APRIL
1963

Practical WIRELESS

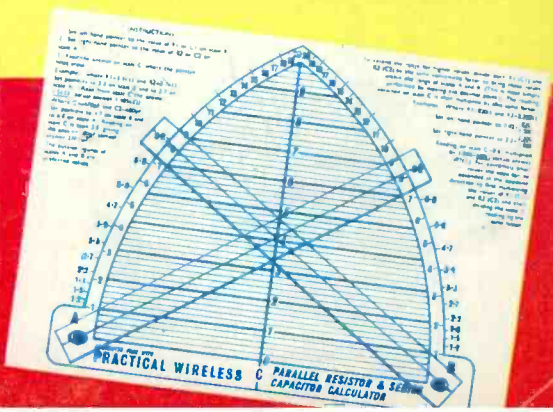
2/-

DIGITAL REGISTER for Geiger-Counter

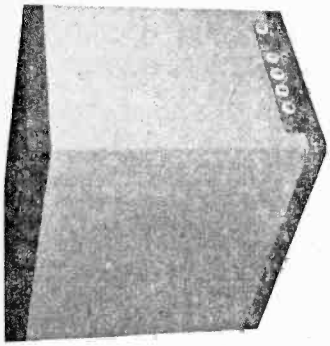
FREE inside!

RESISTOR AND CAPACITOR CALCULATOR

AND COLOUR CODE GUIDE



INTRODUCING THE R.S.C. BASS-MAJOR 30 WATT GUITAR AMPLIFIER



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

Eminently suitable for bass guitar and all other musical instruments

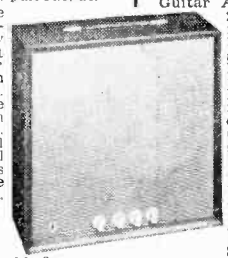
- ★ Incorporating two 12in. heavy duty 25-watt high flux (17,000 lines) loudspeakers with 2in. diameter speech coils. Designed for efficiently handling full output of amplifier at frequencies down to 25 c.p.s.
- ★ Sensitive tweeter unit reproduces frequencies from 3,000 c.p.s. up to 17,000 c.p.s.
- ★ Heavily made cabinet of convenient size 24 x 21 x 14in. has an exceptionally attractive covering in two contrasting tones of Vynair.
- ★ For 200-250 v. to 50 c.p.s. A.C. mains operation.
- ★ Four jack socket inputs and two independent vol. controls for simultaneous connection of up to four instrument pick-ups or microphones.
- ★ Separate bass and treble controls providing more than adequate "Boost" or "Cut".
- ★ LEVEL frequency response throughout the audible range.
- ★ SUPERIOR TO UNITS AT TWICE THE COST.

39½ Gns. Send S.A.E. for leaflet. OR DEPOSIT of £4.3.0 and 12 monthly payments of £3.9.11. Carr. 17/6.

R.S.C. JUNIOR GUITAR AMPLIFIER 5-watt high quality output. Separate bass and treble "cut" and "boost" controls. Sensitivity 15 m.v. Two high impedance inputs. 10in. loudspeaker. Handsome, strongly made cabinet (size 14 x 14 x 7in. approx.) finished in attractive and durable polychrome. 200-250 A.C. mains operation. **£8.19.6** Or DEPOSIT £1 and 9 monthly payments of £1. Carr. 7/6.

LINEAR TREMOLO/PREAMP. UNIT Designed for introducing the Tremolo effect to any amplifier which is fitted with a reserve power supply point for smoothed H.T. and 6.3 v. A.C. L.T. This applies to practically all amplifiers of our manufacture, and to those of several other manufacturers. The unit plugs into power supply point and any input socket of 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. SENIOR Guitar Amplifier 10 watt 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-up can be used at the same time. Two loudspeakers are incorporated, a 12in. high flux 14 watt bass unit, and a 6 x 4in. elliptical for treble. Cabinet is well made and finished as Junior Model. Size approx. 18 x 18 x 8in. Only **15 Gns** Carr. 10/- Send S.A.E. for leaflet. Or DEPOSIT 34/9 and nine monthly payments of 34/9.



R.S.C. SUPER HI-FI 15-watt An exceptionally efficient high fidelity Guitar Amplifier incorporating a heavy 20-watt speaker with excellent frequency response. Individual bass and treble controls give ample "boost" and "cut". Two high impedance jack socket inputs are separately controlled. If required one or two additional inputs can be provided at a cost of 7/6 per extra socket. Cabinet is of substantial construction and attractively finished in two tones of polychrome. Size approx. 20 x 8 x 10in. Operation from 200-250 v. 50 c.p.s. A.C. mains. **Please do not compare this Unit with others of similar rating until you have heard the difference.** Send S.A.E. for leaflet.

22 Gns. Or Deposit 51/6 and nine monthly payments of 51/6. Carr. 12/6

LEICESTER BRANCH NOW OPEN

TRANSISTOR SALE. Mullard OC71 3/9, OC45 4/11, OC44 4/11, OC72 4/9, OC81 4/11, OC171 8/9, Ediswan XA101 3/9, XB102 3/9, XA112 3/9, XB113 3/9, XB104 3/9, XC101A 3/9. Postage 6d. for up to 3 Transistors.

D.C. SUPPLY KIT. 12 v. 1 a. consisting of a partially drilled metal case, mains trans., F.W. Bridge Rectifier, 2 fuseholders and fuses. Change Direction switch, variable Speed regulator and circuit. For 200-250 v. A.C. mains. Suitable for Electric Trains. Limited number available at 29/11

SELENIUM RECTIFIERS

F.W. BRIDGE		24 v. 2 amp	.. 14/9
6/12 v. 1 a.	.. 3/11	24 v. 20 amp.	.. 89/9
6/12 v. 2 a.	.. 6/11	H.T. TYPES H.W.	
6/12 v. 3 a.	.. 9/9	150 v. 40 mA	.. 3/9
6/12 v. 4 a.	.. 12/3	250 v. 50 mA	.. 3/11
6/12 v. 6 a.	.. 15/3	250 v. 60 mA	.. 4/11
6/12 v. 10 a.	.. 26/9	250 v. 80 mA	.. 5/11
6/12 v. 15 a.	.. 35/9	250 v. 250 mA	.. 11/9

CONTACT COOLED. 250 v. 75 mA, F.W. (Bridge), 10/11. 250 v. 50 mA, F.W. (Bridge), 8/11. H.W. 250 v. 60 mA, 5/11.

LINEAR TAPE PRE-AMPLIFIER Type LP/1. Switched Negative feedback equalisation Positions for Record 15in., 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. Only 9 Gns. S.A.E. for leaflet.

HUGE PURCHASE OF BRAND NEW 24 v. 20 Amp. F.W. (Bridge) SELENIUM RECTIFIERS. each **59/9**

EX. GOVT. SELENIUM RECTIFIERS 12v 1S AMP (BRIDGE) F.W. ONLY 19/9

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

HI-FI 10 WATT AMPLIFIERS. Brand new. Manufacturer's discontinued line. Fitted latest Mullard valves. Dual inputs for "mike" and gram., etc. Bass and Treble Controls. High sensitivity and quality. Output for 3 ohm or 15 ohm speaker. For 230-250 v. A.C. Carriage 4/6. Only **£7.19.9**

THE SKYFOUR T.R.F. RECEIVER A design of a 3 valve long and medium wave 200-250 v. A.C. Mains receiver with selenium rectifier. High gain H.F. stage and low distortion detector. Valve line-up 6K7, SP61, 6V6G. Selectivity and quality excellent. Simple to construct. Point-to-Point wiring diagrams, instructions and parts list. 1/9, maximum building costs £4.19.6. inc. attractive Walnut veneered wood cabinet 12 x 6½ x 5in.

MULTI-METERS. CABY MI. Sensitivity 2000 ohms per volt. A.C. and D.C. 54/-. A.10. Basic Meter sensitivity 155 micro-amps A.C. and D.C. ranges £4.17.6. B.20. Sensitivity up to 10,000 ohms per volt A.C. and D.C. £6.10.0.

EX. GOVERNMENT ACCUMULATORS. Size 7; x 4 x 2in., 2v. 16 A.H. brand new. 6/9 each. 3 for 15/6.

EX. GOVT. SMOOTHING CHOKES. 200 mA, 3-5 H, 50 ohms, Parmeko 8/9; 100 mA, 5 H, 100 ohms 3/11; 150 mA, 10 H, 50 ohms 9/9; 80 mA, 20 H, 900 ohms 5/9; 120 mA, 12 H, 100 ohms 8/9; 50 mA, 50 H, 1,000 ohms 6/9; 100 mA, 10 H, 100 ohms 6/9; 60 mA, 5-10 H, 250 ohms 2/11.

COMPLETE POWER PACK KIT. 19/11 Consisting of Mains Trans., Metal Rectifier, Double electrolytic, smoothing choke chassis and circuit. For 200-250 v. A.C. mains. Outputs 250v. 60mA, 6.3v. 2a.

R.S.C. POWER PACK. 39/9. Louvred metal case only 8 x 5½ x 2¼ins. Stove enamelled. For 200-250v. A.C. mains Output at 4 pin plug and socket 250 v. 60 mA, fully smoothed and 6.3v. 2a. Suitable for power requirements of almost any Pre-amp or Radio Tuner.

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 79/6, carr. 5/- or assembled ready for use £5.15.0

R.S.C. (Manchester) Ltd.

MAIL ORDERS to 5 County Arcade, Leeds 1. Terms: C.W.O. or C.O.D. No C.O.D. under £1. Postage 2/9 extra under £2. 4/6 extra under £5. Trade Supplied. S.A.E. with all enquiries please.

LEICESTER:	BIRMINGHAM:	SHEFFIELD:	HULL:	LIVERPOOL:	BRADFORD:	MANCHESTER:	LEEDS:
32 High St.	6 Gt. Western Arcade Birmingham	13 Exchange St. Castle Market Bldgs. Sheffield	51 Savile St., Hull	73 Dale St. Liverpool 2	56 Morley St. (above Alhambra Theatre) Bradford	P-10 Crown St. (Market St.) Manchester 2	5-7 County (Mecca) Arcade Briggate, Leeds
	No half-day	Half-day Thursday		Half-day Wednesday		No half-day	Half-day Wed.

AUDIOTRON HI-FI TAPE RECORDER KIT 25½ GNS. Carr. 17/6

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

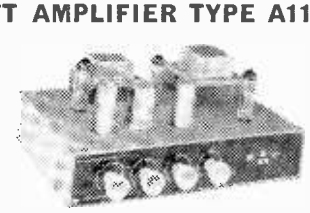
Incorporating the latest Collaro Studio Tape Transcriptor. The Audiotrine High Quality Tape Amplifier with negative feedback equalisation for each of 3 speeds. High Flux P.M. Speaker, empty Tape Spool, a Reel of Best Quality Tape and a Handsome Portable carrying Cabinet with latest attractive two-tone polychrome finish, 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 £2.13.9** and 12 monthly payments of **44/-**. Cash price if settled in 3 months.

ONLY 3 PAIRS OF SOLDERED JOINTS PLUS MAINS

SPECIAL NOTE. The Tape Decks we supply are latest models. Where customers already have a Deck or wish to use one of those being offered cheaply we can supply Kit less Deck at **13 gns.** carr. 10/-. Or deposit **2 gns.** and 12 monthly payments 23/9. Also if required we can supply in lieu of portable cabinet and 7 x 4in. speaker, the Equipment Cabinet illustrated at foot of opp. page and a high flux 8½ x 5¼in. speaker for **8½ gns.** extra

HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP STAGES



Two input sockets with associated controls allow mixing of "mike" and gram., as in A.10. 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 condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut". Frequency response ± 3 D.B. 30-30,000 c/s. Six negative feedback loops. Hum level 60 D.B. 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, GUITARS,** etc.

OUTPUT SOCKET with plug provides 300 v. 30 mA, and 6.3 v. 1.5 a. For supply of a **RADIO FEEDER UNIT.** Size approx. 12-9-7in. For A.C. mains 200-250 v. 50 c.p.s. Output for 3 and 15 ohms speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. Only **8 Gns.** Carr. (Or factory built 51/- extra.)

If required louvred metal cover with 2 carrying handles can be supplied for **18/9. TERMS ON ASSEMBLED UNITS. DEPOSIT 24/9 and 9 monthly payments of 24/9.** Send S.A.E. for illustrated leaflet detailing Ready-to-assemble Cabinets. Speaker. Microphones, etc., with cash and credit terms.

B.S.R. MONARDECK TAPEDECKS. Speed 3¾in. per sec. With high quality recording heads. **£6.19.6.** Carr. 5/-. Cabinets to take Deck and amplifier **39/6.**

R.S.C. TRANSISTORISED GRAM. AMPLIFIER. Output 1 watt. for 3 ohm speaker. Transistors Mullard OC71, OC81D. OC81, OC81. Fitted Vol. Control with switch. Assembled and tested. Suitable for any normal crystal pick-up. Only **59/9.**

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER

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 of "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/-.

Kit can be supplied assembled ready to use for **59/6** extra.

