortion $\leqq$ 0·2%. Total Intermodulation Distortion $\leqq$ 0·5% for the full output.

Another type of distortion is transient distortion, and although it is rarely mentioned it is none the less important. This appears as the inability of the amplifying system to respond to sudden changes of amplitude and frequency. It is usually evaluated by measuring the rate of decay of a suddenly interrupted steady frequency. If this distortion is severe it is very probable that the frequency emitted at decay would be different from the steady frequency that was interrupted. It is difficult for a listener to differentiate between this type of distortion and that due to resonance. A much more convincing test is carried out by using square waves. See Fig. 3.

It is time now to discuss some typical circuits, their merits and functions.

MAIN AMPLIFIERS

The basic requirements of a main amplifier are low harmonic distortion, linear frequency response, adequate power output, good transient response, low hum and noise level, and low output impedance. The last item on the list has not yet been discussed but will be tackled under Negative Feedback.

Output Stage

The most common type of output stage on a main amplifier is the Ultra-Linear type. This is also referred to as "distributed load" and is a modified form of the conventional push-pull output stage, the tetrode screens being connected to tappings on the output transformer to give a mode of operation between tetrodes and triodes. See Fig. 4.

This distributed load has a number of advantages; less overall feedback is required for a given result giving a greater margin of stability, reduction of harmonic distortion, greater efficiency (36% against 27% for triodes or triode connected tetrodes) and much lower peak variations in current than are inherent with triode output stages.

Damping and Negative Feedback

The damping factor is the ratio of load impedance/output impedance. By applying overall feedback to the amplifier (including the output transformer) the output impedance as seen by a speaker at the output terminals is considerably reduced. As an example a damping factor of 30 would reduce a normal 15Ω output impedance to one of 0·5Ω. A high damping factor or low output impedance improves the transient response of the speaker by bringing it quickly to rest. The principle is much the same as shunting a galvanometer to bring the needle quickly to rest. A little thought here will tell you that from the laws of electro-magnetic induction there will be a current induced in the coil that will oppose its motion.

Some amplifiers have a variable damping control and the range covered is from about 30 to infinity. This helps to attain the critical damping required for less expensive speaker systems —this seems rather fruitless in a hi-fi system. A good quality speaker will gain little with a damping factor greater than about 30, especially if the speaker is properly housed.

Negative Voltage Feedback

This entails that a portion of the output voltage appears in the grid circuit of the input valve. See Fig. 5. From the circuit, and typical figures of 20 volts across the o/p transformer at full output we have

$$\text{Voltage across Rf} = \frac{200 \times 470}{470 + 3{,}600}$$

$$= 2{\cdot}3\text{V}$$

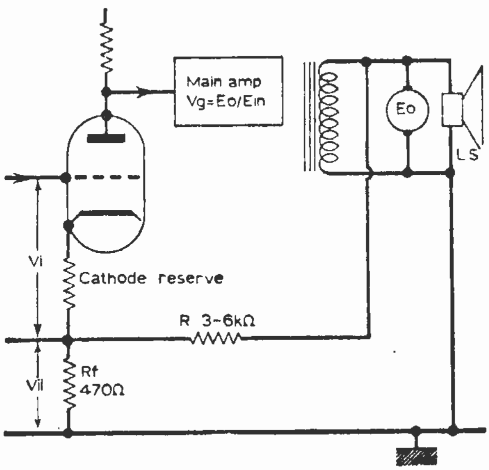


Fig. 5: Negative voltage feedback circuit.

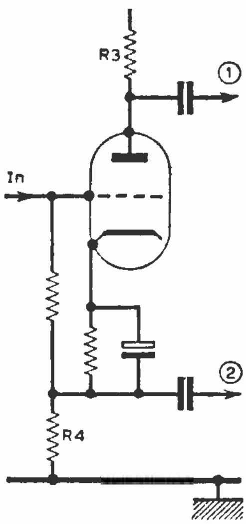


Fig. 6: A cathode-follower phase splitter circuit.

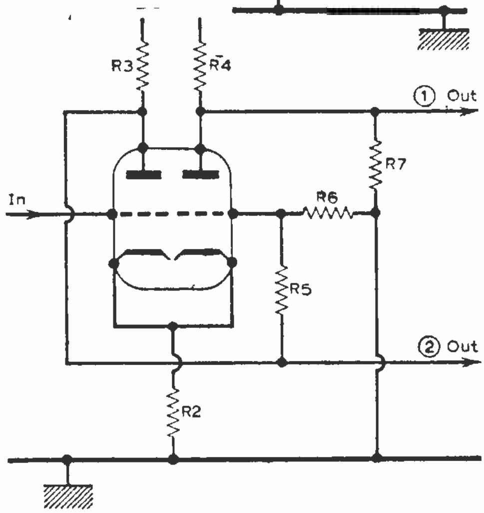


Fig. 7: A cathode-coupled phase inverter stage.

hence the total input now required for full output would be that required for full output without feedback plus 2·3V. The feedback ratio is Vi/Vii.

Instability

One form is transient, and is usually triggered off by a transient signal, the sound tending to be slurry. A good amplifier should be stable even when a capacitive load of up to 2μF or an inductive load of up to 150mH is connected across the output terminals.

Phase Shift

To reduce phase shift at low frequencies the first stage is coupled directly to the phase inverter. To reduce phase shifts in the output transformer at high frequencies a capacitor is connected in parallel with the feedback resistor.

Phase Splitters

There are three basic types. (1) The Cathode Follower. (2) The Paraphase. (3) The Cathode —Coupled.

The Cathode Follower

The criteria for selecting a particular type of phase splitter are linearity, voltage gain, and maximum voltage available. The circuit is shown in Fig. 6. Briefly, the gain is less than unity and the output is fed to the output valve grids. The anode load is split up equally (R3 and R4). The linearity is best for small voltage inputs and matched values of R3 and R4 are essential. The main disadvantage is that the two outputs are at different impedances, the cathode follower being the lower. This phase splitter is also sometimes referred to as the "split load" version.

Paraphase

This consists of one output being fed directly to the grid of one of the output valves; whilst the other goes via a single stage whose sole purpose is to reverse the phase. The gain of this additional stage must obviously be unity.

Cathode Coupled

The circuit in Fig. 7 is virtually self-explanatory; but a brief description will not be out of place. The basic circuit requires that (R5+R6)=R7; and that R5/R6=Vg where Vg is the voltage gain of the first section—this depends on valve used and values of resistors linked with the stage. The omission of the by-pass capacitor across R2 gives a better balance of the two outputs. A modification rarely seen is to split the anode load R3 into two resistors R3a and R3b say, where R3a/R3b=Vg. This also requires an additional capacitor to feed into the grid of the second stage from the junction of these two resistors. The modification extends the high frequency response.

Another variation of this type of phase inverter used for direct coupling to the previous stage is shown in Fig. 8. C3 is to provide correct bias conditions for the second section and together with R2 it controls the low frequency response of this stage.

Input Stages

These are straight amplifier stages with few additions. The two most common are the inclusion of a CR network in the anode of the valve: this produces an advance in phase which increases the stability of the amplifier at high frequencies. The feedback loop from the output stage terminates at the cathode of this stage and occasionally at the grid. A typical stage is shown in Fig. 9. As with all stages preceding the main amplifier the noise level and distortion must be kept at a low level. This is why the resistors in the anode and grid are low noise high stability components.

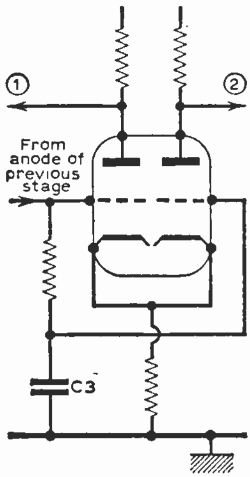


Fig. 8: A variation on the circuit of Fig. 7.

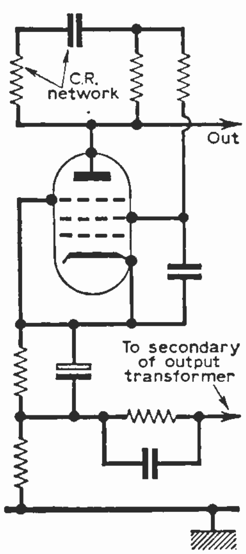


Fig. 9: An input stage of an amplifier in which a CR network in the anode circuit helps stability at high frequencies.

Preamplifiers

Preamplification may be required with the main amplifiers to provide an adequate output with different inputs. The preamplifier also includes treble and bass controls, and can be designed to give compensation for the bass attenuation and treble boost which have been applied by the manufacturers during recording to obtain a better signal to noise ratio. The more comprehensive types also provide equalisation facilities for tape recording and playback.

Hum and noise introduced in the pre-amplifier count as a signal and are further amplified—they are not reduced by feedback. Fully comprehensive pre-amplifiers are very difficult to design as frequency selective networks are likely to produce large phase shifts and hence instability, if they are included in the feedback loop.

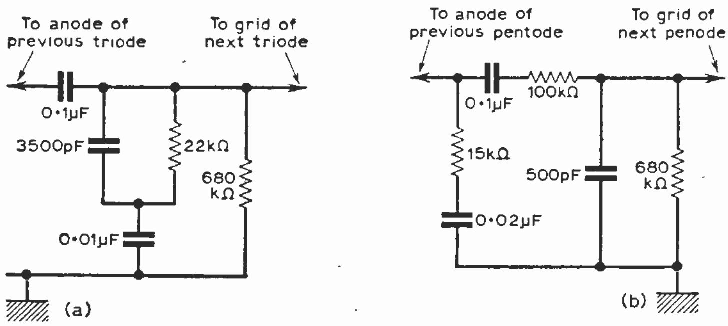


Fig. 10: Record equalisation arrangements for preamplifiers with (a) triode circuits and (b) pentode circuits.

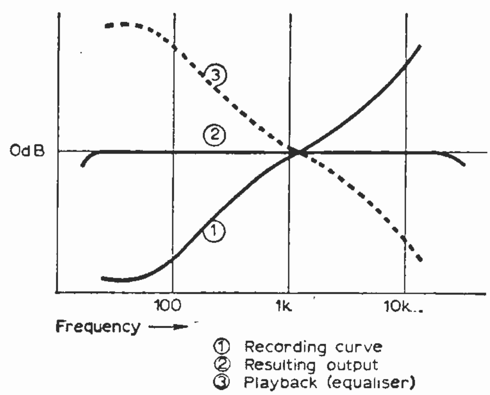


Fig. 10 (c): Illustrating graphically the action and effect of record equalisation.

Record Compensation

The standard at present adopted by most major recording companies is the RIAA characteristic. In this system the low frequencies are reduced on recording and the high frequencies increased: the former prevents one record groove from riding into an adjacent one, whilst the latter improves the signal to noise ratio on playback. In order that the output be the same as, or very similar to, the recorded signal, there must be some facility in the pre-amplifier to re-shape this curve into a dB nought line. The only way that this may be done is to apply an equal and opposite boost or cut to the recording curve as required. This is known as recording equalisation. Two simple circuits are given for use with triode and pentode valves in Fig. 10.

Tape Equalisation

This is slightly more complex, as the equalisation required is different for recording and playback. The dB nought point here is approximately 200c/s and may be compared with that of the disc by subtracting 8dB from the particular make of tape head response.

TONE CONTROLS

There are two main types in use: (1) The passive type. (2) The feedback type.

The Passive Type

This is simply a network of resistors and capacitors that give a purely relative boost or cut. They are always preceded or followed by an additional amplifying stage as they introduce a considerable reduction in signal level. They are, however, flexible if properly designed but introduce a fair amount of phase shift and cannot for this reason be included in a feedback loop.

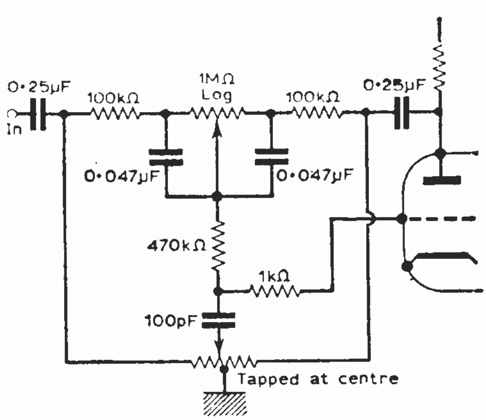


Fig. 11: A typical feedback type of tone control network.

Feedback Type

These are more recent in design and have a considerable advantage over the previous type. A typical circuit is given in Fig. 11 and was designed for an SP61 valve or a modern equivalent. The modern valve must have the same mutual conductance or the bass boost will not be very effective. R1 is linear and R2 logarithmic. The mid frequency gain is unity, so that it may be inserted in circuit with no loss. At an output of 4V the total distortion is under 1%.

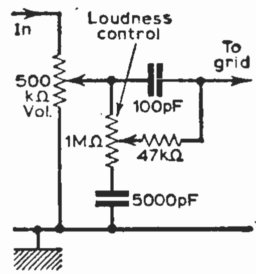


Fig. 12: A loudness control network.

Some other facilities offered by pre-amps. are loudness controls, rumble and scratch filters. Loudness controls compensate for the response of the ear at low output levels. The response of the ear at different output levels is given by the Fletcher-Munson curves. These may be found in a text book on sound. A simple circuit is as in Fig. 12. The loudness control is set so that its slider is furthest away from the 0·005μF capacitor. Next the maximum volume required is set by using the volume control. Volume and bass are now automatically set by operating the loudness control.

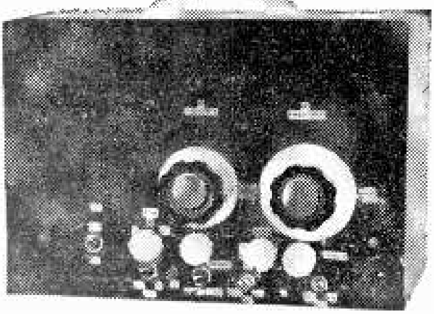
Rumble Filters

These are used to attenuate frequencies below about 35c/s at a rate of at least 12dB per octave. This sort of filter is useful for: (1) Reasonable reproduction off a low grade of turntable. (2) Preventing overload of a main amplifier having a limited low frequency response.