HI-FI CRYSTAL PICK-UP HEADS. (Cartridges.) Acos Standard replacement for Garrard, B.S.R. and Collaro. **19/9.** Acos Stereo-Monaural **49/9.** Ronette Stereo-Monaural **59/6.** B.S.R. Stereo **39/9. BRADMATIC RECORDING HEADS.** High Impedance Record/Playback **22/-.** Low Impedance Erase. **12/6. PICK-UP ARMS.** Complete and with latest Acos/hi-fi Turnover Cartridge **29/11. CRYSTAL MICROPHONES.** Hand type NP110 **14/9,** R.T.C. **19/9,** Acos Mic 40 **25/9,** Acos Mic 45 **29/9,** Stick type Acos 39-1 **39/9,** BM3 with neck band and heavy table stand **59/9,** Lapel type **35/9. COLLARO JUNIOR** 4-speed Single Player Unit and Crystal Pick-up with hi-fi Turnover head. Only **£3.19.6. B.S.R. UA14 4-sp'd AUTO-CHANGERS** with hi-fi turnover head. **£6.19.6.** Carr. 4/6. **GARRARD AUTO-SLIM 4-SPEED AUTO-CHANGER** with high fidelity pick-up. Latest model. For 200-250 v. A.C. mains. **£7.19.6.** Carr. 5/6. **GARRARD AT6 AUTO-SLIM DE-LUXE 4-SPEED AUTO-CHANGERS.** Turnover GC8 head, for 200-250 v. A.C. mains, **11 gns.** Carr. 4/6. **GL3A MINIATURE 2-3 WATT GRAM AMPLIFIER.** For use with any single or auto-change unit. Output for 2-3 ohm speaker. For 200-250 v. A.C. mains. Size 11¼ x 2½ x 2¼in. Controls: Vol. and Tone with switch. Only **59/6.**

R.S.C. BATTERY CHARGING EQUIPMENT

All for A.C. Mains 200-250v., 50 c/s. Guaranteed 12 months.

HEAVY DUTY CHARGER KIT 6/12 v. 6 amps. variable output. Consisting of Mains Transformer 0-200-230-250 v.: F.W. (Bridge) Selenium Rectifier: Ammeter, Variable Charge Rate Selector Panels, Plugs, Fuses, Fuseholder and circuit, **59/9.** Carr. 4/6.

CHARGER KIT, 12v. 14 AMP or 24v. 7 amp. Consisting of mains trans. 200-230-250 v. F.W. (Bridge) selenium Rectifier. F Ammeter, Fuses. Variable Resistor and Circuit. Only **6 gns.** Carr. 15/-. Please state if 12v. or 24v. kit required.

SOLDERING IRONS. 230-250 v. 30 watts. First quality. For Radio work, **19/9.** Spare elements and bits available.

Assembled 4-5 amps. 6/12 v.

Fitted Ammeter and variable charge rate selector. Also selector plug for 6 v. or 12 v. charging. Louvred steel case with stoved blue hammer finished. Fused and ready for use with mains and output leads. Carr. 5/-. Terms: Deposit **13/3** and 5 monthly payments 13/3. 6/12 v. 3a., all facilities as above. Only **59/9,** carr. 3/9

69/9

ASSEMBLED 6/12 v. 2 amps, Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case finished attractive hammer blue. Fused, ready for use with mains and output leads

49/9 Carr. 3/9

6/12 v. 1 amp. 27/9 Less meter.

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**
6 v. 2 amps **19/9**
6v. or 12v. 2 amps **25/9**
6 v. or 12 v. 2 amps, inclusive of Ammeter **35/9**
6 v. or 12 v. 4 amps **45/9**
6 v. or 12 v. 4 amps, with Ammeter and variable charge rate selector **52/9**

CHARGER AMMETERS 0-1.5 a., 0-3 a., 0-4 a., 0-7 a., 0-25 a., 0-60 a., **8/9.**

ASSEMBLED 12V. 10 Amp with variable charge rate adjustment, ammeter and strong louvred, stove enamelled case. Ready for use. Only **7 gns.** Carr. 10/- or in Kit Form **5 gns.**

R.S.C. MAINS TRANSFORMERS (FULLY GUARANTEED)

Interleaved and Impregnated. Primaries 200-230-250 v. 50 c/s. Screened

TOP SHROUDED DROP THROUGH
250-0-250v. 70mA. 6.3v. 2a, 0-5-6.3v. 2a **17/9**
350-0-350v. 80mA. 6.3v. 2a, 5v. 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 **25/9**
300-0-300v. 130mA. 6.3v. 4a. 6.3v. 1a. for Mullard 510 Amplifier.. .. .. **29/9**
300-0-300v. 100mA, 6.3v. 4a, 0-5-6.3v. 3a **26/9**
350-0-350v. 100mA. 6.3v. 4a, 0-5-6.3v. 3a **26/9**
350-0-350v. 150mA. 6.3v. 4a, 0-5-6.3v. 3a **29/9**
425-0-425v. 200mA. 6.3v 4a, 5v. 3a .. **49/9**

FULLY SHROUDED UPRIGHT
250-0-250v. 60mA. 6.3v. 2a, 0-5-6.3v. 2a, Midget type 2½-3-3½in. **17/11**
250-0-250v. 100mA. 6.3v. 4a, 0-5-6.3v. 3a **27/9**
300-0-300v. 100mA. 6.3v. 4a, 5v. 3a .. **27/11**
300-0-300v. 130mA. 6.3v. 4a, C.T. 6.3v. 1a, for Mullard Amplifier **33/9**
350-0-350v. 100mA. 6.3v. 4a, 5v. 3a .. **27/11**
350-0-350v. 150mA. 6.3v. 4a. 5v. 3a .. **35/9**

FULLY SHROUDED (continued)—
425-0-425v. 200mA. 6.3v. 4a, C.T. 5v. 3a **55/-**
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, 5000Ω to 3Ω **4/6**
Small Pentode 7/8,000Ω to 3Ω **4/6**
Standard Pentode 5,000Ω to 3Ω .. **5/9**
Standard Pentode 7,000Ω to 3Ω .. **5/9**
10,000Ω to 3Ω **5/9**
Push-Pull 8 watts, EL84, or 6V6 to 3Ω or matched to 15Ω **9/9**
Push-Pull 10-12 watts to match 6V6 or EL84 to 3-5-8 or 15Ω **19/9**
Following types for 3 and 15Ω speakers:
Push-Pull 10-12 watts 6V6 or EL84 .. **18/9**
Push-Pull 15-18 watts, 6L6, KT66 .. **22/9**
Push-Pull Mullard 510 Ultra Linear.. **29/9**
Push-Pull 20 watts, sectionally wound, 6L6, KT66, EL34, etc. .. **49/9**

MIDGET MAINS Primaries 200-250 v. 50 c/s. 250 v. 60 mA. 6.3 v. 2a **11/9**
250-0-250 v. 60 mA. 6.3 v. 2a .. **12/11**
Both above size 2½ x 2¼ x 2¼ins.

FILAMENT TRANSFORMERS
All with 200-250 v. 50 c/s. primaries 6.3 v. 1.5a. **5/9**; 6.3 v. 2a, **7/9**; 0-4-6.3 v. 2a, **7/9**; 12 v. 1 a. **7/11**; 6.3 v. 3 a, **8/11**; 6.3 v. 6 a, **17/6**; 12 v. 1.5 a. twice, **17/6.**

SMOOTHING CHOKES
150 mA, 7-10 H H 250 ohms **11/9**
100 mA, 10 H 200 ohms **8/9**
80 mA, 10 H 350 ohms **5/9**
60 mA, 10 H 400 ohms **4/11**

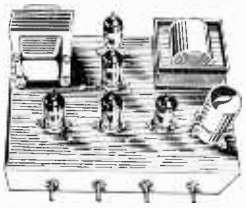
CHARGER TRANSFORMERS
All with 200-230-250 v. 50 c/s Primaries; 0-9-15 v. 1½ a, **12/9**; 0-9-15 v. 2a, **14/9**; 0-9-15, v. 3 a., **16/9**; 0-9-15 v. 5 a., **19/9**; 0-9-15 v. 6 a., **23/9**; 0-9-15 v. 8 a., **28/9.**

AUTO (Step up/Step down) TRANS. 0-110/120-220/250 v. 50-80 watts, **13/9.** 250 watts, **39/9**; 150 watts, **27/9.**

MICROPHONE TRANSFORMERS 120 : 1 high grade, clamped, **6/9**; 120 : 1 Plotted. Mu-metal screened, **9/9.**

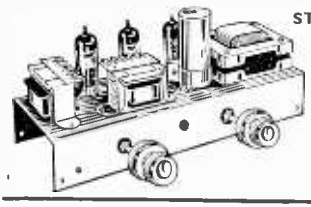
10/14 WATT HI-FI AMPLIFIER KIT

A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded ultra output transformer to match 3-15 speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 1/6. (Free with parts.)



All parts sold separately. ONLY **£6.19.6** P. & P. 6/6.

STEREO AMPLIFIER Bargain Offer

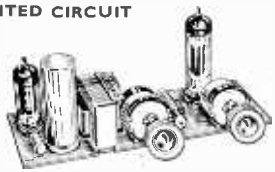


★ 4 watts per channel.
★ Full tone and volume controls.
★ Complete with sockets etc.

89/6
P. & P. 2/6.

AMPLIFIER ON PRINTED CIRCUIT BOARD

Two valve. UY85, UL84 O.P. trans., use with 80 volt tap off motor. **39/6.**
P.P. 2/6 on above. Dropper res. for filaments if required. **2/6.**



B.S.R. AUTO UNITS

160 v. Suitable for use with above. (Slightly soiled.) **£4.4.0.**
P. & P. 5/-.

LARGE CABINET Suitable for above two items. Complete with 3 ohm speaker. **£3.9.6.** Carr. 5/-.
Superior CABINET Similar to above to take 8 x 5in. speaker, with motor board, will accommodate BSR UA14 or UA16. **£3.9.6.** Carr. 5/6. Speaker 15/- extra. P. & P. 1/6 extra.

BRAND NEW 3 OHM LOUDSPEAKERS

2½in. **12/6**; 5in. **12/6**; 6½in. **15/-**; 10in. **21/-**; 12in. **27/6.**

Goodmans 5in. tweeter	.. 10/6
E.M.I. 2½in. tweeter..	.. 10/6
Goodmans 10in. x 6in.	.. 22/6
E.M.I. 13½in. x 8½in. high flux	32/6
Rola Celestion approx. 9in. x 6in. middle register speaker	10/6

Also 15 ohm 12in., 30/-
P. & P. 1/6 per speaker.

4-SPEED PLAYER UNIT BARGAINS

SINGLE PLAYERS
TU/12, **£3.10.0.** Carriage 3/6.
AUTO CHANGERS
B.S.R.UA14, **£6.2.6.** Latest B.S.R. UA16, **£7.2.6.** Latest Garrard "Auto-Slim" **£6.17.0.** Carr. 5/- on each.

RECORDING TAPE

P.V.C. base, full frequency L.P. tape. 7in., 1800ft. (normally 50/-) **27/6**; 5¼in., 1,200ft. (normally 35/-), **18/9.** P. & P. 1/- per spool. Ideal for 2 or 4 track recorder.

TAPE DECKS

COLLARO STUDIO DECK
£10.10.0, plus 5/6 carr. and ins.
B.S.R. MONARDECK
(Single speed) 3¾in. per sec., simple control, uses 5¾in. spools, **£6.15.0** plus 5/6 carr. and ins. (Tapes extra on both).

RECORD PLAYER AMPLIFIER

2 valve, A.C. mains, 3 watts output, ready built, tested and complete with valves and output transformer. Size 7in. w. x 2½in. d. x 5½in. h. **55/-.** P. & P. 3/-.
Suitable speakers: 6in. **15/-** or 10 x 6in. **22/6.** P. & P. 1/6 on each.

SPECIAL BARGAIN OFFERS!

MAINS TRANSFORMER. Impregnated and fully shrouded. Size 4½ x 3½ x 2¾in. Weight 6 lbs. Tapped primary 205, 225, 245 v. Electrostatic screen. Output 360-0-360 v. at 120 m/a D.C. plus 1050 v. half wave at 3 m/a D.C. 6.3 v. at 3.5 amps, centre tapped 5 v. at 2½ amps and 6.3 v. at .6 amps. PRICE ONLY **21/-** each, P. & P. 5/-.

CARBON MIKE INSERTS. Brand new, 2½in. dia., **3/6.** P. & P. 9d.

GORLER F.M. TUNER HEADS. 10.7 Mc/s I.F., **15/-**, plus 1/9 P. & P. (ECC85 valve 8/6 extra).

ELECTROSTATIC H.F. TWEETERS. Type L.S.H. 75. Size 3 x 3in., **2/6** each, plus 9d. P. & P.

MIDGET 2/GANG CONDENSERS. Capacity 195 and 100 pF. Polystyrene case with built-in trimmers. Size ¾ x ¾ x 1 in. Not used but removed from P/C Boards. Two for **9/-**, plus 1/- P. & P.