Scratch Filters

These are usually quite comprehensive giving various degrees of cut at different frequencies. This sort of filter is useful for: (1) Acceptable reproduction of worn records. (2) Eliminating side band interference on radio.

The above article has skimmed over a vast and fascinating topic, the sole object is to help you understand in principle at least some of the aspects of amplification and, I hope, kindle some interest that will prompt you to further reading—if this has been achieved in part if not in whole the purpose has been fulfilled. ■



AF/RF

THE author's main interest lies in audio amplifiers, and in order to be able to make any worthwhile assessment of their performance, a fairly good quality audio oscillator is needed. The oscillator to be described here was designed to meet the two basic demands of moderate quality and extreme economy.

The complete signal generator is built on three 7in. x 4in. x 2½in. aluminium boxes. The first contains the power pack, which also provides excess power for use with external equipment, the second houses the audio oscillator, and the third holds a simple r.f. oscillator. If the r.f. oscillator is not required it may be omitted and the case made smaller.

THE CIRCUIT OF THE AUDIO OSCILLATOR

The audio oscillator had to be simple, stable, able to be accurately calibrated, and have a wide range. The multivibrator provides a stable, steady signal and can have a wide range when used in conjunction with a frequency dependent Wein bridge, and it is this type of oscillator that is used in many cheaper signal generators. Its main disadvantage is its poor wave-form, usually being somewhere between a sine and a square wave.

The waveform of the multivibrator can be considerably improved by reducing the gain of one or both of the valves in the loop until a point is reached when the valve is only just oscillating. It is then producing quite a fair sine wave. In this unit, this is done by lowering the value of one of the anode resistors, R3. The value given is just sufficient to maintain oscillation over the whole range, but with some valves it may be necessary to increase it slightly to maintain oscillation.

To obtain the square waveform, an EF91 which was running with about 25V on its anode, was overdriven. This has the effect of clipping the top 80% of the sine wave, leaving quite a good square wave.

The audio oscillator does not provide a constant output over the whole range, and two compensating networks have been introduced to give a lift to frequencies above about 10kc/s, and to those below about 75c/s. R8, R9, C9 all form the treble boost circuit and R16, R17, C14 form the bass boost circuit. These components also form an attenuator to keep the output at the required level to prevent overloading.

The second half of the ECC82 (V2B) is used as a cathode follower output stage. This provides a low output impedance, the output being taken

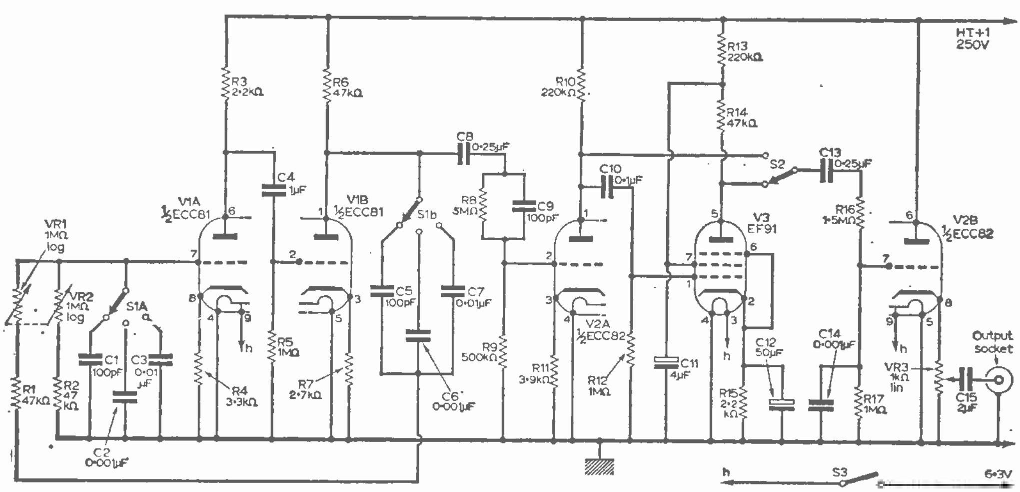
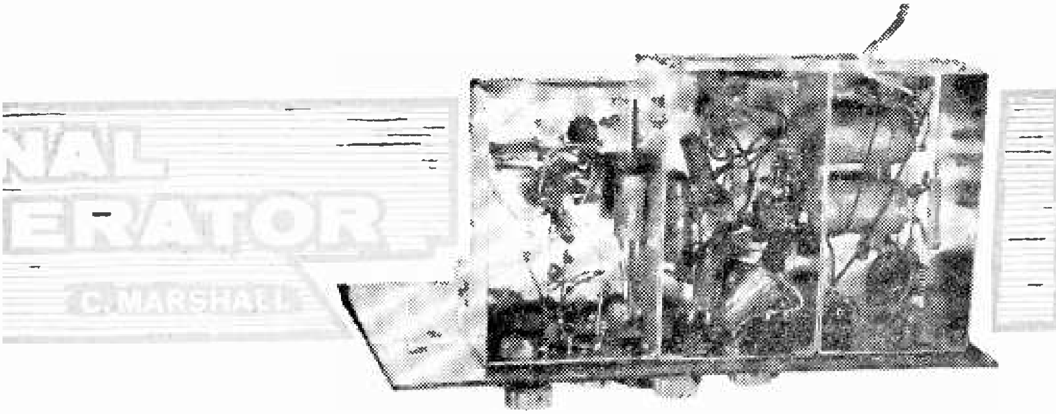


Fig. 1: The circuit of the audio oscillator section of the signal generator. This stage can be built and used as a separate unit.



from the potentiometer in the cathode circuit via C15, a $2\mu F$ capacitor. The unit is therefore suitable for transistor circuits, as well as valves. The power supply circuit is quite conventional. Two h.t. feeds are provided, one for the audio, the other for the r.f.; this is to prevent interaction. A simple filter is included in the mains lead. Better smoothing can be obtained by replacing R28 by a 10H 30mA smoothing choke and reducing the two 4·7kΩ resistors (R26, R27) to 1kΩ. This also makes much better regulation. If the power pack is to be used to supply external apparatus as well, choke smoothing is essential. A larger transformer can be used if extra power is required.

ASSEMBLING THE A.F. OSCILLATOR

The chassis should be carefully marked out as in Fig. 2. The holes on the front panel should be marked with particular accuracy, as with standard sized switches and potentiometers there is only a small margin to spare. Their positioning should be checked with the components to be used before the holes are drilled. The holes on the side are counter-sunk. A small aluminium bracket is drilled to take the fine frequency control and this is firmly bolted to the chassis. The spindle should be about 2in. above the top of the chassis.

Wire-up the frequency band switch (S1a, b) then the fine frequency control VR1, 2. The oscillator valve (V1) is then wired, all leads being kept short and direct as possible to reduce stray capacities to a minimum. This valve should be tested, by connecting it to the power supply and switching on. When a pair of headphones are connected from the anode of V1a to chassis, via a $2\mu F$ paper capacitor; a note of variable frequency should be audible. If oscillation ceases on any part of the band, this is probably due to slightly low gain in V1, and can be remedied by slightly increasing R3. The relative positions of the component are shown in Fig. 3; the connections of the components are omitted to avoid congestion, but they may easily be found by referring to Fig. 1, the circuit diagram.

The whole of the base of V2 should then be wired, leaving C10 "flying" for the time being. The wiring of the waveform switch S2 is included in this part. When the waveform switch is put to "sine", the unit functions fully, providing a compensated output over the range 15c/s—15kc/s at a voltage of about 6V, the amplitude remaining constant on each band within ± 3dB. This should be tested now, and if compensation is not sufficient, it should be altered. Component values for these networks given in Fig. 1 are meant only as a rough guide.

AUDIO GENERATOR COMPONENTS LIST

Resistors:

R1*	47kΩ	R10	220kΩ
R2	47kΩ	R11	3·9kΩ
R3	2·2kΩ 5% H.S.	R12	1MΩ
R4	3·3kΩ H.S.	R13	220kΩ
R5	1MΩ	R14	47kΩ
R6	47kΩ 5% H.S.	R15	2·2kΩ
R7	2·7kΩ H.S.	R16*	1·5MΩ
R8*	1MΩ	R17*	1MΩ
R9*	500kΩ	* See text	

All 10% ¼W carbon unless otherwise stated.
VR1, 2 1MΩ log. twin-gang potentiometer.
VR3 1kΩ lin. carbon or w.w. potentiometer.

Valves:
V1 ECC81 V2 ECC82 V3 EF91

Switches:
S1 2-pole, 3-way S3 On/off toggle
S2 1-pole, 2-way

Capacitors:

C1	100pF mica 2%
C2	$0·001\mu F$ mica 2%
C3	$0·01\mu F$ mica 2%
C4	$1\mu F$ paper
C5	100pF mica 2%
C6	$0·001\mu F$ mica 2%
C7	$0·01\mu F$ mica 2%
C8	$0·25\mu F$ paper
C9*	100pF mica
C10	$0·1\mu F$ paper
C11	$4\mu F$ electrolytic
C12	$50\mu F$ electrolytic 12V
C13	$0·25\mu F$ paper
C14*	$0·001\mu F$ paper
C15	$2\mu F$ paper 150V

All 350V unless otherwise stated
* See text

Miscellaneous:
Two B9A and one B7G valveholders. 7in. x 4in. x 2½in. aluminium chassis. Output socket, etc.

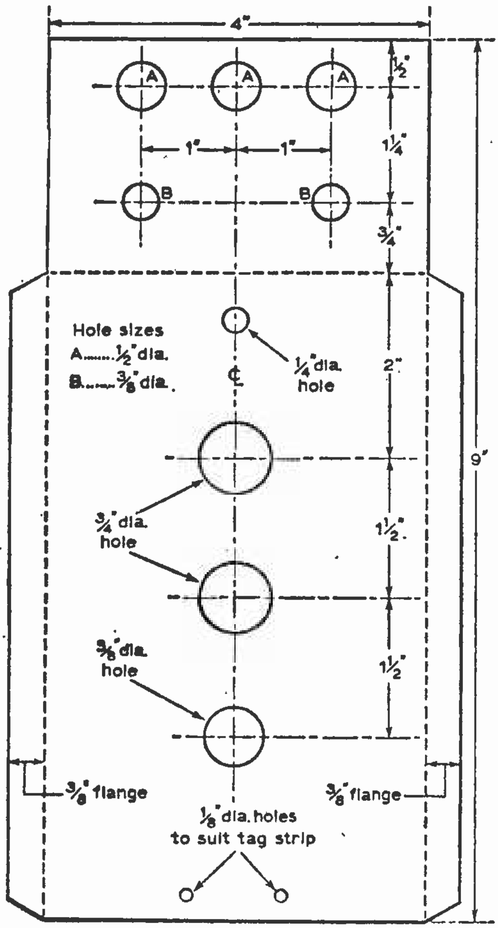


Fig. 2: Drilling layout for the audio oscillator chassis. Dimensions may have to be altered for different components.

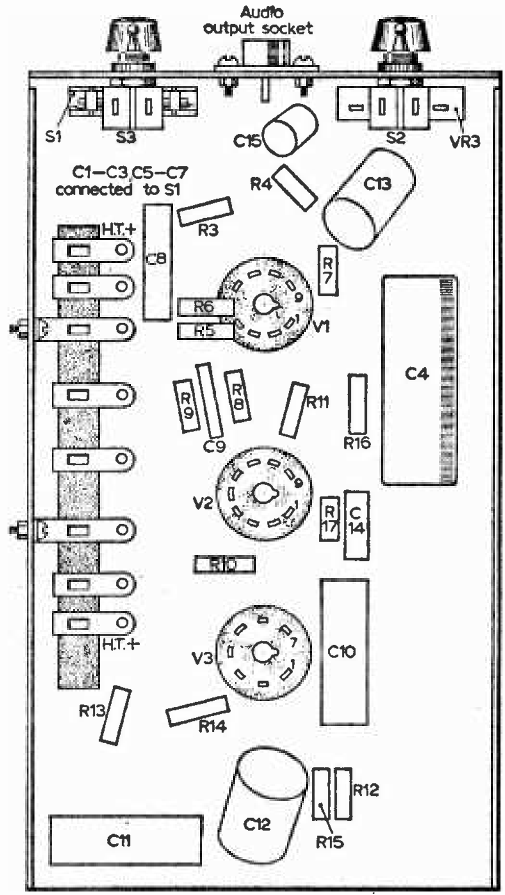


Fig. 3: Component layout from the underside. Valve-holder spigots should be taken to chassis. VR1, 2, R1, R2 are above the chassis.

THE COMPENSATING NETWORKS

R8, R9, C9 form a high-pass filter increasing the gain as the output falls at the higher frequencies. R9 should be 500kΩ. R8 is adjusted to give about 13V r.m.s. at the anode of V2a at a frequency of about 5kc/s. Various values of C9 may be tried, to find a value that will raise the output at the highest frequency, yet not affect the lower frequencies too much. If the output at V2a anode rises to about 15V r.m.s. at any point, R8 should be increased a little, and the value of C9 altered.

When satisfaction is gained here, attention can be turned to the low-pass filter C14, R17, R16. This boosts the output at the low frequency end of the scale. R16 is adjusted to give about 5·5V r.m.s. output at the cathode of V2b at 20c/s. C16 is then experimented with, to keep the level of signals above 50c/s, below 6V r.m.s.. If the output rises above 6V, distortion will begin in the output stage. When this stage is working correctly, final adjustments should be made to the first network to give the correct output. A final check on the constancy of the output should be made.

COMPLETING THE UNIT

The EF91 (V3) should now be wired. All wiring should be as used in v.h.f. circuits—extremely short and direct. An impaired high frequency response here means a worsening of the rise time of the square wave. The EF91 is a valve designed for high frequency use, and this is one reason for its choice for this function. The other is its low cost.

When all the wiring is complete, it should be checked for constructional errors and short circuits. A pair of high impedance headphones may now be connected to the coaxial output socket and the unit fully tested if a power supply is available. If not, a suitable unit will be described next month.

Check that the frequency controls are fully variable, that the sine/square switch works (smooth and rough note) and that the output control is functional. Check the compensation (with a sine wave, into a resistive load).

CALIBRATING THE AUDIO OSCILLATOR

When the author had built the audio oscillator he was faced with the problem of calibrating it. As he had no access to an oscilloscope he decided on using a frequency dependent Wein Bridge network. The circuit and method of using this network is given in Fig. 4a.

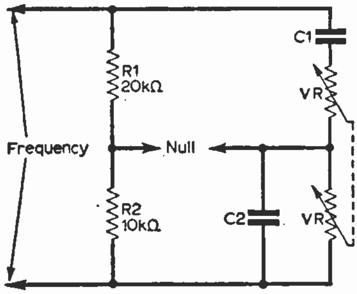
R1 should be as near as possible twice R2, measured on an ohmeter. Values of about 20kΩ and 10kΩ are about optimum. The frequency of the network giving null on the indicator is then given by

$$F = \frac{10^6}{2\pi RC}$$

where R is the resistance of one half of the double variable resistor VR (both halves always equal) in ohms, and

$$C = \sqrt{C1^2 + C2^2} \text{ in } \mu F.$$

If C1 = C2 then C also = C2 or C1.



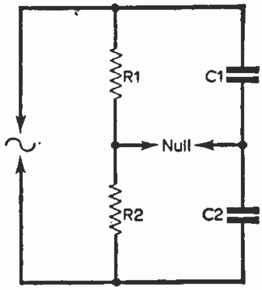


Fig. 4a (left): The frequency measuring circuit VR is a 1m Ω twin-gang log. potentiometer. Fig. 4b (right): The bridge circuit.

R1 and R2 are opposite halves of a potentiometer, measured on the ohmeter. When the value of C2 has been found, calculate the value of C, then connect up the frequency measuring bridge.

Fix a temporary scale, marked in degrees, onto the frequency control, and turn to the highest frequency and switch to the highest range. Rotate the variable resistance until a null, or lowest reading is obtained. Measure the resistance of VR and note it. Turn the control down about 30° and repeat. When the whole range has been thus noted, repeat the procedure twice more for each dial setting, then take the average. An example of the table is given in Table 1.

When range 3 has been calibrated, turn to the highest frequency of range 2. Take three resistance readings at this dial setting. Take the average

TABLE 1

1st R Value	2nd R Value	3rd R Value	Average R	C	RC	2πRC	F	Range	Dial
90kΩ	92kΩ	88kΩ	90kΩ	0·013μF	1,147	7,350	136c/s	II	20°
75kΩ	85kΩ	80kΩ	80kΩ	0·013μF	1,040	6,300	159c/s	II	60°
27kΩ	29kΩ	30kΩ	29kΩ	0·013μF	380	2,400	420c/s	II	100°
15kΩ	17kΩ	16kΩ	16kΩ	0·013μF	204	1,300	760c/s	II	150°
12kΩ	12kΩ	12kΩ	12kΩ	0·013μF	156	980	1·02kc/s	II	200°
7kΩ	7kΩ	7kΩ	7kΩ	0·013μF	91	565	1·77kc/s	II	250°

The null indicator may be a low-reading a.c. voltmeter or a magic eye.

Using an ordinary bridge circuit, compare the value of C1 (a 1,000pF 1% mica capacitor). A circuit is given in Fig. 4b. Here,

$$\frac{C2}{C1} = \frac{R1}{R2} \text{ at null}$$

$$C2 = \frac{C1.R1}{R2}$$

resistance and calculate the frequency. Replace C1 and C2 by two nominally 0·01μF capacitors, and take three more resistance readings.

As the dial has not been moved, the frequency must still be the same, therefore R.C. must still be the same. From this a new value of C can be found, which is used for calibrating range 2. This value of C corresponds also to $\sqrt{(C1^2 + C2^2)}$.

Repeat the above instructions to calibrate range 2. and also the highest frequency of range 1. Replace the two capacitors by two more, of say 0·1μF., and find the corresponding value of C. Calibrate range 1.

—continued on page 73

Correspondents

I AM 14 years old and my hobbies are short wave listening and electronics. I would like to correspond with readers who share these interests.

Rashad Mohamed.
9/13 Eldhams Road,
Madras—18,
South India.

Competence

I HEARTILY agree with Mr. Collister's letter in the February issue. However, I would go further and suggest that no one can call himself a competent constructor until he has designed some of his own circuits.

No really competent constructor would ever contemplate the use of International Octal valves, except in the rare case where he needed high powered valves (i.e. 807's). Manufacturers will not even look at an I.O. valve now we are in the transistor age, so why should the constructor? I am sure that P.W. could take the lead in this, and not publish circuits using out-of-date valves. In the last 12 months, circuits using over 30 standard valves have been published in it, and considering they could easily be replaced by more efficient miniature valves, it would seem highly desirable to do so. So let's see a little less of the 6K8's, and 6V6's and more ECH81's and ECL86's.

R. A. Packer.
Sevenoaks,
Kent.

Some circuits feature Octal-type valves because so many constructors have stocks of these in their "junk boxes". We get many letters requesting designs based on these valves from beginners and "old timers" alike.—Editor.

Correspondents

I WOULD like to correspond with a boy of my own age (13½) who has a tape recorder (with a view to tape messages) and an interest in short wave radio.

M. Moulsdale.
Forest House,
Sandiway,
Nr. Northwich,
Cheshire.

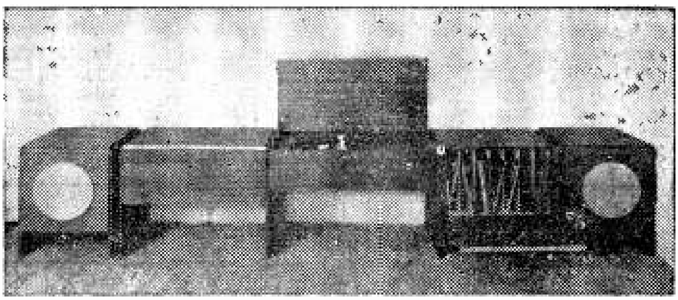
NEWS AND.

A CALLSIGN THE HARD WAY

Ronald Vincent of Cricklewood, London, took less than a year to pass the G.P.O. Morse Test and the City and Guilds R.A.E. which allows him to transmit under the callsign G3TXB. Not a remarkable feat under normal circumstances, perhaps, but a tremendous achievement if you are both blind and handless like Ron Vincent.

Mr. Vincent, who is a member of St. Dunstan's, lost his sight and his hands in World War II while serving with the Royal Artillery, but with the help and guidance of a friend, he has overcome these disadvantages and obtained his "ticket". Now with his own s.s.b. transceiver, fitted with a tuning device which audibly tells him when the transmitter is accurately tuned, he is regularly making amateur contacts throughout the world.

DO-IT-YOURSELF EQUIPMENT HOUSING



The hi-fi installation above is a combination of individual units all made from "Vipboard". "Vipboard" is veneered chipboard which is available in a large number of standard sizes. The edges as well as both faces of the board are veneered and the surfaces are sanded ready for finishing. All this greatly simplifies cabinet construction especially if "Vipboard" designs, such as these new audio equipment housings, are adopted. The installation illustrated is only one of a large number of combinations of units which can be achieved to house tuners, tape decks, record decks, amplifiers, records and loudspeakers.

Free instructions for these designs are available from G.W.E. Boards Ltd., 6 John Street, London, W.C.1, or from do-it-yourself shops.

OUT—ONE I.F. STAGE

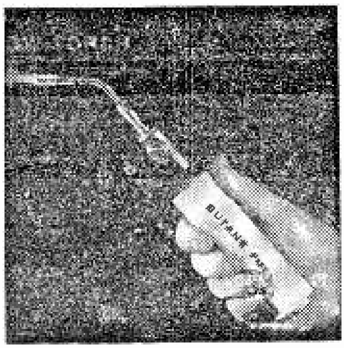
A new development by Mullard which will probably cut down the number of i.f. stages in domestic transistor radios, was announced recently. This development is a new r.f. transistor designed for use at frequencies up to 100Mc/s, with a high-gain, low-noise, good power-efficiency performance.

The Mullard type number for the transistor is BF115. It is, in fact, a silicon epitaxial planar device having high forward gain, coupled with a low value of feedback capacitance. These features enable a high overall gain to be achieved which means that in some applications, at least one stage of i.f. amplification can be dispensed with.

..COMMENT

POCKET BLOW-TORCH

There are times, even with radio work, when an ordinary soldering iron has not sufficient heat capacity to make a satisfactory joint in a short time, and when a healthy gas flame would do a much better job. Previously this would have involved special equipment but now Henri Picard & Frere Ltd. (34 Furnival Street, London, E.C.4) are marketing a hand-held blow-torch which screws directly on to an ordinary gas lighter refill.



The device—called the "Supa Nova"—will provide a flame up to 3in. in length, with one refill lasting from 1½ to 2¼ hours.

DIAL " WHITEHALL 1212 "

When Scotland Yard moves to its new building at No. 10 Broadway, Westminster. next year, its world-famous telephone number, "Whitehall 1212" will go with it. But it will be a completely new telephone exchange which handles all calls to that number.

Standard Telephones and Cables Limited will instal the new 1,800-extension exchange as well as a 150-line automatic teleprinter exchange.

PIPELINE COMMUNICATIONS

In the face of strong international competition, an order worth well over £½ million has been placed with The Marconi Company by Sui Northern Gas Pipelines Ltd. of Karachi. This order is for telecommunications and other equipment for the first 300 miles of a new natural gas pipeline to be laid in the northern part of West Pakistan. This pipeline will run from Múltan—a pipeline terminal fed from one of the world's largest natural gas fields at Sui—to the major industrial centres of North Pakistan.

The Marconi equipment, which will comprise a v.h.f. multi-channel communications system, will follow the route of the pipeline to provide full telemetry, telephone and teleprinter facilities. A standby h.f. radio system will also be installed under the contract.

NEW PORTABLE PROFESSIONAL TAPE RECORDER

A new portable professional tape receiver, which weighs only 10¾ lb., is announced by EMI Electronics Ltd., Hayes, Middlesex. Facilities incorporated in the new model (type L4) include provision for a fourth magnetic head for sound sync for film recording, remote control, press-button operation and mixing for two mic. inputs.

Power is supplied by a 14V rechargeable battery and the recorder is available in half and full track versions.

Leader Changes

I WOULD like to congratulate you on the new presentation of the " leader page ". I think that the way the contents are set so that the article subject, the author and the page number, can be seen at a glance, will prove very handy when looking through old issues for that " elusive article".

Keep up the good work, this new style of presentation gives new life to the magazine.

S. Milton.

Woodford Bridge,
Essex.

Ex-government Equipment

I WAS pleased to see the article on s.s.b. reception for the R1155 by Mr. McKinney (P.W., April issue).

With so much ex-government equipment still on the market, it is always good to see these modifications as they give the constructor a chance to obtain first-class equipment at a very moderate price, and apart from P.W. articles, information is almost non-existent.

G. Fry.

Harlow,
Essex.

Tapespondents

I WOULD like to tapespond with any ham/s.w.l. enthusiasts. My tape recorder is a Robuk (3-speed, 7in. spool). All tapes will be answered. My age is 37, but I will be glad to hear from any age group.

R. Moseley.

80 Gordon Street,
Northampton.

Correspondents

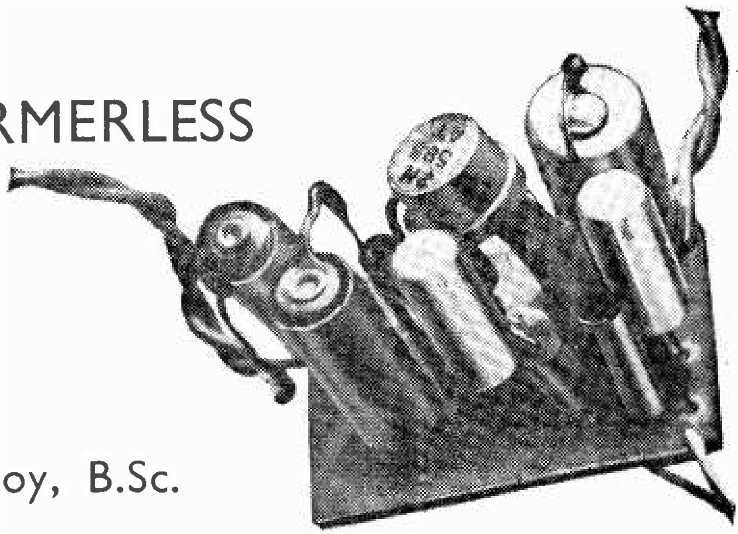
I AM interested in radio and electrical servicing as well as ham radio. I would be delighted to correspond with radio amateurs and Servicemen from any country.

N. J. Weerasuriya.

9/1 St. Peter's Lane,
Moratuwa,
Ceylon.

TRANSFORMERLESS

Transistor Amplifier



By A. J. McEvoy, B.Sc.

A THREE-TRANSISTOR PRINTED-CIRCUIT DESIGN

SINCE the introduction of the transistor it has become standard practise to employ a pair of transistors in class B push-pull in the audio output stages of portable apparatus. This is done in order to obtain a reasonable power output with due regard to battery economy.