ACOS CRYSTAL MIKES. Hi-imp., Stick type. **25/-.** P. & P. 1/6.

TRANSISTOR DRIVER and O/P TRANSFORMERS. (Tapped 3 ohms and 15 ohms output), plus 4 suitable Transistors giving approx. 1 watt output. **30/-.** P. & P. 2/-.

3 PUSH-BUTTON TRANSISTOR SWITCH. D.P.—D.T. Each Switch 5/6 amd 1/- P. & P.

OUTSTANDING OFFER!

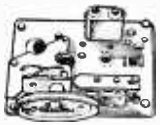
TELEFUNKEN HI-FI STEREO AMPLIFIER. 110/250 v. A.C. input. 5 watt undistorted output (10 watts nominal). Size 12 x 9 x 2in. Weight 9 lb. Complete with spec. and instructions. **£5.19.6.** Carr. 5/-.
Also **Model S82.** Similar specification but with balance control. **£6.19.6.** Carr. 5/-.

SPECIAL PURCHASE! TURRET TUNERS

by famous maker.

Brand new and unused. Complete with PCC84 and PCF80 valves. 34-38 Mc/s I.F. Biscuits for Channels 1 to 5 and 8 and 9. Circuit diagram supplied.
ONLY 25/- each. P.P. 2/6.

F.M. TUNER HEAD



A permeability tuned tuner head by a famous maker, supplied without valve (ECC85) and drum and spindle, **18/6,** plus 1/9 P. & P. Valve 8/6 extra. Drum and spindle 3/6 extra.

E.M.I. 4-speed Player and P.U.

FURTHER HUGE PURCHASE enables us to offer these **67/6** P. & P. at 4/6.

Heavy 8½in. metal turntable. Low flutter performance 200/250V shaded motor with tap at 45V for amplifier valve filament if required. Turnover LP/78 head.

TRANSISTOR PERSONAL RADIOS

Complete with leather case, personal earphone and PP3 battery. Will receive Luxembourg etc. loud and clear.

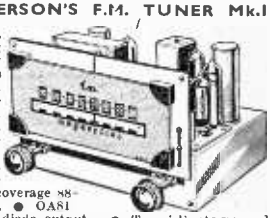
SIX TRANSISTOR TYPE
Size 4 x 2½ x 1¼in.
£4.19.6.

EIGHT TRANSISTOR TYPE
Size 4½ x 2½ x 1¼in.
£5.19.6.
Both plus P. & P. 2/6.

LOUDSPEAKER SILKS

Heavily woven in champagne and brown. 48in. wide. Originally 35/- per yard length.
OUR SPECIAL PRICE **12/-** per yard length. P. & P. 1/6. Also Red Rexine, Dark Grey and Oatmeal fabrics for cabinet covering, 54in. wide, **13/6** per yard length. P. & P. 1/6.

HARVERSON'S F.M. TUNER Mk.I



● F.M. tuning head by famous maker. ● Guaranteed non-drift. ● Permeability tuning. ● Frequency coverage 88–100 Mc/s. ● OA81 balanced diode output. ● Two I.F. stages and discriminator. ● Attractive maroon and gold dial (7 x 3in. glass). ● Self powered, using a good quality mains transformer and valve rectifier. ● Valves used ECC85, two EF80s, and EZ80 (rectifier). ● Fully drilled chassis. ● Size of completed tuner 8 x 6 x 5¼in. ● All parts sold separately, **£5.19.6.** plus 8/6 P.P. and ins. Circuit diagram and illustrations 1/6 post free.
Mark II Version as above but complete with magic eye, front panel and brackets. **£6.12.6.** P. & P. 8/6.
Mark III Version as Mark I but with output stage (ECL82) and tone control. **£7.7.0.** P. & P. 8/6.
Handsome Metal Cabinets, Choice of Grey, Black or Green. To fit Mark I, 25/-, P. & P. 2/6. To fit Mark II 17/6, P. & P. 2/6.

6 TRANSISTOR AND DIODE SUPERHET

A first-class 2 waveband transistor superhet in kit form. ● Printed circuit panel (size 8½ x 2½in.) ● 3 pre-aligned I.F. transformers. ● High-gain Ferrite rod aerial. ● All 1 First-grade transistors. ● Car aerial winding. ● Push-pull output. ● All parts supplied with simple instructions.

All parts sold separately
ONLY £4.5.0 P. & P. 2/6

2½in. 35 ohms speaker, **10/6**; 3½in. 35 ohms speaker, **16/6**; 35 ohms 5in. P.M., **18/6**; 7 x 4in. 35 ohms speaker, **21/-.** P. & P. 1/6 per speaker.

Portable CABINET

Size approx. 9½ x 6¾ x 3½in. Suitable for above using 3½in. speaker. **25/-.** P. & P. 2/-.

COIL AND TRANSFORMER SET FOR TRANSISTOR SUPERHET

3 I.F. transformers, one oscillator coil, one driver transformer and wound Ferrite aerial (med., long and aerial coupling), **28/6** complete, post 1/-. 6 transistor printed circuit, board to match. **8/6.** post 9d. Circuit diagram 1/6 extra.

QUALITY RECORD PLAYER AMPLIFIER

A top-quality record player amplifier. This amplifier (which is used in a 29 gn. record player) employs ECC83, EL84, EZ80 valves. Bass, treble and volume. On/off controls.

PRICE 69/6 P. & P. 3/6

DITTO. Mounted on board with output transformer and 6½in. speaker.
Complete at **89/6,** P. & P. 4/6

TRANSISTORS

GET15 (Matched Pair) **15/-**

OC71	.. ..	5/-	PXA101	..	6/6
OC72	.. ..	6/-	XA103	..	6/6
OC75	.. ..	6/-	V10/10p	..	12/6

Set of Mullard 6 transistors **25/-.** Set of G.E.C. 1,874; 2873; 3, 81 or GET114, **20/-.** All Post Free.

Stern's MULLARD DESIGNS

COMPLETE KITS OF PARTS

MULLARD 3-VALVE PRE-AMPLIFIER TONE CONTROL UNIT

Designed mainly for Mullard Range of Amplifiers, also suitable for any Amplifier requiring input up to 250mV. Incorporates 5 input Channels, including for Tape and Magnetic Pickups. Separate Bass and Treble controls. High pass filter 20 to 160 c/s, low pass filter 5-9 Kc/s. Totally enclosed in case size 11¼" x 4¼" x 4".

KIT OF PARTS **£10.0.0** ASSEMBLED & TESTED **£13.13.0**

MULLARD "5-10" MAIN AMPLIFIER

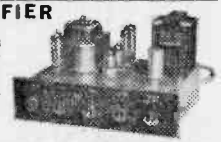
For use with MULLARD 2-stage pre-amplifier with which an undistorted power output of up to 10 watts is obtained. SPECIFIED COMPONENTS AND MULLARD VALVES including PARMEKO MAINS TRANSFORMER and choice of PARMEKO or PARTRIDGE Output Transformer.

COMPLETE KIT (Parmeko Output Trans.) **£10.0.0**

ASSEMBLED AND TESTED **£13.10.0**

ABOVE incorporating PARTRIDGE OUTPUT TRANS. £1.6.0 extra.

THE MULLARD 510/RC AMPLIFIER



The popular complete "5-10" incorporating Control Unit providing up to 10 watts high quality reproduction. Specified components and new MULLARD VALVES. Includes PERMEKO MAINS TRANSFORMERS and choice of PARMEKO or PARTRIDGE Output Transformers.

COMPLETE KIT **£12.0.0**

ASSEMBLED AND TESTED **£16.0.0** With PARTRIDGE OUTPUT TRANS. £1.6.0 ex.

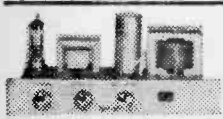
THE MULLARD 33/RC

A HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-WATT MULLARD "3-3" DESIGN.

KIT OF PARTS **£8.8.0**

ASSEMBLED AND TESTED **£11.10.0**

Complete to the MULLARD specification including PARMEKO OUTPUT TRANSFORMER. Switched inputs for 78 and L.P. records plus a Radio position. Extra power to drive a Radio Tuning Unit is also available.



THE "MONO-GRAM"

A small Amplifier of genuine high quality performance. Incorporates new MULLARD ECL86 Valve, separate BASS and TREBLE controls and produces up to 3 watts undistorted output.

Kit of Parts **£4.10.0** Assembled and Tested **£6.0.0**

Perfectly suited for Portable Installations for which purpose we offer PORTABLE CASE (£3.10.0), the AMPLIFIER (Kit) and 8" x 5" SPEAKER (£1.0.0). All for **£9.0.0**

Alternatively with ASSEMBLED AMPLIFIER **£10.0.0**

The Case quoted above will accommodate some 4-speed Single Record Units. A larger model is available for extra 10/-. With this Equipment a COMPLETE PORTABLE RECORD PLAYER can be built for **£14.0.0**

MULLARD FOUR CHANNEL MIXING UNIT

Self powered Cathode follower output. Incorporates two inputs for CRYSTAL MICROPHONES, one for CRYSTAL PICK-UPS and a fourth for Radio or Tape.

KIT OF PARTS **£8.8.0** ASSEMBLED AND TESTED **£11.10.0**

Alternative Model I/L provides for one input matched for moving coil or ribbon mike £1.17.0 extra.

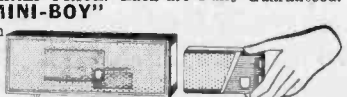
! ! SENSATIONAL BARGAINS ! !

A BULK PURCHASE ENABLES US TO OFFER THESE TWO GRUNDIG MODELS AT APPROX. HALF PRICE. Each are Fully Guaranteed.

THE GRUNDIG "MINI-BOY"

THE "LITTLE" SET with "BIG" PERFORMANCE LIST PRICE IS £26.5.0

OUR PRICE ONLY **£10.10.0** INCLUDING SPEAKER ENCLOSURE



A six Transistor (plus two Diodes) Portable covering the Medium Waveband. Small enough to slip into Handbag or Pocket (4" x 2½" x 1") but when at home "big set" performance is obtained simply by slipping the set into the companion Speaker Enclosure (size 9¼" x 3½" x 1½").

MULLARD'S 2-VALVE PRE-AMPLIFIER TONE CONTROL UNIT

Employing two EF86 valves and designed to operate with the Mullard MAIN AMPLIFIER but also perfectly suitable for other makes.

★ Equalisation for the latest R.I.A.A. characteristics.
★ Input for Crystal Pick-ups and variable reluctance magnetic types.
★ Input (a) Direct from High Imp. Tape Head. (b) From a Tape Amplifier or Pre-Amplifier.
★ Sensitive Microphone Channel. ★ Wide range BASS and TREBLE Controls.

KIT OF PARTS **£6.6.0** ASSEMBLED AND TESTED **£9.10.0**

PRICE REDUCTIONS

(a) THE KIT OF PARTS to build both the "5-10" Amplifier and the 2-Valve Pre-Amplifier.... **£15.10.0**

(a) Assembled and Tested..... **£21.10.0**

(b) THE KIT OF PARTS to build both the "5-10" Amplifier and the 3-Valve Pre-amplifier..... **£19.10.0**

(b) Assembled and Tested..... **£25.10.0**

With PARTRIDGE OUTPUT TRANSFORMER £1.6.0 extra.

HIGH FIDELITY LOUDSPEAKERS

WE STOCK THE COMPLETE RANGE BY GOODMANS, WHARFEDALE and W.B. STENTORIAN

A few recommended examples

8 INCH TYPES

GOODMANS "AXIETTE"	£5.5.0
W.B. HF 816	£5.19.6
WHARFEDALE "SUPER 8/RS/DD"	£6.14.0

10 INCH TYPES

GOODMANS "AXIOM 10"	£5.16.8
W.B. MODEL HF 1016	£7.0.0
WHARFEDALE "GOLDEN 10/RS/DD"	£17.17.0

12 INCH TYPES

GOODMANS "AXIOM 201" 15 watts	£9.15.0
GOODMANS "AXIOM 301" 20 watts	£14.10.0
W.B. MODEL HF 1214 15 watts	£10.5.6
WHARFEDALE "W12/RS"	£10.10.0
WHARFEDALE "Super 12/RS/DD"	£17.10.0

LEAK AND QUAD AMPLIFIERS IN STOCK

LEAK "TL/12 PLUS" POWER AMPLIFIER with the "POINT ONE PLUS" PRE-AMPLIFIER, 14 watts rated output. **£31.10.0**

LEAK "TL/25 PLUS" with the "POINT ONE PLUS" PREAMPLIFIER, 28 watts rated output **£37.16.0**

LEAK "STEREO 20" POWER AMPLIFIER with the "VARISLOPE STEREO" PRE-AMPLIFIER, 22 watts (11 watts per channel) **£55.9.0**

QUAD II POWER AMPLIFIER with QUAD II CONTROL UNIT. 15 watts output..... **£42.0.0**

RECORD PLAYERS

THE COLLARO "JUNIOR" 4-speed single player with separate crystal pick-up..... **£3.10.0**

THE NEW GARRARD "AUTOSLIM" 4-speed Autochanger with crystal pick-up..... **£7.10.0**

GARRARD "AUTOSLIM DE LUXE" 4-speed Autochanger, incorporates transcription Pick-up Arm **£11.8.0**

THE COLLARO "C60" 4-speed autochanger unit with Studio "O" pick-up **£6.19.6**

B.S.R. Model UA14, a 4-speed Mixer Autochanger with crystal pick-up **£6.10.0**

The new **GARRARD Model 4HF** High Quality Single Record Player fitted with the latest T.P.A. 12 pick-up arm and G.C.S. crystal Cartridge **£16.17.6**

GARRARD Model S.R.P.10. Single Record Player fitted with high output crystal pick-up **£5.0.0**

PHILIPS Model AG1016. A 4-speed Player can be operated both manually and automatically. Suitable for Mono or Stereo operation.... **£12.12.0**

Carr. and Ins. on each above 5/- extra.