Amplifier Outputs

However, at the start, expensive transformers were required, one as phase-splitter to ensure that opposite halves of the cycle were applied to each transistor, and the other to match the output of the transistors to the loudspeaker. Some years ago, use of this second transformer was rendered unnecessary by the introduction of the single-ended push-pull arrangement using a loudspeaker of higher impedance to match the output directly. The driver transformer is also eliminated so that an even smaller and cheaper output stage is made possible with no loss of performance. In this circuit use is made of the now familiar n-p-n junction transistor. This device is a "mirror image" of the more familiar p-n-p type, that is, all the polarity-dependent properties are reversed. Therefore, if a

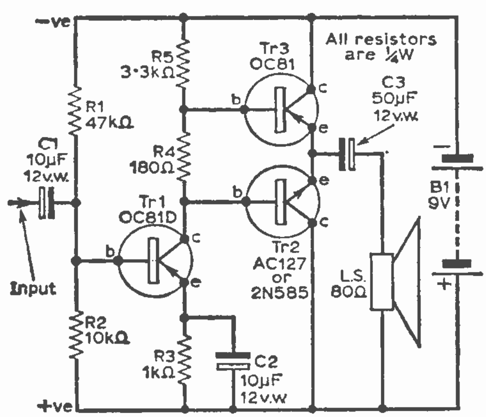


Fig. 1: The three-transistor, transformerless circuit of the amplifier.

COMPONENTS LIST

Resistors:

R1	47kΩ	R4	180Ω
R2	10kΩ	R5	3·3kΩ
R3	1kΩ	All ¼W carbon	

Capacitors:

C1 10µF electrolytic 12V
C2 10µF electrolytic 12V
C3 50µF electrolytic 12V

Transistors:

Tr1 OC81D Tr3 OC81
Tr2 AC127 or 2N585

Miscellaneous:

B1 9V battery
80Ω loudspeaker. Piece of copper-clad paxolin laminate. Some concentrated ferric chloride, (see text).

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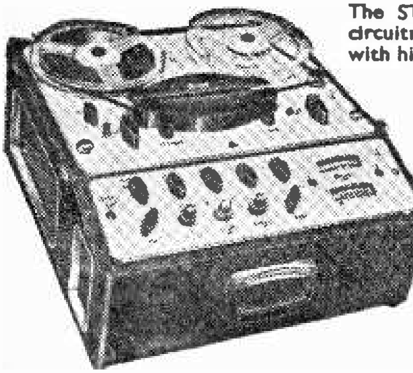
STB2 - STB2 - STB2

ANOTHER BRILLIANT DESIGN from BRENELL



The STB2 is a masterpiece in mechanical engineering and electronic circuitry. It is a versatile mono/stereo tape recorder and has been designed with high fidelity stereo installations particularly in mind.

SPECIFICATION (STB 2/5/2)

It has all the standard Brenell features of 4 tape speeds, frequency correction at all speeds, three Papst outer rotor motors, pause control, monitoring and superimposing, 8¼in. dia. reels, fast rewind, etc., plus—adjustable attenuators on all input channels to ensure perfect matching with all auxiliary equipment—dual concentric recording level and playback level controls—cathode follower output—four channel mixing on mono programme sources—twin recording and twin playback pre-amplifiers—comparison of original and recorded signal—adjustable bias level—recording facilities for 1/2 and 2/2 track—playback facilities for 1/2, 2/2, 1/4 and 2/4 track—sound on sound facilities—two edgewise meters for recording level, tape output level and bias level—optional extra: stereo power amplifiers and monitoring speakers.

ALTERNATIVE MODEL STB 2/510/2 has special deck to accommodate 10½in. N.A.B. reels.

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DAF96	6/6	ECC82	5/-	EF92	4/-	EZ81	5/6	PCL85	7/6	U191	13/6	UY85	5/6	6A7	12/6	6CD6G	25/-	6V6GT	7/6	12BE6	7/6
DF91	3/-	ECC83	5/6	EF98	10/-	GZ32	12/6	PCL86	10/-	U301	18/6	VP4B	17/6	6A8	8/6	6CH6	10/-	6X4	4/6	12K7GT	5/-
DF96	6/6	ECC84	6/6	EF183	9/-	HL41DD		PL36	11/6	U801	19/6	VR150/30		6AL5	3/6	6C6	5/6	6X5G	5/-	12K8GT	10/-
DK91	5/6	ECC85	6/-	EF184	8/-		12/6	PL81	7/6	UABC80	5/6		7/-	6AM6	4/-	6F6	5/9	6X5GT	8/6	12Q7GT	6/-
DK92	7/-	ECH35	12/6	EL33	17/6	KT66	17/6	PL82	7/6	UAF42	8/6	W81M	6/-	6AQ5	6/6	6H6	2/-	6/30L2	12/6	12SQ7	12/-
DK96	7/6	ECH42	8/6	EL41	9/-	KT81	10/6	PL83	7/6	UBC41	13/6	X61M	13/6	6AT6	4/6	6J5G/GT		7B6	21/-	19AQ5	8/-
DL92	5/-	ECH81	7/-	EL42	9/-	KTW61	7/-	PL84	7/-	UBF80	7/6	X78	26/-	6B8G	2/6		5/6	7B7	9/6	25Z4	7/6
DL94	7/-	ECH83	5/9	EL84	5/9	MU14	17/6	PY32/3	10/-	UBF89	7/6	X79	40/-	6BA6	5/6	6J7G	5/-	7C5	10/6	35L6GT	8/6
DL96	6/6	ECL80	6/6	EL95	9/6	N78	22/6	PY81	6/-	UCH42	8/6	1R5	5/6	6BE6	5/6	6K7G	2/-	7C6	9/6	35W4	6/6
EABC80	5/6	ECL82	8/6	EM80	8/-	OZ4	5/-	PY82	5/6	UCH81	7/-	1S5	4/6	6BJ6	8/-	6K7GT	2/6	7H7	6/-	35Z4	6/6
EAF42	8/6	ECL86	8/6	EM81	8/-	PCC84	6/-	PY83	7/6	UCL82	8/6	1T1	3/-	6BR7	10/6	6K8G	4/-	7S7	18/-	50C5	8/6
EB91	3/6	EF41	7/6	EM84	8/-	PCC89	8/9	PY800	8/6	UCL83	9/-	3T4	5/-	6BR8	12/6	6K8GT	9/6	7Y4	6/6	80	7/6
EBC41	8/-	EF80	5/-	EY51	7/6	PCF80	7/-	PZ30	12/6	UF41	7/6	3V4	7/-	6BW6	9/-	6L6G	7/6	8D3	4/-	90CG	25/-
EBF80	7/6	EF85	5/-	EY86	7/-	PCF86	9/6	8B61	3/-	UF89	7/-	5U4G	4/-	6BW7	9/-	6Q7G	6/-	10F1	10/-	99CV	25/-
EBF83	8/-	EF86	7/-	EZ40	7/-	PCL82	7/6	U14	9/-	UL41	7/6	5V4G	9/-	6C4	3/6	6Q7GT	10/-	12AU7	5/-	807	9/6

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signal is fed equally to a p-n-p and a n-p-n transistor, both biased in class B, opposite half-cycles are amplified; a separate phase-splitter is not required.

The Circuit

The circuit employs a conventional p-n-p common-emitter driver, directly coupled to the p-n-p/n-p-n pair. R4 is inserted to eliminate cross-over distortion by ensuring that both transistors draw some current throughout the cycle. The circuit of Tr1 is arranged so that, with 9V h.t., the emitters of Tr2 and Tr3 are at approximately 4·5V, and each has thus a slight forward bias, built up across R4. The characteristics of Tr2 and Tr3 should be closely matched, and such pairs are now available, although instructions are given below for a method of compensating for any mismatch.

The Printed Circuit Board

The prototype, after "breadboard" development, was assembled on a printed circuit, and this version will now be described. Fig. 2 shows the layout of the copper-clad paxolin panel used. Holes were first drilled for the components, and then those portions of the copper foil which were to form the conductors varnished. The unwanted copper was then unprotected, and was removed by etching in concentrated ferric chloride This process was described a number of times in more detail by previous writers in this magazine.* On completion of the etching process, the circuit panel was cleaned and the components mounted and soldered to the conductors. The transistors were added last of all.

Testing

A test may now be made with a suitable signal input, e.g. a crystal mike or gram. pick-up. The unit should draw about 3mA with no input and up to 13mA at full output. This output should be comparable in volume and quality with that of conventional units. If distortion is noticed, it may be that the input signal is too high and is overdriving the unit. However, if it persists at a lower input, it is probably due to mismatch of the output transistors, and this can be compensated for to some extent by a suitable change of the working points of the output transistors. Now R3 sets the bias of, and hence the current in, Tr1; and thus it fixes the operating conditions of the output pair, since the base and emitter voltages depend on this current. Temporary substitution of a variable (say a 5kΩ, which could later be used as a volume control) would enable a suitable value to be chosen easily.

The writer considers that many constructors will have applications at hand for this type of unit, and therefore a discussion of its employment is omitted. As well as its immediate practical uses, it is an interesting introduction to the possibilities opened up by the introduction of the n-p-n transistor. ■

* 'The Home Production of Printed Circuit Boards' by H. W. Rutt, October 1963, "Practical Wireless."

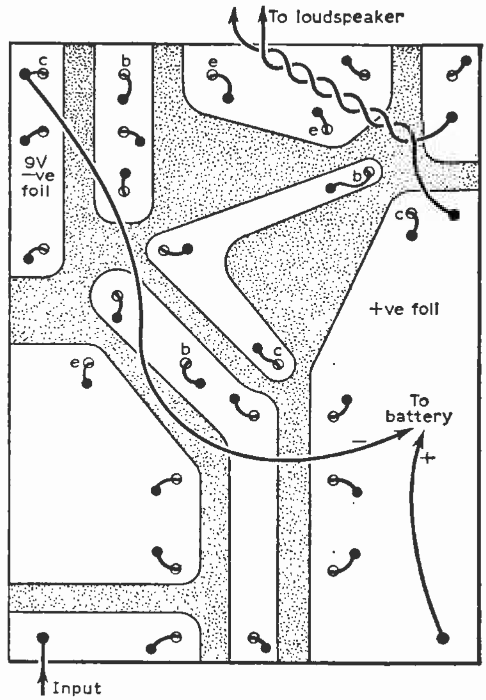


Fig. 2: The layout for the printed circuit. The shaded portions are etched clean of the copper.

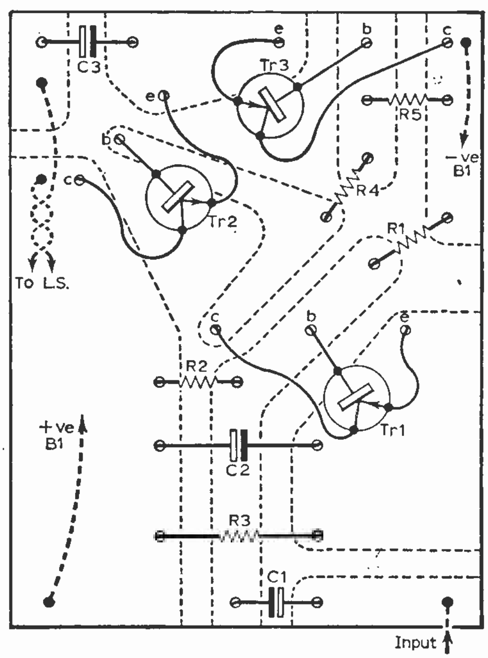


Fig. 3: The layout of components on the plain side of the board. The actual size of the board is 1in. x $1\frac{3}{8}$in.

A COMMENTARY BY HENRY

PRACTICALLY WIRELESS

No. 9 Space Age Spawn

FACT has a nasty habit of catching up with fiction. Yesterday's wonders are old hat tomorrow, so we spend today churning out prophecies, sure that some of our random shots will score bulls-eyes. Or, Cassandra-like, bemoan the march of progress that we see carried to frighteningly logical conclusions.

Our sympathy goes out to the Luddites, even modern ones who object to tape recording transcripts in the hallowed halls of justice. As one who developed part of his thick skin by indulging in a short spell of time-and-motion study Henry feels a twinge of *rapport* with enthusiasts like C. J. Collister (*Letters to the Editor*, January, 1965), who worry about the prefabrication of our hobby.

This worry goes deeper, as any student of the radio trade will know. The educationalists, for example, look with trepidation to the TV-teaching techniques that are now almost a necessity with the explosion of learning population and the dearth of competent instructors.

Until the designers bring out a monitor screen that will yell *Wake up at the back there* at the first signs of inattention we feel the day of the tutor is not over.

A monitor screen that will yell.

But let's carry it a bit farther. Why bother to learn electronics at all? After all, as IBM have already stated, the formal circuit designer cannot hope to compete with a properly programmed computer. "Reliable circuit design" (their quote) can be better performed by a machine than a man.

All right, let's all concentrate on the mystique of programming. After all, the heroes of the women's magazines, who were once airline pilots or heart surgeons just out of medical school, are now computer programmers—hadn't you noticed?

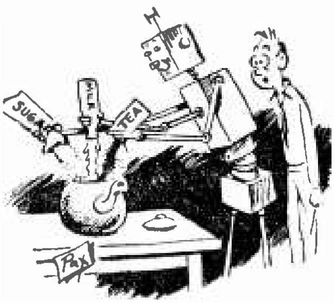
You can forget about *that* idea—it's already out of date! Again quoting, this time from "New Thinking" in *Electronics Weekly* of January 13: *One of the stumbling-blocks which have to be overcome in extending the use of computers is the human dislike of admitting that many routine but nevertheless skilled designs tasks can be performed better by one of these "idiot" and "stupid" machines than by arduously learned human skills.*

Given the original inspiration of a human brain the computer can be made to design a circuit, supervise the machinery that will assemble it, cross-check for errors and even modify to improve its own design.

You see where this is leading? One of these beasts can now *design* and *build* another.

This concept at first leaves me rather breathless . . . until I think again of that "H" factor. No matter how carefully the programmer checks his dots, how rigorously the error test is applied, it only needs one tiny fly in the ointment to throw the whole project out of gear. With automation on this scale 99·9% reliability is not enough.

Do you need more reassurance? Then turn to the fairly



Performed better by machines.

recent criticisms of both the Society of Electronic and Radio Technicians and the Television Society. At a meeting of SERT it was claimed that many well-qualified service engineers were leaving the radio trade to go into industry. Their reason was not lack of pay or slave-driving conditions but a *dislike of the design and the quality of construction of some of the current TV models.*

In the ensuing correspondence in the trade Press—which has to be seen for its acrimony to be believed—one quotable phrase was: " . . . *jungle circuits may be needed in these designs but there is no excuse for jungle layouts*".

He has a case. Any radio enthusiast who worries about his "kitchen-table construction" need only take a glance at some of the latest TV receivers to gain fresh confidence. Bits and pieces hang everywhere like decorations on a Christmas tree. All done in honour of the great god "Production Economy".

So Henry has no fears for our electronic future. Let the Tin Men proliferate as they will—but so long as a radio bod can *make* a set, instead of merely assembling a standardised receiver, his contribution is still acceptable.

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BOOKS REVIEWED

PHILIPS PAPERBACKS

Prepared by Centrex Ltd., Eindhoven, a subsidiary of N. V. Philips. The English editions are distributed in this country by Iliffe Books Ltd.

All have the same page size ($8\frac{1}{2}$in. x $5\frac{1}{2}$in.) and are square back bound with glossy stiff card covers.

The first three in the series were reviewed in the January 1965 issue—the four following reviews complete the story on the first batch of titles.

P4: DIRECT CURRENT AND MAGNETISM
120 pp., 92 illus. Price 10s. 6d.

P5: ALTERNATING CURRENT AND ACOUSTICS
116 pp., 86 illus. Price 10s. 6d.

P6: RADIO VALVES
126 pp., 90 illus. Price 10s. 6d.

P7: A. F. AMPLIFICATION
109 pp., 82 illus. Price 10s. 6d.

THESE four books form the first part of a radio servicing series and are based on the original *From the Electron to the Superhet* by J. Otte, F. Salverda and C. J. Van Willigen. The present editions are edited by Edgar J. Black.

The books follow much the same pattern as the other Philips paperbacks to which, of course, they form companion volumes. All are written in simple language and each chapter is followed by a short summary of the ground covered, together with a few test questions.

Direct Current and Magnetism starts off at the ground floor, giving an easy-to-read account of basic electrical theory, the actual coverage of the volume taking in the nature of electricity and its behaviour, resistors, batteries and accumulators, magnetism and meters. This is all good basic material, highly suitable for the raw beginner. The text is enlivened with some good illustrations which go a long way to put over the points being discussed.

Alternating Current and Acoustics is really in two parts. The first deals with the origin and generation of alternating current, the construction of coils and capacitors and the effect of R, L and C on alternating current. The second part covers the nature of acoustics and the construction and operation of the various devices used for sound recording and reproduction.

Radio Valves deals in the established pattern with the equipment needed for the reception of radio waves, the amplification and demodulation of signals, power supplies and, of course, the radio valve itself.

A.F. Amplification elaborates on the audio side of things but also covers oscillators of various types, r.f. amplification, a.g.c. and some notes on measuring instruments.

It will be clear from the above that the titles of each individual volume are to some extent titles of convenience, since there is a certain amount of overlapping between the adjacent volumes. This is to be expected, perhaps, when a larger work is being chopped up into more manageable portions. If one is buying the complete series of books no problems arise, but it might prove disconcerting for a purchaser to obtain, for instance, **A.F. Amplification,** only to find that half the book does not deal with a.f. at all!

This reservation apart, however, a reviewer can only highly commend these volumes as extremely good value for the beginner to radio work. Read in sequence they will provide a good insight into the understanding of what makes radio work.—*W.N.S.*

TRANSISTOR CIRCUIT MANUAL
By Allan Lytel
Published and distributed in U.K. by W. Foulsham & Co. Ltd.
255 pp., $8\frac{1}{2}$in. x $5\frac{1}{2}$in. Price 35s.

DO you know anything about transistors? Could you draw out from memory or know where you could lay your hands on a particular circuit? Let's see—how about a diode f.m. transmitter or a 300V regulated power supply? What about a self-excited 70Mc/s oscillator, a tunnel diode square wave oscillator or a 125W class B push-pull amplifier? Been caught out yet? Because if not it is easily possible to list over 200 different circuits using transistors with no more to hand than the "Transistor Circuit Manual".

This contains in one volume just about every conceivable application from a non-saturated flip-flop to a UJT timer. Nearly all circuits are accompanied by text which explains their function, use and the action of the circuit. There can be little doubt that this work would be a decided asset to anyone interested in semiconductor devices.

However, although the book is one of the most interesting it is also one of the most frustrating. In many of the circuit diagrams an odd component is not marked and no value is given in the text. This is particularly so in the case of coils and/or transformers. PP 174 depicts a self-oscilliating mixer 6—26Mc/s and components are marked C1, C2. etc., but no values at all are given. The only information furnished is the transistor type and the battery voltage. Again, in the circuit depicted on page 103 one SCR is unmarked and a variable resistance is shown briding two 3·9kΩ fixed resistors, but this has no value assigned to it and no mention is made of it in the text.

There are numerous omissions of this nature throughout the book and although this volume made interesting reading this lack of odd component values did rather tend to spoil what would otherwise be a very excellent book.—*D.J.G.*

TAPE RECORDERS—HOW THEY WORK
By Charles G. Westcott and Richard F. Dubbe
Published and distributed in U.K. by W. Foulsham & Co. Ltd.
177 pp., 8½in. x 5½in. Price 24s.

A TOME of knowledge suitable for all who possess, or are interested in tape recorders. Contained in its 177 pages is a full and interesting discussion of practically every aspect of the subject.

The enthusiast will gain knowledge, knowledgeable ones will gain enthusiasm and even the group of hi-fi types whose sole delight is splitting hairs over trifling details will benefit. They will, of course, continue to split hairs but after reading this volume will be able to do it with greater technical accuracy.

The book is sensibly divided into chapters in such a way that each section of the tape recorder can receive adequate discussion. Bias oscillators have a complete chapter all to themselves as have equalisation circuits, record/playback and erase heads, drive motors, and there are, in fact, 11 such divisions each treating a different facet of recording.

The text is simply written and although such a subject is of necessity technical by nature, the reader is not dragged into boring discussions with pages of higher mathematics. As this is an American publication there is a two-page introduction which carefully points out any differences in the text which might confuse.

Many interesting and useful circuits are given complete with values and there are numerous illustrations and photographs especially in the section dealing with the mechanical side.

This book can confidently be claimed as a useful addition to any bookshelf not only from an interest point of view but also as a source of reference.—*D.J.G.*

PRACTICAL STEREOPHONY, by H. Burrell Hadden
Published by Iliffe Books Ltd.
159 pp. 8¾in. x 5½in., stiff cover.
Price 37s. 6d.

THE author of this book, as an instructor of the Central Programme Operations Department of the BBC, has been delving into the problems of listening for many years. *Practical Stereophony* is really a review of the subject, with much more weight given to the recording side of the technique than to the domestic situation. Nevertheless, the amateur hi-fi fan has much to learn from his professional brothers, and this book will shatter a few illusions and perhaps instil a few ideas.

Mr Hadden is not concerned (unlike too many writers in recent years) to beat a big drum for one or other of the rival systems of stereo recording and reproduction. He begins with chapters on the theory of hearing, the stereo effect, some of the significant history, and the technical production of stereo signals.

Most weight is given to the co-incident microphone technique, with only a few paragraphs on the widely spaced omni-directional microphone method.

In a later chapter, however, various types of microphone arrangement are impartially discussed. Tape club people should be particularly interested in some of the methods, and the effects that can be achieved with quite modest equipment, intelligently sited.

Sandwiched between these chapters the author discusses some "pseudo-stereophony" devices. Surprisingly, he does not wholly deprecate the artificial production of "the true, the whole" sound. Indeed, he reveals that several methods of reflection and diffusion were used in standard broadcasting techniques for years before true stereo became practicable.

Chapter 8 (Domestic Recording) enlarges upon some of the earlier discussion of microphone techniques and goes on to describe, with circuits, pre-amplifiers and mixers. Chapter 9 (Domestic Reproduction) deals with loudspeaker placing, matching, stereophonic radio and the necessary decoders, and gives as a bonus, the circuit of the Quad 22 stereo control unit.

It is indeed regrettable, as the author implies, that stereo broadcasting is so long coming to this country, and no doubt true also that stereo tape recording will not come into its own until stereo radio is an accepted part of life. (Although just what gods Mr. Hadden propitiated when he made that anti-copyright statement we are not in a position to disclose!)

The final chapter is a short review of some systems of spreading the sound source in large auditoria, fascinating for the detail given of the problems that earlier experimenters met.

If the flavour of this book is a little donnish, that is only to be expected: it is certainly a guarantee of accuracy. Recommended reading for anyone with more than one ear!—*H.W.H.*

REQUESTS FOR INFORMATION ARE INSERTED IN THIS COLUMN ON THE UNDERSTANDING THAT READERS USING THE SERVICE UNDERTAKE TO REPLY TO ALL OFFERS RECEIVED AND TO RETURN ALL DATA NOT REQUIRED. BECAUSE OF THE LARGE NUMBER OF REQUESTS RECEIVED, ILLEGIBLE WRITING WILL AUTOMATICALLY DISQUALIFY LETTERS FROM PUBLICATION. FOR THE SAME REASON, WE CAN NO LONGER GIVE SPACE FOR REQUESTS FOR PAST ISSUES OF "PRACTICAL WIRELESS".

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. . . the circuit diagram of the PCR3 communications receiver.—M. GREENSHULDY, Sea Point, Cape Town, South Africa.

. . . modification details (2m and 4m) for the R220.—T. RICHARDS, 28 Deane Road, Liverpool, 7.

. . . the circuit and booklet of Marconi communications receiver CR100.—H. LEWIS, 1 Western Road, Portadawe, Swansea.

. . . circuit, handbook or conversion data of BC 624 C.—S. J. BULLENSIE, 119a Bridge Road, East Molesey, Surrey.

. . . the circuit diagram and any other information on the monitor type 61 oscilloscope.—A. ANGLICAS, 49 Latrigg Crescent, Langley, Middleton.

. . . any circuit information on the Mullard crystal calibrator No. 7 Mk. 2.—W. BOURKE, 33 Victoria Street, Rutherglen, Lanarkshire, Scotland.

. . . the circuit and practical diagram, with any servicing data for the No. 36 set sender and power unit.—E. CARR, G3SDE, 21 Eastfield Crescent, Holmsley Lane, Woodlesford, Nr. Leeds, Yorkshire.

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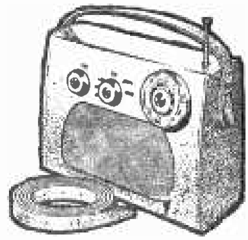

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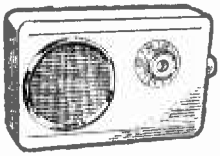

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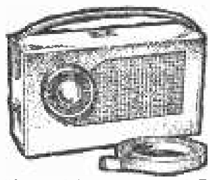

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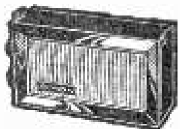

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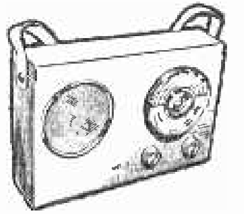

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CABINET AND CHASSIS TECHNIQUES

BY F. L. THURSTON

THERE is nothing more demoralising to the enthusiast who, after hours of loving labour, produces a piece of equipment and proudly announces "I built it myself", than to receive the reply, "yes, it looks like it!".

It is probably true to say that the most neglected part of the whole constructional operation is the final finishing off of the cabinet and front panel, and it is with these stages that this part of the series is concerned.

The Cabinet

The three most generally used methods of cabinet finishing are painting, covering with Rexine or a similar material, and varnishing. The varnishing of wood has already been dealt with in P.W.*, so we shall deal only with painting and covering.

For a really professional looking job, there is nothing to beat the use of Rexine or imitation leather for radios, tape recorders, etc. Additionally, these materials are a perfect way of camouflaging inadequate carpentry such as gaping holes and badly overlapping sides!

When sticking Rexine to wood, use a glue such as Copydex, which is semi translucent when dry and will not show up if splashed on the outside of the covering by accident. On metal, use an impact adhesive.

Painting should generally be used only on test equipment and front panels. Two paints which give special finishes are worth a mention. The first is the range of Hammer Finish paints, produced by Finnigan Speciality Paints, of Mickley Square, Stocksfield, Northumberland.

These paints have a resin base, which is mixed with a suspended spray of polarised aluminium particles and blended to include silicon. As a result of the polarised particles, the paint dries completely opaque, even when only the thinnest of coats is applied to a base which is a totally different colour to the actual paint.

The "depth" of hammer, due to the unusual blend of paint, is quite astonishing. In the case of the thin coat mentioned above, a visual illusion of depth to $\frac{1}{16}$in. is general. The silicon additive results in a good hard wearing glossy finish, particularly if baking is used.

The manufacturers claim that perfect finishes can be obtained using brush application. This may be so in the case of an expert, but my own experience suggests that a spray gun should be used, in which case *really* good results are obtained.

The second special type of paint worth mentioning is the well known PANL black crackle paint, produced by The Bruce Miller Co. Ltd., 249 Coastal Chambers, Buckingham Palace Road, London, S.W.1. When dry, this paint gives a deep black glossy crackle, just like you see on a good camera or piece of optical equipment, or on a piece of first-class ex. govt. electronic gear.

Formerly, this paint had to be dried in a gas oven in order to obtain the required crackle, but within the last year the blend has been modified and the paint is now air drying. Good results can be obtained even when the paint is applied with a brush. If the painted panel or cabinet is dried in a gas oven, a particularly good and hard wearing finish results. This, of course, should only be done in the case of metal equipment.

Both of the above types of paint can be laid on without an undercoat, but as with all paints, better results are obtained with an undercoat. Also, if painting on to a metal base, the wearing qualities can be considerably enhanced by stoving.