! ! HOME CONSTRUCTORS ! !

A Range of "Easy to Assemble" Prefabricated Cabinets

Designed by the W.B. "STENTORIAN" COMPANY for "Hi-Fi" Loudspeaker systems or to accommodate high quality equipment. **FULL RANGE IN STOCK, please enclose S.A.E. for descriptive leaflets.**

IF YOU ARE PLANNING TO INSTALL "Hi-Fi" and UNCERTAIN OF THE TYPE OF EQUIPMENT TO USE—OUR WIDELY EXPERIENCED TECHNICAL STAFF WILL WITH PLEASURE PUT FORWARD RECOMMENDATIONS—STATE TYPE OF INSTALLATION CONTEMPLATED AND APPROX. PRICE LEVEL.

CREDIT SALE TERMS are available on all Equipment over £10.0.0.

FULLY DESCRIPTIVE LEAFLETS are readily available—please enclose S.A.E.

Stern's

SPECIALISTS IN SOUND EQUIPMENT FOR OVER 25 YEARS

STEREO TAPE PRE-AMPLIFIER

MODEL STP-1. For use with current TRUVOX, BRENELL, or COLLARO "STUDIO" ¼ and ½ track Stereo Decks. Incorporates Ferroxcube Oscillator, 4 speed Equalisation Signal Level Meter and separate Gain Controls. Includes separate Power Unit.

KIT OF PARTS **£22.0.0** ASSEMBLED **£28.0.0**

MULLARD'S TYPE "C" TAPE PRE-AMPLIFIER

Suitable for most ¼ track, Mono Tape Decks. Incorporates Ferroxcube Push Pull Oscillator and 3 Speed Treble Inductor. Includes separate Power Unit

KIT OF PARTS **£14.0.0** ASSEMBLED **£19.10.0**

MULLARD'S TAPE AMPLIFIER

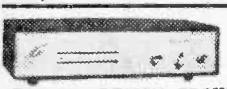
MODEL HF/TR3
Based on Mullards Type "A" design and suitable for most ¼ track Mono Tape Decks. Incorporates Ferroxcube 3 speed Treble Inductor and Gilsen Output Transformer. Includes separate Power Unit.

KIT OF PARTS **£13.13.0** ASSEMBLED **£19.0.0**

STERN'S "ADD-A-DECK"

A self contained Unit consisting of Garrard Deck and matched Preamplifier on one chassis. Provides full tape recording facilities and replays through Pick Up Sockets or standard Radio receiver or Amplifier.

PRICE includes Spool of Tape **£18.18.0**



TUDOR AM/FM TUNING UNIT

A SELF-POWERED HIGH FIDELITY TUNER OF OUTSTANDING DESIGN. PROVIDES FULL COVERAGE of the VHF/FM TRANSMISSION and also the LONG and MEDIUM WAVEBANDS PRICE ONLY **£19.19.0** Deposit £4 and 12 months £1.9.4

Operates perfectly with the STERN-MULLARD AMPLIFIERS and contains matching FRONT PANEL in Black/Gold or White/Black. Also operates equally well with any Amplifier requiring input of 100 to 350 m/Volts.

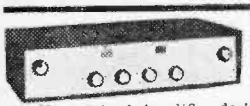
Mk. 11 "Fidelity" FM TUNING UNIT

An attractively presented Unit incorporating MULLARD PERMEABILITY TUNING HEART and corresponding Mullard valve line-up. Very suitable to operate with our Mullard Amplifiers.

KIT OF PARTS **£10.10.0**

ASSEMBLED AND TESTED **£14.5.0**

Full Range of Lustraphone Moving Coil Microphones, Stands and Accessories are in stock



THE "TUDOR" STEREO AMPLIFIER

PRICE **£15.0.0** (Carr. free)

A self contained Amplifier designed to provide high quality stereophonic and monophonic reproduction. Each channel provides a rated output of 6 watts and for monophonic operation approx. 12 watts is produced. Separate BASS and TREBLE CONTROLS.

!! COMBINED PRICE OFFERS !!

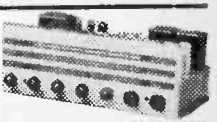
Includes small charge for special testing and PRECISE MATCHING of the ASSEMBLED PRE-AMPLIFIER (or Amplifier) to TAPE DECK

STP-1 (Kit) and "STUDIO" Deck	£39.0.0	Assembled	£46.0.0
STP-1 (Kit) and Brenell Deck	£66.0.0	Assembled	£75.0.0
STP-1 (Kit) and Truvox Deck	£51.0.0	Assembled	£59.0.0
TYPE "C" (Kit) and "STUDIO" Deck	£26.10.0	Assembled	£33.0.0
TYPE "C" (Kit) and BRENELL Deck	£43.0.0	Assembled	£50.0.0
TYPE "C" Assembled and Wearite Deck	£70.0.0	Inc. Head Lift Trans.	
HF/TR3 (Kit) and "STUDIO" Deck	£26.0.0	Assembled	£33.0.0
HF/TR3 (Kit) and BRENELL Deck	£43.0.0	Assembled	£50.0.0
HF/TR3 Assembled and Wearite Deck	£70.0.0	Inc. Head Lift Trans.	

To build a complete TAPE RECORDER we offer HF/TR3 AMPLIFIER STUDIO DECK, PORTABLE CASE, ROLA 10 x 8in. SPEAKER MICROPHONE and 1,200ft. TAPE ALL for £35.0.0.

ALTERNATIVELY WE OFFER....THE COMPLETELY ASSEMBLED and GUARANTEED PORTABLE RECORDER .... (Model CR3/S) .... FOR ... £43.0.0.

ARMSTRONG RADIOGRAM CHASSIS



We have the full range in stock. Prices range from £20.10.0. Full details are readily available.

Stereo Amplifiers

MULLARD'S "10 × 10" STEREO AMPLIFIER

A high fidelity design providing up to 10 watts (per channel). Superb reproduction frequency response flat to within 3db from 3 c/s to 60 Kc/s at 50 mW Total Harmonic Distortion at 10 watts 0.1%

Price (a) ASSEMBLED AMPLIFIER (as illustrated) **£24.0.0**

(b) KIT of PARTS..... **£20.0.0**

Built to the highest technical standards and presented strictly to MULLARD'S specification. Two specially designed GILSON OUTPUT TRANSFORMERS with 20% taps are used.

We can also supply the assembled MAIN AMPLIFIER only for operation with our DUAL CHANNEL PRE-AMPLIFIER: this provides a more versatile installation and be essential if a low output Magnetic Pick-up is to be used. When ordering specify loudspeaker impedance.

(a) THE ASSEMBLED MAIN AMPLIFIER and ASSEMBLED DUAL CHANNEL PRE-AMP..... **£34.0.0**

(b) KIT OF PARTS for both Units..... **£27.0.0**

THE "TWIN THREE" STEREO AMPLIFIER

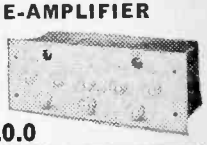
ASSEMBLED AND TESTED

£9.0.0 (Carriage and Insurance 7/6 extra)

Based on a recent design by MULLARD LTD., is ideally suited for use in PORTABLE RECORD PLAYERS for which purpose we offer a specially designed Case: incorporates MULLARD ECL 86 Valves, separate BASS and TREBLE CONTROLS and produces up to 3 watts per channel. Frequency response is 40 c/s to 30 Kc/s, size is only 11¼in. x 3in. x 5in.

To construct a STEREO PORTABLE RECORD PLAYER we offer: Assembled AMPLIFIER with two ROLA 8in. x 5in. LOUDSPEAKERS and PORTABLE CASE for..... **£16.10.0**

MULLARD DUAL-CHANNEL PRE-AMPLIFIER



A four Valve design for both STEREOPHONIC and MONOPHONIC operation. Operates equally well with any make of Amplifier requiring an input of up to 250 m/v.

KIT OF PARTS **£12.10.0** ASSEMBLED AND TESTED **£15.0.0**

CREDIT SALE TERMS ON ALL EQUIPMENT OVER £10

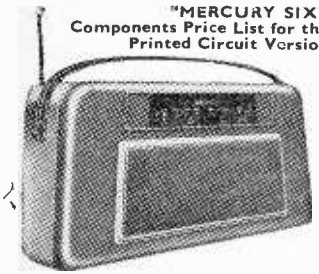
POSTAL ENQUIRIES and MAIL ORDERS TO . . .
STERN RADIO LTD.
6-12, TUDOR PLACE, TOTTENHAM COURT RD.
LONDON, W1. TEL. MUSEUM 6128/9

DEMONSTRATION and SHOWROOMS AT . . .

STERN RADIO LTD.
109, FLEET ST. LONDON, EC4
TEL. FLEET ST. 5812/3
OPEN...9 a.m. to 6 p.m. SAT. close 1 p.m.

PREMIER RADIO
23, TOTTENHAM COURT RD.
LONDON, W1. TEL. MUSEUM 6128/9
OPEN.. 9 a.m. to 6 p.m. THURS. close 1 p.m.

"MERCURY SIX" Components Price List for the Printed Circuit Version



COIL SET (OSC. and 3 I.F.s)	22/-
DRIVER TRANSFORMER. Type PW/DT	8/3
OUTPUT TRANSFORMER. Type PW/OT.	8/-
FERRITE ROD AERIAL. Type PW/FR	8/6
2-GANG CAPACITOR. Type "OO"	12/6
VOLUME CONTROL, EGEN 10K. S/P SWITCH	6/6
SWITCH	3/6
TRANSISTOR Type Y.C. (set of six) } XTAL DIODE Type GD9 }	43/-
SPEAKER	22/5
CASE complete with handle, front grille, studs	25/-
CAPACITORS	17/6
RESISTORS	5/-
TRIMMERS, Type MT.3I/4A, 1/3 ea.	3/9
PRINTED CIRCUIT BOARD	14/6
COMPLETE DIAL ASSEMBLY (BOXED)	14/6
HARDWARE (Screws, Nuts, Washers, Spacers, Battery Clips, Aerial Cradle)	5/9
Postage and Packing	2/6
INSTRUCTION HANDBOOK	2/6
COMPLETE KIT	£9.9.0

Telescopic Aerials

TA1 Nickel 3¾in. closed 14in. open 3/6
TA2 Nickel 8¾in. closed 38¾in. open 6/6
TA3 Chrome 5¼in. closed 31½in. open 9/-

Line Cord. 100 ohms per foot. .2 amp 3 way, 1/9 yard. .2 amp 2 way, 1/6 yard.

Co-Axial cable top Quality Semi air spaced.
20 yards coil ... ... 10/- post paid
40 yards coil ... ... 17/6 post paid
60 yards coil ... ... 25/- post paid

Twin Fig.3. Transparent plastic flex, 18/6 per 100 yards.

CHASSIS

Aluminium Undrilled with Reinforced Corner, available in the following sizes:

6in. x 4in. x 2½in.	4/6 each
8in. x 6in. x 2½in.	6/3 each
10in. x 7in. x 2½in.	7/3 each
12in. x 3in. x 2½in.	5/9 each
12in. x 5in. x 2½in.	6/9 each
12in. x 8in. x 2½in.	8/6 each
14in. x 3in. x 2½in.	6/0 each
14in. x 9in. x 2½in.	12/- each
16in. x 6in. x 2½in.	9/3 each
16in. x 10in. x 2½in.	14/- each

All are four-sided—ideal for radio receivers, amplifiers, power packs, etc.

RECORDING TAPES

Best Quality Good Makes.

STANDARD TYPE

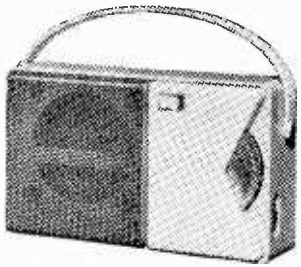
600ft. on 5in. spool	13/6
850ft. on 5¾in. spool	18/6
1200ft. on 7in. spool	22/6

EXTENDED PLAY TYPE

900ft. on 5in. spool	21/0
1800ft. on 7in. spool	37/6

250 ohms Earpiece with Earhanger. 3ft. cord and plug; superpower, 6/- each.

"PRACTICAL WIRELESS" POCKET TRANSISTOR SUPERHET



The new version in a redesigned cabinet with carrying strap.

COMPONENTS PRICE LIST

Coil Set, (Osc. and 3 I.F.s)	22/-
Driver Transformer, Type PW/DT	8/3
Output Transformer, Type PW/OT	8/-
Ferrite Rod Aerial, Type PW/FR	8/6
Printed Circuit Board	7/6
2 Gang Capacitor, Type "OO"	12/6
Volume Control, Type V.C.1545	8/-
Switch	3/6
Hardware (Screws, nuts, washers, spacers, battery clips, cable cradles, cable studs, cable strapping)	4/-
Transistors, Type YC (Set of 6) **Xtal Diode,** Type GD9 }	43/-
Speaker	17/10
Case	12/6
Capacitors	15/-
Resistors	5/-
Trimmers, Type MT3I/4A (3 required)	3/9

CONSTRUCTION LEAFLET AND "BLOW-UP" CIRCUIT DIAGRAM. PRICE FOR THE COMPLETE KIT £7.19.6.

ALUMINIUM PANELS

For use with our chassis, as front panels base plates, etc. Available in the following sizes:

14 x 9in. 4/- each
12 x 12in. 4/6 each
12 x 8in. 3/- each
10 x 7in. 2/3 each

TRANSISTORS AND DIODES

Transistors		OC75	8/-	OCP71	25/-	OA73	3/-
OC35	18/-	OC77	12/-			OA79	3/9
OC36	21/6	OC73	8/-	*Matched Prs.*		OA81	2/6
OC44	6/-	OC81	8/-	2xOC72	16/-	OA85	3/-
OC45	6/-	OC84	8/6	2xOC78	16/-	OA91	3/-
OC70	6/6	OC170	9/6	*Diodes*		OA95	3/6
OC71	5/-	OC171	10/6	OA5	6/-		
OC72	8/-	OC201	31/-	OA10	8/-	*Sundry Types*	
OC73	16/-	OC202	26/-	OA70	3/-	PXA102	4/-

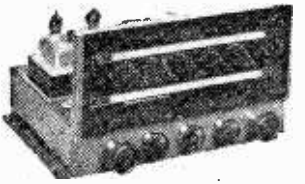
GECSI Audio Red Spot	3/6
White Spot	5/-
GEX34	3/-
GEX35	3/
XD201	1/-

A set of Transistors comprising 1 OC44, 2 OC45, 1 OC81D, 2 OC81, 32/6 set.
Set of Audio Transistors, 1 x OC81, 2 x OC81, Driver Matched Pair, 15/6 set.

Empty Plastic Tape Spools. 3in., 1/6; 5in., 2/-; 7in., 3/-.

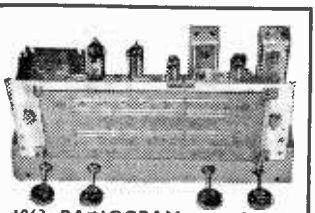
Milliameter. By Sparton of Canada. 0—300 M/A 2½in. dia., 14/- each.

ARMSTRONG AF208AM/FM RADIOGRAM CHASSIS



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

£21.4.0 *Carr. Free*



1963 RADIOGRAM CHASSIS

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

A.C. 200/250 v. 4-way Switch; Short-Medium, Long/Gram. A.V.C. and Negative feedback, 3 ohm output, 5 watts. Chassis 13½ x 9½ x 2½in. Glass dial, horizontal or vertical wording, size 10in. x 4½in. Aligned and calibrated. Isolated Chassis.

£8.19.6 Carr. & Ins. 4/6

BARGAIN SALE PRICES

New Boxed VALVES 90-day Guarantee

OZ4	5/-	6K7G	5/-	EABC80	8/-	PCL82	10/-
1R5	8/-	6K8G	5/-	EB91	4/-	PCL84	10/-
185	6/-	6L6G	8/-	EBC41	8/-	PL81	10/-
1T4	3/-	6N7M	5/-	EBC81	8/-	PL83	8/-
2X2	2/-	6Q7G	6/-	EBF80	9/-	PY33	15/-
3B4	7/-	6SN7	5/-	ECH42	9/-	PY80	7/-
3V4	7/-	6V6G	5/-	ECH81	9/-	PY81	8/-
3Q5	7/-	6X4	5/-	ECL82	10/-	PY82	7/-
5U4	6/-	6X5	6/-	EF85	6/-	PQ25	7/-
5Y3	6/-	12AT7	6/-	EF89	8/-	SP41	3/-
5Z4	9/-	12AU7	6/-	EL32	5/-	SP61	3/-
6AC7	4/-	12AX7	7/-	EL84	7/-	U22	7/-
6AM6	4/-	12BH7	7/-	EY51	9/-	UBC41	8/-
6AT6	6/-	12K7	5/-	EY86	9/-	UBC81	9/-
6BA6	7/-	12K8	14/-	EZ40	7/-	UBF89	9/-
6BE6	5/-	12Q7	5/-	EZ80	7/-	UCH81	9/-
6BW6	7/-	25Y3G	9/-	EZ81	7/-	UCL82	10/-
6C4	5/-	35L6	9/-	HABC8010		UCL83	12/-
6D6	5/-	35Z4	5/-	HVR2A	5/-	UF89	9/-
6G6	4/-	807	5/-	KT33C	8/-	UL41	9/-
6H6	3/-	954	2/-	KT76	8/-	UY41	7/-
6J5	5/-	DAF96	8/-	MU14	7/-	UY85	7/-
6J6	5/-	DF96	8/-	PCC84	8/-	UU9	7/-
6J7G	6/-	DK96	8/-	PCF80	8/-	VR150	7/-
6K6	5/-	DL96	8/-	PCF82	8/-	W81	6/-

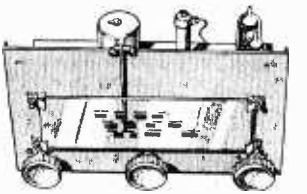
I.F. TRANSFORMERS 7/6 pair
465 K/s Slug Tuning Miniature Can, 2 x 1½ x 1¾in. High Q and good bandwidth. Data sheets.

NEW ELECTROLYTICS **FAMOUS MAKES**

TUBULAR		TUBULAR		CAN TYPES	
1/350V	2/-	30/350V	5/6	16/450V	5/-
2/350V	2/3	100/25V	3/-	32/350V	4/-
4/450V	2/3	250/25V	3/-	47/350V	6/6
8/450V	2/3	500/12V	3/-	100/270V	5/6
16/450V	3/-	1,000/12V	3/-	5,000/6V	5/-
32/450V	3/9	8+8/450V	3/6	32+32/350V	5/-
25/25V	1/9	8+16/450V	3/9	32+32/450V	6/-
25/50V	2/-	16+16/450V	4/3	32+32+32/350V	7/-
50/25V	2/-	32+32/350V	4/6	50+50/350V	7/-
50/50V	2/-			64+120/350V	11/6
				100+200/275V	12/6

COMPLETE RADIO CHASSIS £4.19.6. post free

4 Mullard valves. 5in. speaker.
Superhet Circuit. BRAND NEW.
Size 9 x 6 x 5¼in. high. Tested by us ready for use. 200/250 v. A.C.-D.C. Mains.



DE LUXE MODEL as illustrated with illuminated dial. Fully tunable with Medium and Long Wave. 12-month Guarantee. Only **£4.19.6** post 5/-.

MAINS TRANSFORMERS 200/250 v. A.C.
Postage 2/- each transformer.

STANDARD, 250-0-250, 80 mA, 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, 220-0-220, 50 mA. 6.3 v. 2 a. .. 17/6
STD. 250-0-250, 65 mA, 6.3 v. 3.5 a. .. 17/6
HEATER TRANS. 6.3 v. 1½ amp. .. 7/6
Ditto, tapped 1.4, 2, 3, 4, 5, 6.3 v. .. 8/6
Ditto, sec, 6.3 v. 4 amp. 10/6
GENERAL PURPOSE LOW VOLTAGE, 2 amp. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24, 30 v. 22/6
AUTO TRANSFORMER 150w. .. 22/6
0, 115, 200, 230, 250 v., 500 w. .. 82/6
MULLARD "510" Mains transformer .. 30/-
PARMEKO MAINS TRANSFORMER. Made for special contract, the ratings can safely be doubled. Guaranteed 2 years. Primary 0-110-210-230-250 v. H.T. 300-0-300 v. 50 mA. L.T. 6.3 v. 1.8 amp. Size 4 x 3½ x 3in. 17/6

MAINS POWER PACK. Size 3¾ x 4¼ x 4 in. with mains transformer, metal rectifier and condensers to provide smoothed H.T. output 220 v. 45 mA. D.C., L.T. 6.3 v. 2 a., Centre tapped. All ready built on a strong metal chassis. Brand New. Bargain. Post 2/6 .. .. 29/6

INTERVALVE TRANSFORMERS 3:1 or 5:1, 9/-.
O.P. TRANSFORMERS. Heavy Duty 50 mA. 4/6. Multi-ratio. 7/6. Multi-ratio heavy duty push pull, 10 w.. 15/6. Miniature, 3S4, etc., 5/9.
L.F. CHOKES 15/10H. 60/65 mA, 5/-; 10 H., 85 mA, 10/6; 10 H., 150 mA. 14/-.
FULL WAVE BRIDGE SELENIUM RECTIFIER: 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.
4 AMP CAR BATTERY CHARGER with amp. meter Leads, Fuse Case, etc., for 6 v. or 12 v., 69/9.
AMMETER 0 to 5 amp. 9/6.

BOOKS list S.A.E.

40 Circuits for Germanium Diodes 3/-.
"W.W." Radio Valve Data, 6/-.
High Fidelity Speaker Enclosure, 5/-.
Valve and TV Tube Equivalents, 9/6.
TV Fault Finding, 5/-.
Quality Amplifiers, 4/6.
Radio Valve Guide. Books 1, 2, 3, or 4, 5/- each.
Transistor Superhet Receivers, 7/6.
Practical Radio Inside Out, 3/6.
Master Colour Code Chart, 1/6.
Transistor Controlled Models, 7/6.
Principles of Colour TV 16/-.

4 TRANSISTOR PUSH-PULL AUDIO AMPLIFIER

Size 3 x 1¾ x ¾.
A ready built miniature push-pull amplifier with input and output transformers, 4 transistors. Ideal for use with record players, intercoms, BABY ALARMS, etc. Complete with full instructions and circuit.
Price **52/6** 9 v. Batt. 2/3, 2¼in. Speaker 15/-

C.R.T. BOOSTER TRANSFORMERS
for heater cathode short circuit, or tubes with failing emission. Full instructions supplied. mains input. **Type A optional 25%, and 50% boost, 2v. or 4v. or 6.3v. or 10.8v. or 12.6v. State voltage required. PRICE 10/6.**

LOUDSPEAKERS P.M. 3 OHM. 2½, 3, 4in., 5in. Rola, 7in. x 4in. Rola, 15/6; 6½in. Rola, 15/6; 8in. Plessey, 17/6 10 x 6in. 22/6; 10in. Rola, 30/-; 4in. Tweeter, 25/-; 12in. R.A. 30/-.
13¾ x 8in., Double Cone E.M.I. 35/-.
STENTORIAN HF1012. 10in. 3 to 15 ohms, 10 w. 82/6
35 ohm, 7 x 4in., 21/-; 5in., 17/6; 3½in., 15/6.

BAKER SELHURST LOUDSPEAKERS

Details S.A.E.
12in. Baker 15w. Stalwart 3 or 15 ohms, 45-13,000 c.p.s. 90/-
12in. Stereo. Foam Suspension, 12w., 35-16,000 c.p.s. .. £6.17.6
12in. Standard H.D. 20w, 40 - 14,500 c.p.s. .. £8
15in. Auditorium, 35 w., Bass, 20 c.p.s. to 12kc/s. £18
Details and Enclosures plan S.A.E.

TWIN GANG TUNING CONDENSERS. 365 pF, miniature 1in. x 1½in. x 1⅝in., 10/-. 500pF Standard with trimmers, 9/-; midget, 7/6; with trimmers, 9/-; 500pF slow motion tuning standard or midget. 9/-.
SMALL 3 gang 500 pF, 17/-. **SINGLE** 365 pF 7/6. **SINGLE** 25 pF, 50 pF, 75 pF, 100 pF, 160 pF, 5/6. Solid dielectric 100, 300, 500 pF, 3/6.
CONDENSERS. New stock. 0.001 mfd. 7 kV. T.C.C., 5/6; Ditto, 20 kV, 9/6; 0.1 mfd., 7 kV, 9/6. Tubular 500 v. 0.001 to 0.05 mfd., 9d., 0.1, 1/-; 0.25, 1/6; 0.5/500 v., 1/9; 0.1/350 v. 9d.; 0.1/2,000 v. 0.1/1,000 v., 1/9; 0.1 mfd., 2,000 volts, 3/6.
CERAMIC CONDS. 500 v. 0.3 pF to 0.01 mfd., 9d.
SILVER MICA CONDENSERS, 10% 5 pF to 500 pF 9d.; 600 pF to 3,000 pF, 1/-. Close tolerance (±1 pF) 2.2 pF to 47 pF, 1/-. Ditto 1% to 50 pF to 815 pF. 1/-; 1,000 pF to 5,000 pF, 1/9.