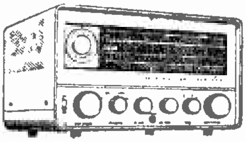
This applies with nearly all paints, but it is advisable to experiment on a piece of scrap before going on to the prototype job, to check the suitability of the particular paint for the process and to find the best temperature.

Particularly attractive results are obtained if equipment is given either a two tone or two colour finish. Greys and greens are particularly suitable.

Front Panels

The advice for painting or covering cabinets also applies for front panels. A most important point, paint will take very well if applied directly to aluminium. This is because aluminium oxodises almost as soon as it comes into contact with the

* Cabinet Care, by M. A. Quales, August, 1964.



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7 valves + Rectifier. 4 Bands 550 Kc/s—31 Mc/s. 'S' Meter-BFO-ANL-Bandspread Tuning 200/250v A.C. Brand New. **24 Gns.** carr. paid.

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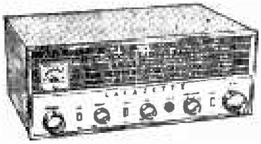

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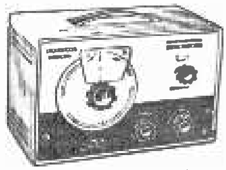

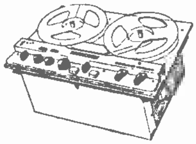

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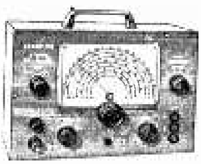

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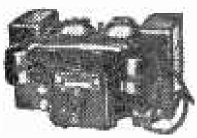

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		50mA	22/6	50V. DC	22/6
		100mA	22/6	100V. DC	22/6
		150mA	22/6	150V. DC	22/6
50µA	32/6	200mA	22/6	300V. DC	22/6
100µA	29/6	300mA	22/6	500V. DC	22/6
200µA	27/6	500mA	22/6	750V. DC	22/6
500µA	25/-	750mA	22/6	15V. DC	22/6
50-0-50µA	29/6	1-0-1mA	22/6	50V. AC	22/6
100-0-100µA	27/6	1A. DC	22/6	150V. AC	22/6
500-0-500µA	22/6	2A. DC	22/6	300V. AC	22/6
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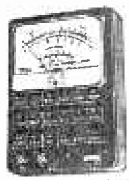

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0/5K/500K/5 Meg Ω
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0/10/50/500/2,500V. DC
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0/2 Meg Ω
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air, and the thin layer of surface oxodisation acts as a barrier which prevents the paint from reaching the aluminium. It is this same barrier which makes normal soldering or welding of aluminium impossible. Paint applied directly to aluminium will peel off very easily.

To overcome this difficulty, the aluminium should be roughened slightly (mechanically, electrochemically or chemically) prior to painting, and a special primer paint should be used.

Roughening the Surface

The most satisfactory way of roughening, or etching, the metal, is by chemical means. Four possible methods are worthy of mention. (1) A caustic soda solution is made up to a strength of between 5 and 15% concentration and heated to between about 120 and 160°F. Great care should be taken when mixing the solution that no splashing takes place. The mix should be kept well away from the eyes, clothes and children. When ready, pour into a Pyrex dish or photographic developing dish, and immerse the aluminium in it.

The degree of etch will be clearly visible to the operator while the panel is immersed. The etched finish that results from the treatment is itself very attractive and is often used as a decorative finish on commercial components and articles, the pattern obtained depending on a number of factors, including time of immersion, and the temperature and strength of the mix.

When ready, remove the panel from the tank, using a pair of tongs, and wash under the running water. After drying, do not touch the treated surface with bare hands.

It may be found that, after removing the panel from the mix, areas of black smut are evident on the surface of the panel. This shows that the panel is an aluminium alloy containing copper, and should also be immersed in a solution containing 5% of nitric acid and 5% hydrofluoric acid, removed from the bath and washed again.

(2) This involves etching in a solution of 10% sodium carbonate instead of caustic soda. Both of the above methods give a finish that is decorative and useful in their own rights.

(3) This method is most recommended. Mix a solution containing 5% of anhydrous Sodium Carbonate and 1% of Sodium Chromate. Bring the solution to a temperature of between 90 and 100°C, i.e., near boiling point. Immerse the aluminium in the hot mix for between 3 and 10 minutes. On removing the aluminium from the mix, it should be seen to be covered with a uniform velvety film, which may vary in colour, depending on the composition of the alloy, from light grey to near black. Finally, the treated plate should be washed off in boiling water. Note that the aluminium should be free from grease before starting the treatment.

All of the chemicals involved should be well stoppered up in glass containers when not in use, and must on no account be allowed to come into contact with the eyes, clothing or children. When working with chemicals, always do so in a room that is well ventilated or in the open.

An alternative (though inferior) to the above methods, is scouring with steel wool or emery paper.

The best priming paints for use on aluminium and its alloys are the zinc chromate types, but either red oxide or red or white lead primers will prove satisfactory.

Labelling

Wording on the front panel will generally be done with transfers, and the only point that needs mentioning here is that the wording should be painted over with a coat of clear mat varnish to improve the damage resistance qualities of the finished job.

A far more permanent method of labelling a panel is with tool stamps: they consist of a short steel bar with a raised number or letter formed in one end. They are struck with a hammer to form an indentation of the character. The metal removed from the indentation should be removed with a fine file.

Marking should be carried out before painting. If the panel is subsequently baked or is not painted at all, a good way to emphasise the markings is to apply a smear of paint, in a contrasting colour to the rest of the panel, over the general area that has been marked, and then immediately wipe it off again with a rag made damp in thinners. All of the newly laid on paint will be removed except that which is out of reach of the rag in the indentations.

Alternatively, or on panels that have not been baked, a similar process can be used employing soft coloured wax pencils, rubbing well into the indentations, and removing the surplus with a clean, soft rag.

Readers who have access to photographic equipment may find the following method of marking panels with monograms, etc., of particular interest: The panel may first be anodised. The process is not difficult, but it is hardly worthwhile for a single job in which case the local electro-plating works can do it. Alternatively a priming coat of white cellulose should be laid on the panel, preferably by spray gun.

The prepared surface can now be made into a photographic plate, which is equivalent to grade 3 Bromide paper and will be developed and fixed as such, as follows. Obtain a small quantity of Johnsons Granulated Emulsion, obtainable directly from the manufacturers, Johnsons of Hendon Ltd., A 1oz. sample tin costs 15/- and will cover about 25 square feet when made up.

Pour a quantity of the emulsion in a lightproof glass container and mix with cold water in a ratio of about 90:1 by weight and stir well. Leave for about an hour, occasionally stirring with a glass rod. Place the complete container and its contents in a bath of hot water and bring the temperature of the liquid emulsion to 100°F. Strain the warm liquid through a double thickness of undressed lint into a second container which has been prewarmed, and the mixture is ready for use.

It may be applied to the treated aluminium panel either by spray gun or by brush, but care should be taken to ensure that a very even coat is obtained. After application the panel should be left flat and allowed to dry at a temperature of less than 100°F in a dry room.

All of the above work should, of course, be carried out in a darkened room. An image can now be projected into the prepared surface, and meter dials. For radios, etc. the process can be developed and fixed in the normal way.

A similar process can be used for making up used for making really professional-looking dials on glass, but here the glass is pre-treated as follows. Dissolve 1·37 grams of Crome Alum in 100 cc of water, and then add the mix to 50 grams of Gelatin, with both solutions raised to a temperature of between 130 and 160°F. Finally, add water to make the solution up to 1,000 cc. The solution can be fixed to the glass by immersion.

General Points on Design and Accessories

One of the sure signs that a piece of gear is home-built is to see the control spindles and securing nuts and bolts sticking through the front panel. The way around this fault is to mount all the controls, etc., on a panel bolted directly to the chassis, and mount a separate front panel, nicely finished off, in front of this on stand-off mountings.

If handles must be fitted to the equipment, their style and position deserves a certain amount of thought. On test equipment, which may be used "stacked", with one piece of gear on top of another, the handles should preferably be submerged below the top of the case when not in use, and should, in any case, be flexible.

A point also worth remembering is that if fixed handles are mounted on the front panel, and arranged so that they project out beyond the rest of the controls, they will give a measure of protection to the whole panel, and glass fronted meters in particular.

Small rubber feet, fitted to the base of pieces of test gear are very desirable, but remember that, like a stiletto heel, they result in quite a high contact pressure, and are not necessarily suitable for domestic gear that will be placed on top of furniture. Stuck on strips of rubber are to be preferred.

As mentioned in part 2 control knobs, handles, etc., can be copied and moulded in glass fibre materials. It was also mentioned that a range of pigment colourings are available to give the resins a nice finish.

With these points in mind, it is of particular interest that a range of metal fillers or pigments is available from Tiranti's, of 72 Charlotte Street, London W.1. The following range of colours are available:—Aluminium, Iron, Bronze, Copper, Gold/Brass, Nickel Silver and Lead. Available in minimum quantities of 1 lb., at which size prices vary between 4s. 3d. and 11s., these fillers are highly recommended.

The resulting glass fibre is so metallic-looking that it is often very difficult to tell that it is not metal at all. This is made even more so by the fact that the finished articles react to metal polish and that some of the "metals" will even tarnish, just like the real thing. A wide range of normal, non-metallic pigments is also available from the same firm. ■

ON THE SHORT WAVES

—continued from page 36

70ft. longwire. **SSB:** FY7YL 1105, HV1CM, KP4CL, OA7G, OA7J 1350, OD5BZ 1100, SVØWB 1100, TG9PM 1318, VE6NX 1600, VE6BR, VE6AO, VE5LM 1540, VK9ZJK 1255, VQ8AMR 1700, VK9JK 1230, W6GVM, W6LDD 1655, XW8AL 1300, ZE1BL 1830, ZL1AKM/MM 1444, YN9JUL 1310, YA4A 1315, 5Z4AA 1355.

P. Coull, New Romney, went fishing with his Codar CR66 and 60ft. longwire. He collected:

14Mc/s. **SSB:** HV1CN 1045, KV4CF 1130, PY2PA 1000, TF3WHI 1055, XE1AB 1330, KV4GR 1135. **AM:** OX3HM 1445.

21Mc/s. **AM:** ET3USA 1105, VK6QL 1055, ZE1BK 1420, ZE7JR 1055, ZS6OF 1100, 5N2EBL 1155. **SSB:** KV4CX.

All the above averaged R5 S8 and SWL Coull says that at the time of writing CEØAG is still at it on SSB (1245—1430).

From Clackmannanshire **J. W. Inglis** got these with an R1155 and 66ft. longwire. *3·5Mc/s.* **SSB:** OZ8KR 2340, VE1IE 2345, GD3GMH 1425, CN8AQ 2100, W2ZPO 0730. *14Mc/s.* HBØAFM 1515, UN1BK 1520, VE3CPA 1525, 4U1ITU 1610, W6HX 1610, 3A2DD 0855.

L. G. Williams (Hayes) bought a Philco 7 transistor receiver, and attached 8ft. of lighting flex to the aerial. Rewards on 14Mc/s a.m. between 1400 and 1630 included: W1CDR, OK1AD, OE1CEW, OK1AGH, UQ2KDD, W6RTR, CT1GE, OH1NX, SM5OV, SP5ACE, W4TK, W3BIW, UA1TT, W1NB, SV1BT, W1JFJ, W2OMM, W1BNS, K1TTY, W8ZO, W1DMN, W1ZRN, VE1IP, W4HDY, EP3RT. Wonder what it would do on the end of a three-element beam?

C. E. Lloyd informs that Z6AP/KC4 is a genuine station and is located in Queen Maud Land, Antarctica. For those who want to know just where, it's 70°S., 2°W.

General News

An interesting contest this month is the Goose Bay QSO party. Licensed amateurs have only to work three members of the Goose Bay A.R.C. to receive a W.A.G. certificate. The contest lasts fifteen days, all bands, all modes. VO2 or /VO2 are the call signs to look for if you are an SWL.

Islands and rarieties active at the time of writing are Jan Meyen Island (prefix LA) where 6 or 7 are active. Willis Island: VK4TE is on C.W. There are three or four VK9'S on Christmas Island and one CR4 on Cape Verde Island. MP4MAH uses mainly SSB from Muscat and Oman. KG6IG Bonin and KG6IF Marcus Island are quite active. Ascension Island is on with the call ZD8. Also look for Jarvis and Palmyra Island (KP6AZ), FB8WW on Crozet Island, Virgin Islands (KV4), Macquarie Island (VKØ), and VU2NRA Andaman Island. Then there's still Kerguelen Island FB8, New Amsterdam and St. Paul Island FB8, and Tokelau Island ZM7AE.

Contests for April include: April 3—4th International SRKB V.H.F. Contest, April 4th QRP Contest (low power), 10—11th CQ. WW SSB Contest. April 24—25th PACC Contest ('phone and C.W.). 1—15th Goose Bay ARC. QSO Party. May 2nd, 144Mc/s Portable Contest.

Deadline for this month is 27th.

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● **SCOOP! B.S.R. U.A. 14 Autochangers.** T.C. 8 Mono P.U. Brand new and boxed. Wired for stereo. Note **OUR** price **£5.10.0.** P.P. 5/-. Latest model.

● **SCOOP! Garrard Autoslim.** Mono P.U. Brand new and boxed. Wired for stereo. Latest model. Note **OUR** price **£6.0.0.** P.P. 5/-.

● **SCOOP! Garrard A.T.5.** Wired for stereo, inclusive of head and mono cartridge (A.T.5 is an auto transcriptor). The finest changer of them all. **OUR price, brand new and boxed £7.5.0** only. P.P. 5/-.

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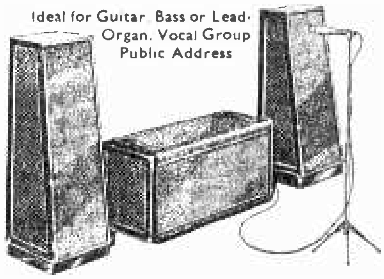

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CLUB NEWS

ACTON, BRENTFORD AND CHISWICK RADIO CLUB
Hon. Sec.: W. G. Dyer, G3GEH, 188 Gunnersbury Avenue, Acton. London, W.13.
At the meeting on Tuesday, 13th April, at 66 High Road, Chiswick, there will be a tape recorded lecture with colour slides, on 160m DX working, by W1BB. This should have been given on 16th March but had to be postponed.