465 kc/s SIGNAL GENERATOR Price 15/-. Uses B.F.O. Unit, ZA 30038 ready made with valve IS5. **POCKET SIZE** 2½ x 4½ x 1in. One resistor to change, full instructions supplied. Battery 8/6 extra. 69V 1½V. Details S.A.E.

WAVECHANGE SWITCHES

8 p. 4-way 2 wafer long spindle	.. ..	6/6
2 p. 2-way, or 2 p. 6-way long spindle	..	3/6
4 p. 2-way or 4 p. 3-way long spindle	..	3/6
3 p. 4-way, or 1 p. 12-way long spindle	..	3/6

Wavechange "MAKITS". Wafers avail. able: 1 p. 12 way, 2 p., 6 way, 3 p. 4 way. 4 p. 3 way, 6 p. 2 way, 1 wafer switch, 8/6; 2 wafer switch, 12/6; 3 wafer switch, 16/-; additional wafers up to 12, 3/6 each extra. **Toggle Switches,** s.p., 2/-; d.p., 3/6; d.p.d.t., 4/-. **Rotary** s.p., 3/6; d.p., 4/6.

CRYSTAL MIKE INSERT, 6/6
Size 1 x 1½in., or 1¼in. dia.
ACOS MIC. 60, insert 1⅞in. dia.....8/6

ACOS 39-1 DE LUXE STICK MIKE 35/-
TSL QUALITY STICK MIKE....25/-

Valveholders. Pax. int. oct., 4d. EA50, 6d. B12A, CRT, 1/3. Engl. and Amer. 4-5 and 7 pin., 1/-. MOULDED Mazda and int. oct., 6d.; B7G, B8A, B8G, B9A, 9d. B7G with can, 1/6. B9A with can, 1/9. Ceramic EF50, B7G, B9A, int. oct., 1/-. B7G, B9A cans, 1/- each.

HI-FI AMPLIFIER. Ready built. A.C. only, 200-250 v. Valves ECL86 and EZ80. 3 watt quality output. Mullard tone circuits, bass boost, treble and volume controls. Separate engraved front panel with de-luxe finish. Heavy duty output transformer 3 ohm. Quality mains transformer. Stove enamelled chassis size 6in. x 5in. x 3in. **Bargain Price £4.10.0.** Circuit supplied.

THE ORIGINAL RADIO COMPONENT

Our written guarantee with every purchase
NEW COMPONENT LIST 1/-.

Bus 133 or 68 pass door
S.R. Station Selhurst

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; D.P. 14/6

80 ohm CABLE COAX

Semi-air spaced ¼in.
Stranded core. 40 yds. 17/6
60 yds. 25/- **6d.yd.**
Fringe Quality
Air spaced **1/-yd.**

TELESCOPIC CHROME AERIALS. 13in. extending to 43 in., 8/6 ea. Coax Adaptor Plug, 1/6 extra.
TRIPLEXERS Bands I. II, III 12/6
COAX PLUG .. 1/- **LEAD SOCKET** .. 2/-
PANEL SOCKETS 1/- **OUTLET BOXES** 4/-
BALANCED TWIN FEEDER yd. 6d. 80 or 300 ohms.
DITTO SCREENED per yd. 1/6. 80 ohms only.
Wirewound Ext. Speaker Control, 10Ω 3/-, 25Ω 6/d.
WIRE-WOUND POTS. 3 WATT. Pre-set Min. TV Types. All values to 10 ohms to 25 K., 3/- ea. 30 K., 50 K., 4/-. (Carbon 30 K., to 2 meg., 3/-).
WIRE-WOUND 4 WATT Pots. Long spindle. Value 50 ohms to 50 K., 6/6; 100 K., 7/6.
PHILIPS TRIMMERS, 0-10 pF, 3-30 pF, 1/-.
TRIMMERS, Ceramic. 30. 50, 70 pF, 9d.; 100 pF. 150 pF, 1/3; 250 pF, 1/6; 500 pF. 750 pF, 1/9.
TV etc. TRIMMER, 1000 pF, with knobs, 2/-.
RESISTORS. Preferred values. 10 ohms to 10 meg., ½ w., 4d.; ¾ w., 4d.; 1 w., 6d.; 1½ w., 8d.; 2 w., 1/-. High Stability. ½ w., 1%. 2/-. Preferred values 10Ω to 10 meg. Ditto 5% 10Ω to 2½ meg., 9d.

5 watt	WIRE-WOUND RESISTORS 10 ohms—10,000 ohms	1/3
10 watt		2/-
15 watt		2/-
12.5K to 47K 10 w.		3/-

AMERICAN "BRAND FIVE" PLASTIC RECORDING TAPE

Double Play	7in. reel, 2,400ft.	60/-	Spare Plastic Reels
	5in. reel, 1,200ft.	37/6	
Long Play	7in. reel, 1,800ft.	35/-	3in. 1/6
	5½in. reel, 1,200ft.	23/6	4in. 2/-
	5in. reel, 900ft.	18/6	5in. 2/-
Standard	7in. reel, 1,200ft.	25/-	5½in. 2/-
	5in. reel, 600 ft.	16/-	7in. 2/6

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

CRYSTAL SET BOOKLET. 1/-.
CRYSTAL DIODE G.E.C., 2/-. **GEX34.** 4/-. **OA81**, 3/-.
HIGH RESISTANCE PHONES. 4,000 ohms. 15/- pr.
SWITCH CLEANER. Fluid squirt spout, 4/6 tin.

HIGH GAIN TV PRE-AMPLIFIERS BAND I B.B.C.

Tunable channels 1 to 5. Gain 18dB. ECC84 valve. Kit price 29/6 or 49/6 with power pack. Details 6d. (PCC84 valves if preferred). Coils only 9/6

BAND III I.T.A.—Same prices. Tunable channels 8 to 13. Gain 17dB. Circuit and Coils only. 9/6.

1/16in. **Paxolin Panels**, 10 x 8in.. 2/-.
Miniature Contact Cooled Rectifiers, 250 V 50mA. 7/6: 250V 60mA. 8/6: 250V 85mA. 9/6: **Selenium Rect.**, 300V-85mA. 5/-.
TV etc., Silicon sub. Min. Rectifier, 125V. 300 mA. 6/6: 250V. 300mA. 14/6.
RM4, RM5, 14A100, 14A116, 10/- each FC31, 20/-
Coils Wearite "P" type, 3/- each.
Osmor Midget "Q" type, adj. dust core, from 4/- each. All ranges, List S.A.E.
Teletron D.W.R. L. and Med. T.R.F. with reaction. 4/-. Med. wave D.R.. 3/6.
Ferrite Aerials, M., 8/9: M. and L., 12/6.
Osmor Ferrite Rod Aerials, L. and M. for transistor circuits, 10/- each.
Ferrite Rods, 5 x ½in.. 3/-.
H.F. Chokes, 2/6. **Osmor QC1**, 6/9.
T.R.F. Coils, A/HF, 7/- pair; HAX, 3/-, Repanco DRR2, 4/-. DRX1. 2/6.
Radio Screwdriver, 5in.. 6d.
Neon Mains Tester Screwdriver. 5/-.
Solder Radiograde, 4d. yd., 1lb. 5/-.
Black Crackle Paint. Air drying. 3/- tin.

Aluminium Chassis, 18 s.w.g. Plain undrilled. 4 sides. riveted corners, lattice fixing holes. 2in. sides, 7 x 4in. 4/6: 9 x 7in., 5/9; 11 x 7in., 6/9; 13 x 9in., 8/6; 14 x 11in., 10/6; 15 x 14in., 12/6: **Aluminium Panels**, 18 s.w.g., 12 x 12in. 4/6: 14 x 9in., 4/-; 12 x 8in., 3/-; 10 x 7in., 2/3; 8 x 6in., 2/-.

"6 + 1" TRANSISTOR RADIO MEDIUM AND LONG WAVE KIT

First class components to make a 6 transistor 2 waveband superhet chassis. Ideal for portable or table radio. All parts including BVA transistors, ferrite aerial, *with car aerial coil*, printed circuit, 8½in. x 2½in., but EXCLUDING speaker and cabinet.
Speakers. 35 ohms. 7 x 4 in. 21/- **£4.5.0**
5in.. 17/6. 3½in., 15/6.

BULGIN PLUGS AND SOCKETS. Non-reversible P74. 2-pin. 4/3: P73. 3-Pin, 4/6; P194. 6-pin. 5/6.
JACKS. English open circuit. 2/6. Closed circuit, 4/3. Grundig type, 3 pin, 1/3. Grundig lead jack. 3/6.
JACK PLUGS. English, 3/-; Screened, 4/-; Grundig, 3 pin. 3/6.
ALADDIN FORMERS and cores, ½in., 8d.; ¾in. 10d. 0.3in. **FORMERS** 5937 or 8 cans TV1 or 2, ¾in. sq. x 2½in. or ½in. sq. x 1¼in., 2/- with cores.
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Practical Wireless

Vol. XXXVIII No. 674 APRIL, 1963

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Contents

The Editor will be pleased to consider articles of a practical nature. Such articles should be written on one side of the paper only, and should contain the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor should be addressed: The Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Owing to the rapid progress in the designs of wireless apparatus and to our efforts to keep readers in touch with the latest developments, we give no warranty that apparatus described in our columns is not the subject of letters patent.

At Your Service

EVERY month we receive many hundred letters from readers wishing to use our Query Service. Most of these are dealt with to mutual satisfaction, but it is only to be expected that with such a vast quantity of mail, readers are sometimes disappointed. We feel it would be useful, then, to outline the nature, purpose and scope of the service.

It is designed primarily to answer queries on articles published in the magazine and to deal with problems which cannot be solved by reference to text books, etc. It involves us in considerable time and expense and for this reason alone it can only be run efficiently if unnecessary time wastage is avoided.

What we CANNOT do

(1) Supply circuit diagrams or blueprints *other than those listed every month on the inside back cover page.*

(2) Design equipment, or supply circuits and wiring diagrams, to individual requirements. *We cannot undertake to run a design service.*

(3) Answer queries on most imported equipment, because technical information is often almost completely lacking.

(4) Supply details for converting war surplus equipment.

(5) *Answer technical queries over the telephone.*

What we CAN do

(1) Deal with queries relating to published articles.

(2) Try to help in technical problems where reference to standard books has not provided a solution.

(3) Give general advice.

(4) Try to help in servicing problems.

What YOU can do

(1) All queries **must** be accompanied by the query coupon from the current issue.

(2) A stamped and addressed envelope **must** accompany the query.

(3) Give clear and concise relevant information on the particular problem.

(4) Avoid "portmanteau" queries.

Failure to observe (1) and (2) will generally fail to elicit a reply. The provision of inadequate data may lead to delays. But delays may also occur through the necessity to locate some obscure facts arising from a query. And, of course, with such a large mail, correspondence does sometimes go astray.

Our whole purpose is to help readers in their problems; on the other hand it should be borne in mind that we offer a **free service** and not a **right** to make excessive demands (see item 4).

These notes are intended to help you to obtain the best service and for us to provide it!

Our next issue dated May will be published on April 5th.

ROUND THE WORLD of WIRELESS

NEWS AT HOME AND ABROAD

Broadcast Receiving Licences

THE following statement shows the approximate number of Broadcast Receiving Licences in force at the end of December, 1962, in respect of wireless receiving stations situated within the various Postal Regions of England, Wales, Scotland and Northern Ireland. The numbers include Licences issued to blind persons without payment.

Region	*Total*
London	614,435
Home Counties	571,385
Midland	413,784
North Eastern	435,330
North Western	374,209
South Western	337,679
Wales and Border Counties ..	188,450
Total England and Wales	2,935,272
Scotland	308,584
Northern Ireland	105,557
Grand Total	3,349,413

More Experimental Stereophonic Transmissions

ON 13th January this year the BBC commenced its second series of field trials of the Zenith-GE stereophonic system using the Wrotham Third Programme transmitter on its normal frequency of 91·3Mc/s.

There are regular morning transmissions of stereophonic programmes each week on Sundays at 10 to 10.30, on Wednesdays at 11 to 11.30 and on Saturdays at 11 to 11.30.

During the five minutes preceding each programme a tuning signal is radiated consisting of two tones of different pitch, the one of lower pitch being on the A (left-hand) channel. This signal lasts for four minutes and is followed by one minute with no modulation. At the beginning of each programme there is a stereophonic announcement for setting-up purposes.

Test Tapes for South Africa

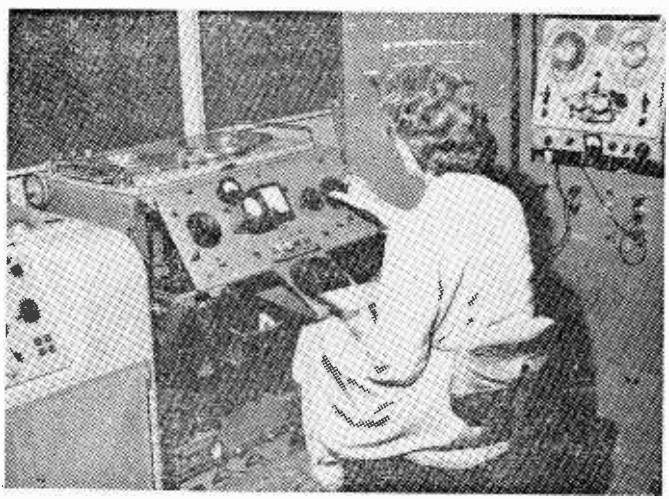
THE South African Broadcasting Corporation has placed orders with EMI Electronics Ltd. for test tapes for use in its broadcasting studios.

The test tapes comprise a sequence of pure tones over a very wide range of frequencies recorded at predetermined intervals. Such test tapes are recorded at the Hayes plant of EMI Electronics Ltd., using magnetic tape which has been carefully selected for uniformity along its entire length.

Tones from a special generator and their related prerecorded announcements, which give an audio indication of the tone to be played back, are recorded on magnetic tape using a specially modified and calibrated EMI studio tape recorder. All known corrections are made to allow for the differences between the replay head used during production and the head of a standard studio tape recorder.

The Largest Stabilised Power Supply

THE recent opening of the new Electronic Telephone Exchange at Highgate Wood by the Postmaster-General, Mr. Reginald Bevins, has brought to light some interesting information on the techniques of time-division multiplexing and



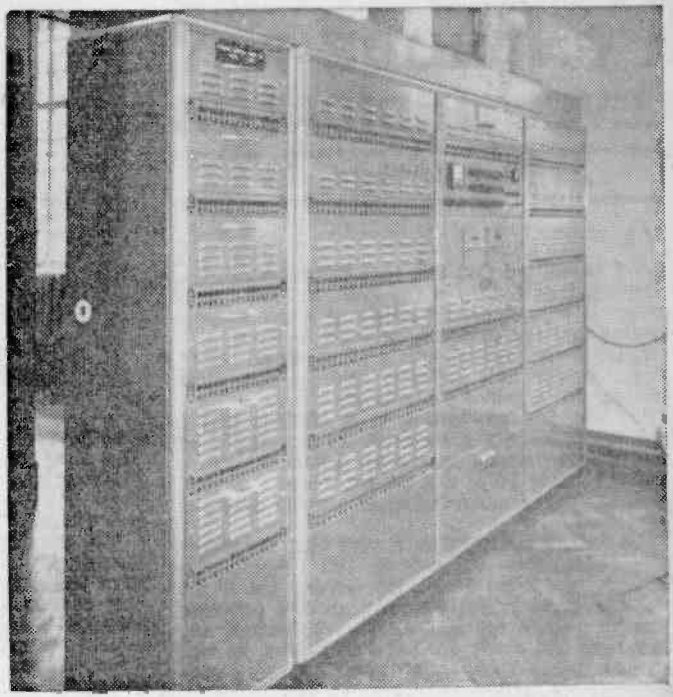
This illustration shows the type of specially modified recorders used by EMI to produce their test tapes, some of which have recently been ordered by the South African Broadcasting Corporation.

"memory" stores, etc., but the problems of supplying power were rather unusual.

The stabilised power requirements were presented to the Post Office by the five telephone companies of the joint committee whose individual members were responsible for separate aspects of the exchange design.

A.P.T. Electronic Industries Ltd. were invited to consider the overall requirements and to design and manufacture suitable supplies.

The result of this exercise was the production of four series-valve stabilised supplies which are probably the largest of their kind in the world. One unit which provides a mean current of 62A at +250V d.c., with peak currents up to 64A, utilises 180 valves type CV345 in parallel driven by a high-gain amplifier to cope with the variable aspect of the load in parallel with an unstabilised supply carrying the constant portion of the load current.



A stabiliser rack for the 250V 62A stabilised power supply at Highgate Wood electronic telephone exchange.

Carrier Frequency Stability Improvement

IN 1945 the BBC inaugurated high-precision frequency control of its 200kc/s transmission of the Light Programme from Droitwich. The long-term frequency stability, which was then within one part in 10^7, has now been considerably improved and is maintained within five parts in 10^9. The diurnal rate of frequency change of the 200kc/s carrier frequency is not greater than +1 part in 10^{10} and the resultant error will be corrected on the first Sunday in each calendar month starting on 3rd February, 1963.

The availability of this transmission will be increased to 20½ hours each weekday during 1963 with the planned extension of the Light Programme transmission hours.

Equipment at the Audio Festival

AT this year's International Audio Festival and Fair to be held at the Hotel Russell, Russell Square, London, the EMI group of companies will display a full range of professional tape recorders, a new stereo domestic tape recorder with general purpose loudspeaker enclosures, professional loudspeakers and Emitape.

The Audio Festival will continue from 18th to 21st April, when all this equipment will be on show to the public.

Radiotelephone Link for Lighthouses

TWO isolated lighthouses, 20 miles apart, whose only means of communication until recently has been a flashing lamp will in future use radiotelephones supplied by the Murphy Electronics Division of the Rank Organisation. The installation will connect the lighthouses, situated off the south-east coast of Ceylon, with each other and with their mainland station at Kirinda.

The Murphy radiotelephones will be installed and ready for use by the end of March and are to be maintained and serviced by the company's agent in Ceylon.

Ultra-Sonic Aid for Blind Persons

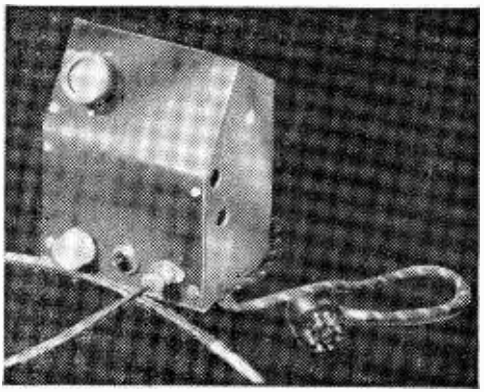
A SONIC aid for blind persons, produced by Ultra Electronics Ltd. on the basis of a design by Dr. Leslie Kay, of the Electrical Engineering Department of Birmingham University, has recently undergone a series of tests.

The aid consists of a transistorised transmitter-receiver which operates with a hand-held "torch", emitting an ultra-sonic beam of energy whose frequency varies with time. Any energy received back by the torch differs in frequency from that leaving it, at that instant, by an amount proportional to the time taken for the energy to travel out and be reflected back. Thus, by receiving the differing signals in an earphone, the blind person is able to judge the distance of an obstacle ahead of him.

After Dr. Kay had evolved a working system he approached the National Research Development Council and St. Dunstan's and NRDC requested tenders for ten of the devices for evaluation purposes. Ultra offered to produce the equipment free of charge and the offer was accepted. Work began on them in January last year and they were delivered in May, 1962.

A CATHODE RAY LEVEL INDICATOR

R. P. Hubbard



The author's prototype unit.

IT is realised that this type of instrument has been described before in the P.W., but the "dead horse" is only flogged because of some unusual features that the device is believed to have.

Its three applications are: a visual signal tracer, an a.c. bridge null indicator and an absorption indicator for a grid-dip oscillator.

For this last application it is obvious that a good d.c. sensitivity is required. In fact, it proved quite easy to obtain maximum deflection with a change of only 1·5V. On the a.c. range, however, the sensitivity is much higher as another amplifier is switched in.

The cost of construction is very low; the valves being obtainable for about 10s. Nothing is particularly critical about the circuit, but if the described form is not followed, careful attention must be paid to the layout. This is because any stray hum can easily spoil the sensitivity, as also can any spurious oscillation caused by the anode circuit of the second valve coming near the input of the first valve.

The Circuit

The circuit is given in Fig. 1. The switch, S1, in the input circuit determines the mode of operation of the instrument; whether it is to be of low gain responding to a.c. and d.c., or of high gain responding to a.c. only. The a.c. signals are routed to V1, a high gain pentode amplifier. It may be noticed that the high tension supply to this amplifier is very well smoothed and decoupled. This is to prevent any unwanted signals, e.g. hum, reaching V2. The cathode bias resistor, R5 in this stage, is left unbypassed so that negative feedback is produced which stabilises the amplifier.

The coupling capacitor, C4, must have negligible leakage or a potential will appear across R6 and as it is rotated the shadow angle on the display will change. The a.c.-d.c. and a.c. signal paths rejoin at the sensitivity control, R6, and the controlled signal is taken from the slider of the control to the grid of V2. V2 is in a special amplifier that produces an output of over 150V peak-to-peak. (It should be mentioned at this stage that the amplifier was designed only for high output with no consideration for distortionless output, as this is quite unnecessary.) The gain of this amplifier is over a hundred for maximum output, but is much more for small outputs.

By means of the resistance network, R8, R9, R10, the potentials on the screen grid and cathode are held steady at approximately 100V, and 1·5V respectively. In the quiescent condition the

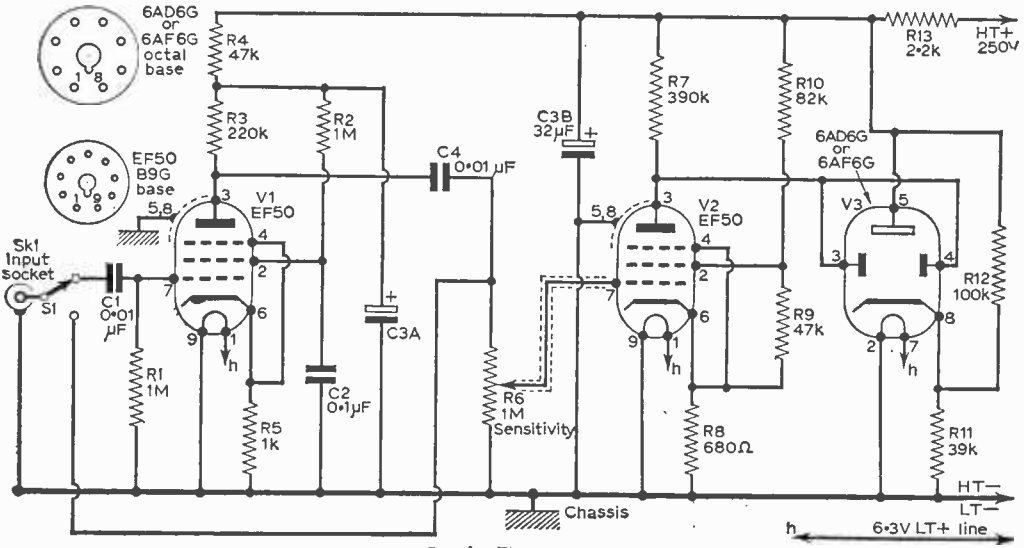


Fig. 1—The circuit.

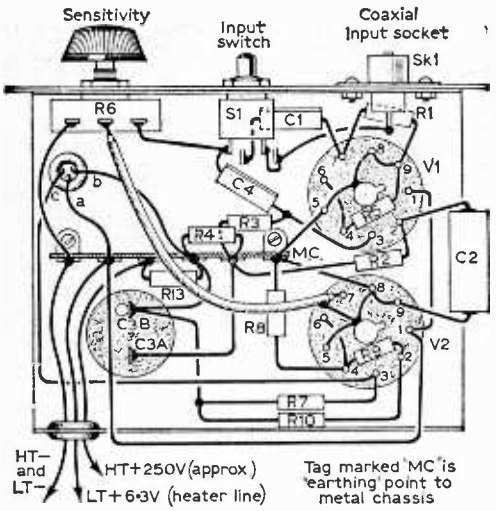


Fig. 2—The complete wiring diagram.

potential on the anode is about 50V. The anode is connected directly to the deflector plates of V3 which has its target connected to h.t.+ and its cathode held at about 100V above chassis potential. This is to fulfil the requirement that for a change in shadow angle of 135°, the deflector plates should change from −50 to +75V when there is 150V at the target.

The components C3B and R13 were first included to isolate the instrument from a power supply common to other equipment, but in the interests of reducing hum level it would be advisable to retain them even if a separate power supply were to be used.

The power required to operate the instrument is 0·75A at 6·3V and 5mA at 250V.

If it is so desired, other valves could be used, such as EF91's instead of the EF50's. An EM84 or EM85 could be used instead of 6AD6G or 6AF6G but R11 and R12 would probably have to

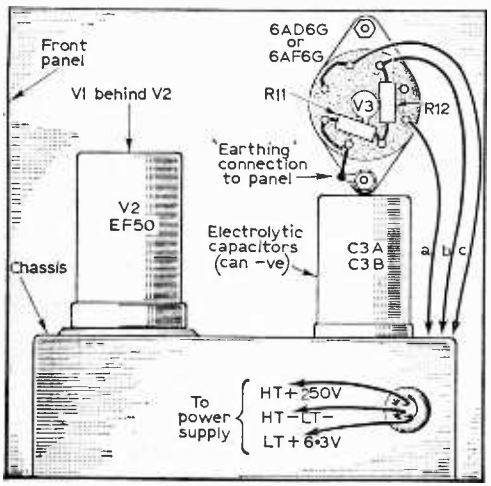


Fig. 3—Connections to the front panel.