BURSLEM AMATEUR RADIO CLUB
Hon. Sec.: J. R. Sherratt, G3SAJ, 23 Ash Way, Ash Bank, Bucknall, S.O.T.
The Club will be on the air looking for contacts and renewing old ones with Mobiles coming into the district *en route* to the Midlands Mobile Rally. Call signs: Top Band: G3HVI (south), G3SAJ (east), G3COY (west) and G4QD (north).

CHESTER AND DISTRICT RADIO SOCIETY
Hon. Sec.: P. J. Holland, Field House, 19 Kingsley Road, Gt. Boughton, Chester.
On 13th April, Mr. H. Morris, G3ATZ, will give a second talk for the beginners, and on the 20th, Mr. B. Fallows, G3OWY, will give a demonstration of v.h.f. convertors.

CLIFTON AMATEUR RADIO SOCIETY G3GHN
Hon. Sec.: J. Rose, G3OGE, 63 Broomfield Road, Beckenham, Kent.
The "junk sale" began on 15th January and had to be continued on the 22nd. The following week, SWL D. Reed presented a quiz. Plans are now in hand to extend the activities of the Club station to the h.f. bands.
Meetings are held every Friday at 8 p.m. at 225 New Cross Road, London, S.E.14.

DERBY AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: F. C. Ward, G2CVV, 5 Uplands Avenue, Littleover, Derby.
At the A.G.M. on 3rd February, B. J. Speakman was elected Chairman and J. C. Brown, G3JFD, Vice-Chairman. It was reported that membership was 175, out of which 72 are licensed.
The Annual Dinner and Dance was held on 13th February and over 180 attended. Mr. J. Clarricoats, O.B.E., G6CL, Secretary of the International Amateur Radio Union, Region 1, was among the Guests of Honour.

FAREHAM AMATEUR RADIO CLUB
Hon. Sec.: N. Carless, G3EER, 16 Waterloo Road, Alverstoke, Gosport.
Club H.Q. is now situated at the Clubroom, Bugle Hotel, West Street, Fareham, and a regular monthly session of Morse and Technical Classes is now in full swing. Meetings are held first Sunday in each month at 7.30 p.m.

HARLOW AND DISTRICT RADIO SOCIETY
Hon. Sec.: G. O'Donald, G3TLJ, "Great East", Roydon Road, Roydon, Harlow, Essex.
Our Mobile Rally will be held on 26th September. The venue, as last year—Magdalen Village Hall, near Harlow.

HUDDERSFIELD RADIO CLUB
R. Higton, 5 Brian Avenue Dalton, Huddersfield, Yorkshire.
The Club held an exhibition of home-built equipment, and is preparing for other exhibitions, competitions etc. A Club station will be formed at a favourable QTH in the near future.

MELTON MOWBRAY AMATEUR RADIO SOCIETY
Hon. Sec.: D. W. Lilley, G3FDF 23 Melton Road, Ashfordby Hill, Melton Mowbray Leicestershire.
On 25th March there was an illustrated lecture, based on Mullard film strips, entitled Basic Valve Circuits. There will be an 8mm cine film evening and a Ragchew.

MID-WARWICKSHIRE AMATEUR RADIO SOCIETY
Hon. Sec.: H. C. Loxley, 5 Guy Street, Warwick.
On 5th April, Part 4 of the Radio Theory lecture was held. This was entitled Valve Performances.
There will be no meeting on 19th April (Easter Monday).

NORTHERN HEIGHTS AMATEUR RADIO SOCIETY
Hon. Sec.: A. Robinson, G3MDW, Candy Cabin, Ogden, Halifax.
On 14th April, the A.G.M. will be held and on the 28th there will be a discussion on the N.F.D.
There will be a visit to Manchester Civil Airport on 12th May.

OXFORD AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: B. Green, G3PMI, H.Q., Cherwell Hotel, Water Eaton Road, N. Oxford.
The Annual Dinner was held in March, and the event of the year, the 10th Anniversary Mobile Rally will be held on 11th July.

PETERBOROUGH AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: D. Byrne, G3KPO, Jersey House, Eye, Peterborough.
A talk on Radio Astronomy will be held on 7th May. Members are organising a Mobile Rally on 4th July at Peterborough.

PRESTON AMATEUR RADIO SOCIETY
Hon. Sec.: C. Noblet, 178 West Park Avenue, Ashton, Preston Lancashire.
At the meeting on 9th March, there was a discussion on National Field Day, and on the 23rd, a talk by the Club Secretary entitled Exchanging QSLs. There will be a discussion on Receivers on 13th April.

RADIO SOCIETY OF HARROW
Hon. Sec.: C. J. Rees, G3TUX, 17 Colburn Avenue, Hatch End, Pinner, Middlesex.
Meetings are held every Friday in the Science Lab. of Roxeth Manor School, South Harrow. On 12th March there was a lecture on Ham Band Convertors, and on the 26th a Junk Sale.

READING AMATEUR RADIO CLUB
Hon. Sec.: N. Taylor, G3TOQ, 83 Stoneham Close, Reading, Berkshire.
At the A.G.M., the following officers were elected: Chairman, C. Nairn, G3GHE; Treasurer, B. Carter, G3AAG; Vice-Chairman, Lt Col. N. Bower, O.B.E., G5HZ; and Hon. Sec., N. Taylor, G3TOQ.

SALOP AMATEUR RADIO SOCIETY
Hon. Sec.: Dr. K. E. Jones, G3RRN, Greystones, Shrewsbury Road, Church Stretton, Salop.
L. F. Ivin, G5IC, gave a talk on 11th February, entitled Neutralisation. J. N. Walker, G5JU, gave a talk on Receivers, and demonstrated the Eddystone EA12 and EC10 receivers. There will be a Construction Competition on 8th April.

A.F./R.F. SIGNAL GENERATOR

—continued from page 51

Frequencies can now be calibrated, and a graph drawn for each band, plotting frequency against dial reading. A new dial can then be drawn, giving frequency directly. The accuracy of fixing the position of the dial can be checked by taking one more frequency check with the bridge.

The accuracy of the calibration depends on two things. Firstly upon the accuracy with which the resistances are measured. A multimeter, battery and series limiting resistor will do the job well, if 1% resistors, a new battery and a slide rule are used. The second factor is the accuracy of the capacitors. This depends on the accuracy of the original C1 and the finding of the values for C. Accuracy of about 2% can be obtained with some trouble and patience.

The output control is best given a linear scale of 0—10, as output varies from one band to another.

At this stage the audio oscillator is complete and ready for use. However next month, the construction of the mains unit and calibration of a suitable r.f. oscillator will be described, to make the complete generator fully versatile.

PREPARING FOR THE R.A.E.

BRIAN ROBINSON.

7. MULTIELECTRODE VALVES; VALVES AS OSCILLATORS

7.1 Interelectrode Capacitances in the Triode

IN the triode there are three interelectrode capacitances which affect the performance of the valve. These interelectrode capacitances are present because the various electrodes act like the plates of a normal capacitance.

In the triode there will be interelectrode capacitances between the anode and the grid; the anode and the cathode; the grid and the cathode. The value of these capacitances is generally only of the order of a few picrofarads —pF (micromicrofarads —$\mu\mu$F) but at radio frequencies their *reactance* is very low, and this means that a virtual short circuit can exist between the electrodes at r.f. Fig. 59 shows in diagram form the various interelectrode capacitances in a triode.

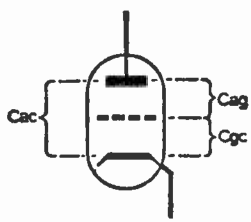

Fig. 59: Interelectrode capacitances in the triode valve.

It is easy to see therefore that if a triode is to be used as an amplifier or oscillator at r.f. (radio frequencies), the capacitance between grid and cathode could short circuit the input circuit, and the capacitance between the anode and cathode could short circuit the output circuit.

Obviously some way has to be found of reducing interelectrode capacitances and one simple way is to introduce a second grid called the *screen grid*.

7.2 The Screen Grid Valve or Tetrode

The *tetrode* is a four electrode valve which has a *screen grid*. This screen grid is positioned **between the** *control grid* and the anode and acts

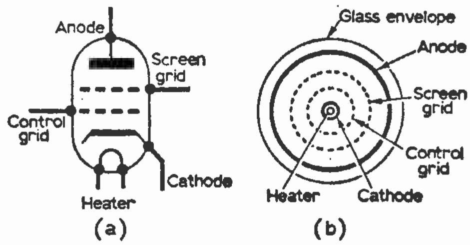

Fig. 60 (a): Circuit representation of a tetrode; (b) a horizontal cross-section of the actual valve.

as an electrostatic shield which prevents coupling between the anode and control grid.

A positive voltage must be applied to the screen and this attracts electrons from the cathode. Most of these electrons are travelling so fast that they pass through the mesh of the screen and are attracted towards the anode. Some of the electrons however strike the screen and therefore *screen current* flows. Some form of connection of the screen to the cathode must, however, be made if the screen is to be an efficient shield. This connection will generally take the form of a capacitance called a *by-pass* capacitance which has a reactance of only a few hundred ohms at the frequency being used.

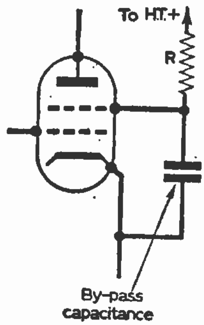

Fig. 61: Connection of the screen grid by-pass capacitance.

One of the effects of adding a screen grid is that the anode resistance of the valve becomes very high, e.g. in the region of 20,000Ω to 2MΩ. It should be remembered that the screen grid is positioned nearer the cathode than the anode.

7.3 Anode Characteristics for the Tetrode

The circuit used to obtain the anode characteristics for the tetrode is the same as that used to obtain the anode characteristics for the triode, (see article 6); except that the screen grid is connected to the h.t. through a resistance of a few thousand ohms. A typical graph of the result of plotting Va against Ia is shown in Fig. 62.

The screen current of the tetrode is shown by a dotted line also in Fig. 62, it will be noticed on the graph that until an anode voltage of about 65 is reached the screen current is greater than the anode current.

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EF52	6/-
EF53	4/6
EF55	8/-
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PY82	5/-
PY83	6/-
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QS150/15	10/-
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RG4/1250	60/-
RK72	6/-
SL30P	15/-
SL30	12/6
SP2	8/6
SP41	1/6
SP61	1/6
SP210	3/6
STV280/40	12/6
STV70/80	8/-
8U2150A	10/-
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UF89	6/-
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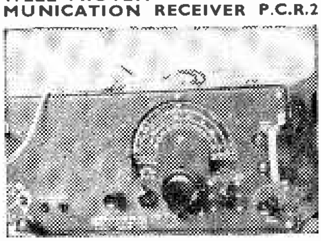

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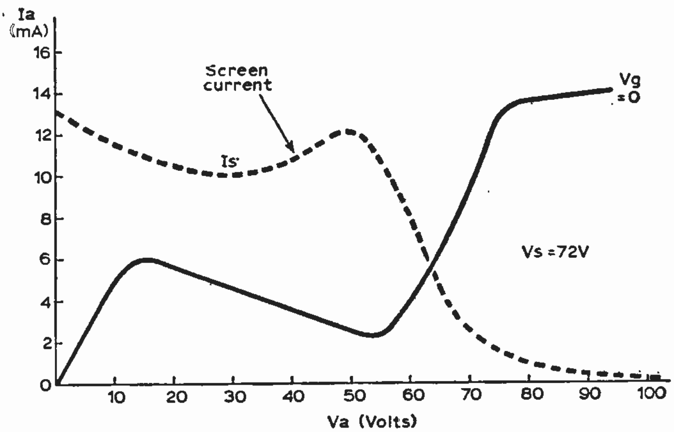

Fig. 62: Ia/Va curve for a tetrode. (Screen current against screen voltage shown dotted.)

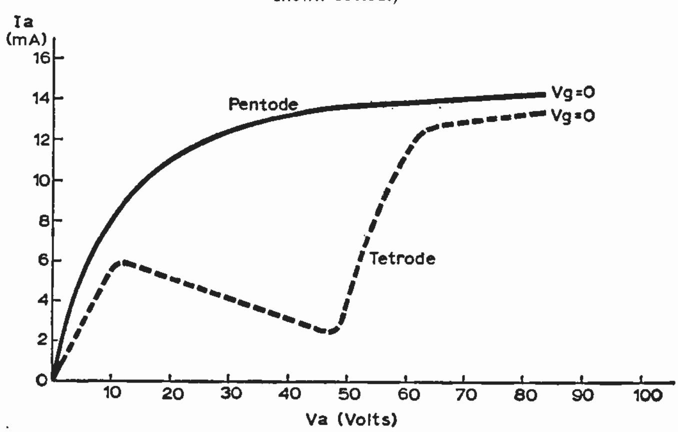

Fig. 63: Ia/Va curve for a pentode. (Same curve for tetrode shown dotted for comparison.)

7.4 Secondary Emission in the Tetrode

As can be seen from Fig. 62, the Va/Ia curve for the tetrode is unusually irregular. This is due to a phenomena called *secondary emission*. Briefly, some electrons strike the anode with sufficient speed to liberate an electron from the anode surface. This electron which has been liberated moves into the space between the anode and the screen grid. Because the screen is at a higher potential than the anode the electron will move towards the screen. This causes an increase in the screen current and a decrease in the anode current; in Fig. 62 it can be seen that the anode continues to lose secondary electrons until an anode voltage of about 65 is reached. Secondary emission does occur after this point but as the anode voltage is now greater than that of the screen the electrons will return to the cathode and their effect will be very small.

7.5 Adding a Third Grid—The Pentode

In the tetrode the irregularity of the Ia/Va curve is likely to cause distortion in a circuit in which the valve is used. If this distortion is to be reduced some way must be found of overcoming the effects of secondary emission. The simplest way to do this is to introduce a *third grid* between the anode and the screen grid. This third grid is called a *suppressor grid*. The suppressor grid is always connected to the cathode with the result that it is always at zero or negative potential with respect to the anode. Therefore any electrons which are liberated from the anode will now pass into the space between the anode and the suppressor grid: but as the anode is always at a higher potential than the suppressor grid the liberated electrons will return to the anode. In the *pentode* (valve with five electrodes) the effects of secondary emission is therefore overcome. A typical Ia/Va curve for a tetrode has been shown as a dotted line for comparison purposes.

7.6 Other Multielectrode Valves

Valves for special applications, such as for frequency changing in a superheterodyne receiver, may have more than three grids. The *heptode*, which has seven electrodes, and the *octode*, which has eight electrodes, are typical examples. Space is, however, too limited to allow any detailed description of these types of valve.

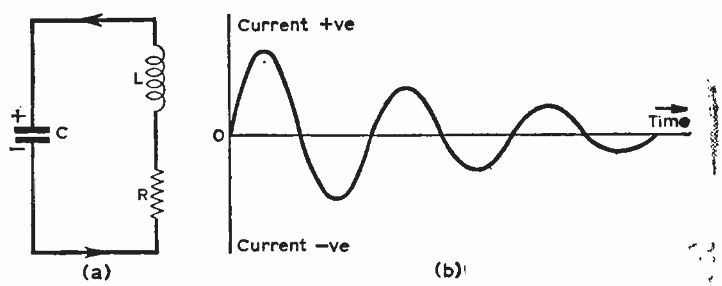

Fig. 64: (a) Discharging a capacitance through a coil; (b) damped oscillations.

7.7 The Triode as an Oscillator

If a charged capacitance is discharged across a coil of inductance L and resistance R, free *oscillations* will be set up. If a graph of current against time is drawn it will take the form shown in Fig. 64.

As can be seen from the graph the *period* of the oscillations is constant, but as the capacitor discharges the *amplitude* of the oscillations decreases. This type of oscillation is called a *damped* oscillation. If the oscillations are to be maintained they must be *undamped* oscillations, and in this case the amplitude would be constant as well as the period of oscillation. A valve can be used to supply the energy required in order to maintain undamped oscillations, but this energy must be supplied under certain specified conditions.

7.8 The Conditions for Oscillation

When a valve, such as a triode, is to be used as an oscillator the valve must supply its energy under the following conditions.

1. The energy delivered by each impulse must be large enough to make up for the energy lost between impulses.
2. The impulses must be in the *correct phase* so as to deliver the energy to the oscillating system.
3. The energy, or impulse, must be supplied at the *same frequency* as that of the oscillatory circuit.

7.9 A Simple Valve-driven Oscillator

A simple valve driven oscillator is shown in Fig. 65. If oscillations are to be maintained, feedback from the output circuit to the input circuit must be ensured. In this oscillator the feedback is obtained because of the *mutual inductance* between the grid coil, L1, and the anode circuit L2 C1. The correct phase relationship between the anode and grid voltages can only be maintained if—

- a the anode and grid coils are wound in the same direction;
- b the ends of the windings are connected as shown so as to ensure the correct phase difference.

It is obvious therefore that the power supplied to the valve in the form of d.c. supplied by the battery is converted into power in the form of an alternating current in the anode circuit.

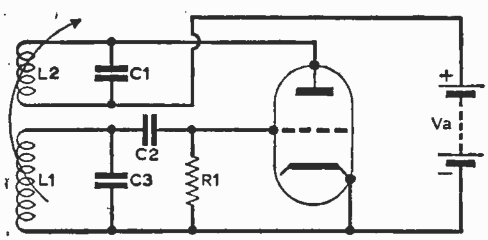

Fig. 65: A simple oscillator circuit.

7.10 Grid Bias in an Oscillator

In Fig. 65 the components C2 and R1 have not yet been mentioned. These components produce a *grid bias voltage* which helps to make the oscillator more efficient. In an oscillator with no grid bias (negative) grid current will flow during the positive half cycle of the grid voltage and the power produced is dissipated in the grid in the form of heat and reduces the efficiency of the oscillator. If the oscillator is to operate with high efficiency the grid must be biased beyond *cut-off* value. If a battery were used to supply the grid bias the initial small oscillations in the circuit would not cause any anode current to flow and oscillation would cease. The bias voltage produced by C2 and R1 however starts at zero and increases with the amplitude of the alternating component of the grid circuit, and therefore permits oscillations to continue. The method of providing grid bias which has been described also helps to maintain the amplitude of the oscillations in the circuit constant.

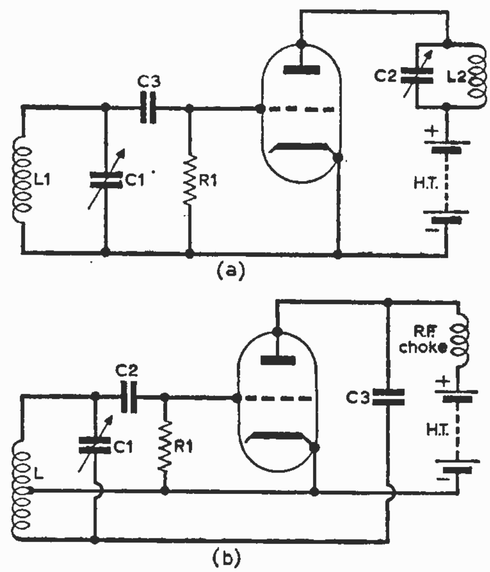

Fig. 66: (a) A tuned-anode, tuned-grid oscillator; (b) The Hartley oscillator.

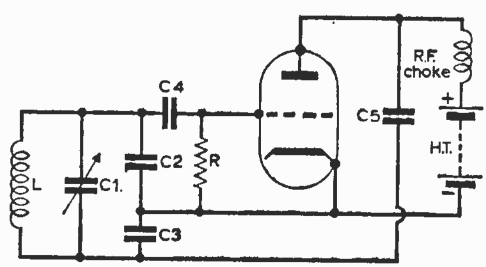

Fig. 66: (c) The Colpitts oscillator.

7.11 The Frequency of Oscillation in an Oscillator

The frequency of oscillation in a valve driven oscillator can be found by referring to Section 4·7 in the February, 1965 issue of this magazine.

7.12 The Efficiency of an Oscillator

The efficiency of an oscillator is simply given by the relationship—

$$\text{Efficiency} = \frac{\text{Output power}}{\text{Input power}} \times 100\%.$$

7.13 Specific Oscillator Circuits

Shown in Fig. 66 a, b, c are three oscillator circuits which are commonly used in amateur radio work. Space does not permit a description of the mode of oscillation of each type and the reader is advised to find out the mode of operation from a suitable text book. (See Article 1.) The reader is also advised to read up more fully the basic principles which must be observed when dealing with valve oscillator circuits.

Question

Using Figs. 62 and 63 as a basis, draw graphs to show—

a The Ia/Va curves, for a tetrode similar to that dealt with in Fig. 62, for values of control grid voltage of 0, −1 and −2V.

b The Ia/Va curves, for a pentode similar to that dealt with in Fig. 63, for values of control grid current of 0, −1 and −2V.

(Curves of the correct shape and approximate position will be acceptable.)

Answer to Last Month's Question

1 Mutual conductance is given by the change in anode current divided by the change in grid voltage which produces this. In the question, the change of anode current was 2·8mA, or 0·0028A, and the change in grid voltage which produced this was 1·6V.

Therefore gm = 0·0028/1·6
= 0·00175 mhos
or 1,750 micromhos (μmhos).

Mutual conductance in mA/V will be given by 2·8/1·6
= 1·75mA/V.

2 In Fig. 58 a change in anode voltage of 40V, (100—60), caused a change in anode current of 2·8mA. The same change in anode current was brought about by a change in grid voltage of 1.6V. Therefore the amplification factor of the valve is given by
60/1·6
μ = 37·5.

3 Cut off for Va = 100V is Vg = —3V.

4 Cut off for Va = 60V is Vg = −1·5V.

Part 8 Next Month

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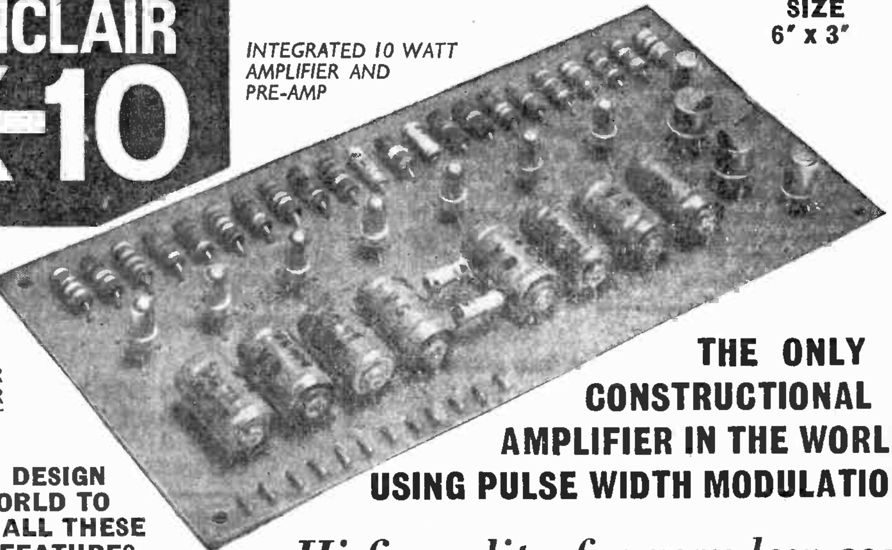

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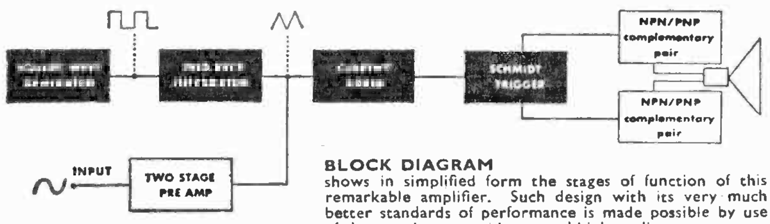

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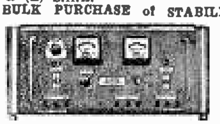

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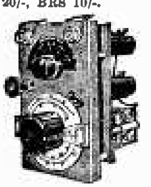

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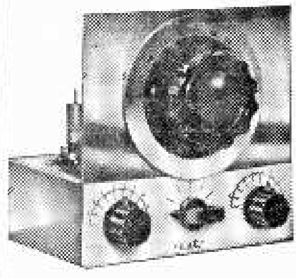

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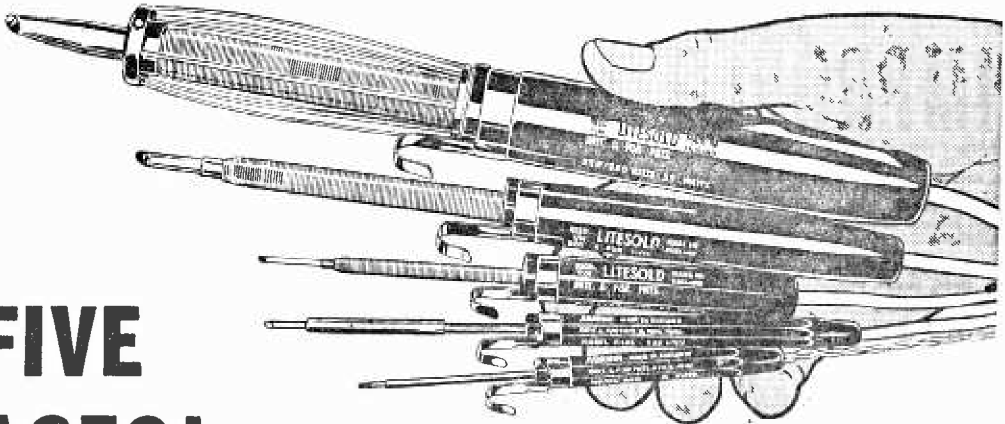

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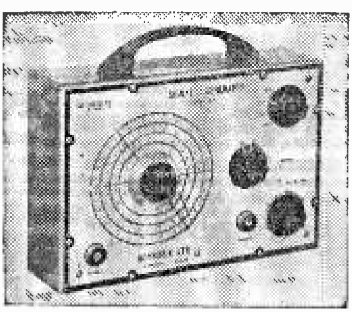

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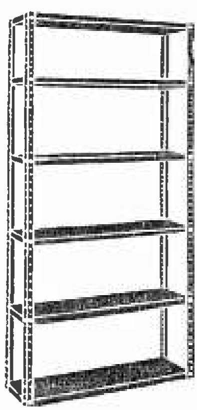

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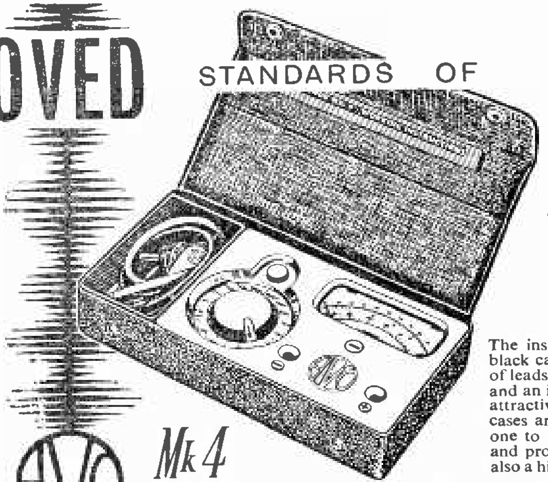

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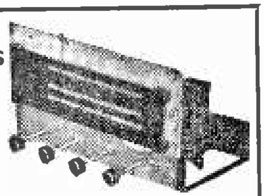

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