COMPONENTS LIST

Resistors:

R1	1MΩ	R5	1kΩ	R10	82kΩ ½W
R2	1MΩ	R7	390kΩ	R11	39kΩ ½W
R3	220kΩ	R8	680Ω	R12	100kΩ
R4	47kΩ	R9	47kΩ	R13	2·2kΩ

R6 1MΩ carbon potentiometer
All resistors ¼W, except R10, R11. Tol. 10% or better for R8, R9, R10, R11, R12; others 20%

Capacitors:

C1 0·01μF paper 250V
C2 0·1μF paper 250V
C3A and B 32 + 32μF elec. 350V
C4 0·01μF paper 250V

Valves:

V1 EF50 V3 6AD6G or 6AF6G
V2 EF50

Miscellaneous:

S1 Single pole changeover switch
Sk1 Coaxial socket

be changed. If either of these valves were used, the amplifier section grid should be connected to the cathode and the anode to h.t.+ through about 1MΩ. In no circumstances, however, should the amplifier section be connected to the display section of the valve. It will be noted that the 6AD6G has no internal amplifier so this problem does not arise.

No difficulty should be found in the construction as no special techniques are used. The chassis and panel were made from 16s.w.g. aluminium sheet. Fortunately, an ex-government unit was available and it proved to be well suited for the

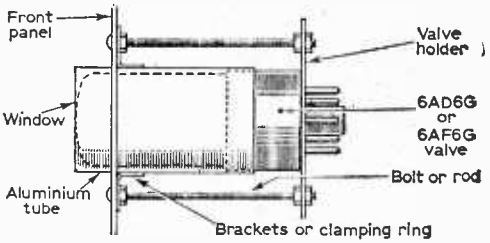


Fig. 4—The mounting details of V3.

purpose as the upper half sloped backwards. A sloping front panel is strongly recommended as it aids viewing considerably.

In the prototype instrument, the smoothing capacitor was of the twist-prong mounting type, but if the constructor has one of these and does not wish to cut the special holes, the capacitor can be mounted easily in a conventional mounting clip.

The housing for the display valve was made from an old halibut oil capsule container which had a hole cut in one end, reduced to the required length and bolted to the chassis together with the valve and valveholder (see Fig. 4).

It will be noticed that there is no provision for the detection of r.f. signals. This is because the instrument would almost invariably be used with a long coaxial cable or screened lead in the input, the capacitance of which would upset the working of high frequency circuits. It is therefore recommended that a suitable detector circuit be made up on the free end of the input lead from a semiconductor diode. ■

Geiger Counter Digital Register

incorporating Scaler and Power Pack

• • •

by
E. Dexter

• • •

THIS ARTICLE DESCRIBES A DIGITAL REGISTER FOR OPERATING THE ADVANCED GEIGER HEAD DESCRIBED IN THE DECEMBER 1962 AND JANUARY 1963 ISSUES.

THE complete circuit is shown in Fig. 1. Around V1, a normal full wave rectifier, is a conventional h.t. supply circuit. A valve rectifier was here chosen because of the necessary high a.c. input voltage to compensate losses in the subsequent stabiliser, making it difficult to get suitable metal rectifier units of reasonable price and size capable of fitting into the small overall dimensions of the whole unit. V2, V3 and V4 and associated circuitry form a conventional electronic h.t. stabiliser.

V3 compares the voltage at the slider of VR1 with the reference voltage present at the neon V4, and amplifies any error detected. The amplified result is used to bias V2, the series-stabiliser valve, in such a sense as to correct the error. C5 serves to perform the same function for a.c., i.e. to remove remaining ripple and other disturbances from the output. The final output from V2 cathode is thus a very steady h.t. supply, whose voltage is virtually independent of input mains voltage fluctuations and output loading, within the rated output of about 25mA. The voltage is determined solely by V4 and the setting of VR1, and is arranged to be continuously variable from about 200 to 350V, by means of VR1.

The circuitry around V8 to V11 will be recognised as an incorporation of the already published simple digital counter circuit, with only some minor modifications to suit present purposes. The most important of these modifications is here that the output pulser V11, operating the digital relay, is given its own separate (unstabilised) h.t. supply from a tapping on the mains transformer and D1, R3, C3, C4. This is to prevent any interference with the many other circuits in this unit when the digital relay takes its heavy surges of current on each count. Whilst this measure wa not needed in the simple digital counter alread published, its omission here causes primar interference with the new circuitry around V7, th digital scaler.

BINARY SCALER

This digital scaler serves the function of censo ing the input pulses from the Geiger head, and nc allowing everyone through to the counter, but onl *exactly* alternate ones, regardless of the statisticall random intervals between successive pulse characteristic of this whole field of work. V7 thu posesses a "Memory"; it can remember, for quite unlimited long time if necessary, whether let the last pulse through or not, and thus whethe it must let the next one through or not, regardles of how long it must wait for it, whether thousandth of a second or many hours. "forgets" only if the whole unit is switched o in the meantime, of course! V6 is a pulse pre amplifier, operative only when the memory circu (binary scaler, V7) is in operation, to make certai that a sufficient amplitude reaches V7 for prope functioning under all circumstances.

It is seen that S3 enables the unit to be switche for direct feed of all pulses into the counter, or fo "divide-by-two" scaling via V7, at will. Specia switching arrangements insensitive to stray capa cities have been devised, enabling a simple toggl switch to be used with full success.

NEGATIVE POWER SUPPLY

Finally, the power supply section contains ye another (negative) stabilised supply over D2, R1 C7, C8. This provides two separate stabilise

negative voltages: one of about 100-110V for bias operation on the digital counter section (from V5), and the other, using V5 and the power Zener diode D3, to give a supply of about −130-140V for the Geiger tube cathode feed. This voltage is somewhat higher than originally specified for the head, yet is perfectly satisfactory without any modification of the head whatsoever. The reason for this measure is as follows. The Digital Counter Section will operate well over an h.t. range of 210 to 340V, needing nothing but slight bias correction on VR2 for the various voltages, and even this is necessary only if the input pulse amplitude from certain head circuits is small.

The various samples of the specified Mullard MX124/01 tube and similar types have operating voltages lying between about 340 and 470V. The difference between this range and the counter range is seen to be around 130-140V, explaining why this voltage is then used for the Geiger tube cathode, thus allowing the Geiger tube anode to be fed from the same stabilised h.t. as the Digital Counter. However, this voltage is too high for counter bias input to VR2, as it would make adjustment of VR2 too harsh and critical. Thus the full negative voltage is supplied by the neon stabiliser V5 and the Zener diode stabiliser D3 in series, using only the correct portion for VR2.

Note carefully that the calibration to be placed on VR1 is to be such as to indicate the actual full Geiger tube voltage being applied to the head, i.e the actual positive h.t. being produced *plus* the constant stabilised negative voltage. The h.t. value alone is of no interest. Calibration of VR1 is thus to be performed against a meter connected between the h.t. and bias pins of the Head Power Feed Socket, P1.

A self-starting synchronous clock unit is used for timing the counting period, this being switched simultaneously with the digital counter section h.t. (S2). It is important to use a *self-starting* synchronous clock-unit, preferably also with a digital time display instead of by means of hands on a dial (operation-hours timer for industrial machinery).

Those constructors well versed in metal and lathe work can easily make their own digital timer, using any cheaply available loose self-starting synchronous motor as sometimes advertised in these pages, driving a suitable counter such as a cyclometer or revolution counter through suitable gearing.

PROTECTIVE DEVICES

The electrical protection is simple, using just a mains primary fuse of 500mA or 1A (slow-blow) rating, certainly no higher rating. This gives normally adequate protection, provided one does not use a mains transformer of larger rating than here specified—particularly, one should not use an item with further (then unused) additional secondaries.

The type of transformer specified is a perfectly

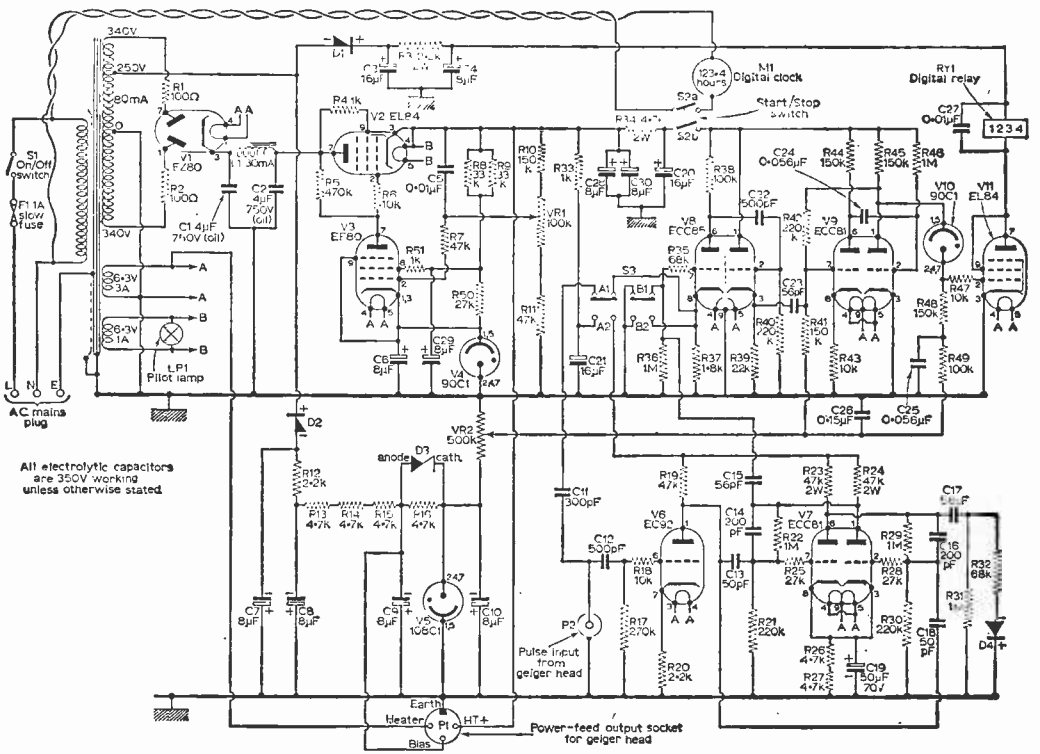


Fig. 1: The complete theoretical circuit of the digital register.

standard item, with 340-0-340 windings for a maximum of 60 to 80mA (350-0-350 will do, too). The windings must be tapped at 250-0-250V. Two heater windings are needed, one at 6·3V 3A for all valves except the EL84 (V2), which is run off a separate 6·3 1A winding also feeding the pilot lamp. The rectifier is fed from the main 3A heater winding with one side earthed, as it has a normal heater-to-cathode rating of 500V.

Only the EL84/V2 cannot tolerate this high heater to cathode voltage, and thus requires the separate heater supply, one side of which is commoned to its cathode.

VENTILATION

It is extremely important to pay attention to proper ventilation in circuits of this type, because they must be capable of extremely long periods of non-stop operation—far more so than ordinary wireless sets and amplifiers.

The present circuit contains eleven valves, yet uses a quite small compact design. It is thus clear that the use of any old layout in a closed cabinet is likely to promote the interior reaching the conditions of a small furnace after very few hours, giving early breakdown. Some simple thermal principles must therefore be understood and made they are of general applicability. The following facts are to be made use of:

(a) A component does not reach a certain temperature as such, but a certain required *excess* temperature over its surroundings, in order to dissipate the wattage lost in it.

(b) The exterior colour of the component influences the necessary excess temperature per watt needed, all else being unchanged. The darker the colour, the smaller the necessary excess temperature per watt.

(c) The required excess temperature is greatly reduced if the air is allowed to circulate away (convection).

(d) Where a component does not produce heat itself, but is close to other heat producers, it must ideally be polished bright, so as to reflect heat rather than absorb it.

It follows at once that the use of asbestos within the cabinet can probably do more harm than good. It is best to line the cabinet top inside with a bright piece of sheet aluminium. Spacing this in a sloping fashion from the wood (see Fig. 4), it reflects heat and guides it easily out of a suitably generous ventilation slit at the back. Because it is brightly polished, it hardly heats up itself, even though powerful valves immediately below it may be belching heat up against it.

In conjunction with this very effective measure, a right and a wrong layout can make all the difference. The principal heat-generating components in the present circuit, V1, V2, V11 and the mains transformer, are mounted near the rear of the cabinet, so that a strong convection current cools them locally at the rear, without the heat ever getting into other parts of the cabinet.

Finally, whatever one may think aesthetically, a good jet-black external finish to the cabinet is highly desirable, as it keeps the exterior cool. Also, it is in fact the most "neutral" for sober laboratory apparatus anyway.

Note also the small clearance of the chassis either side from the inside cabinet sidewalls (Fig. 4). This is very important, to prevent sub-

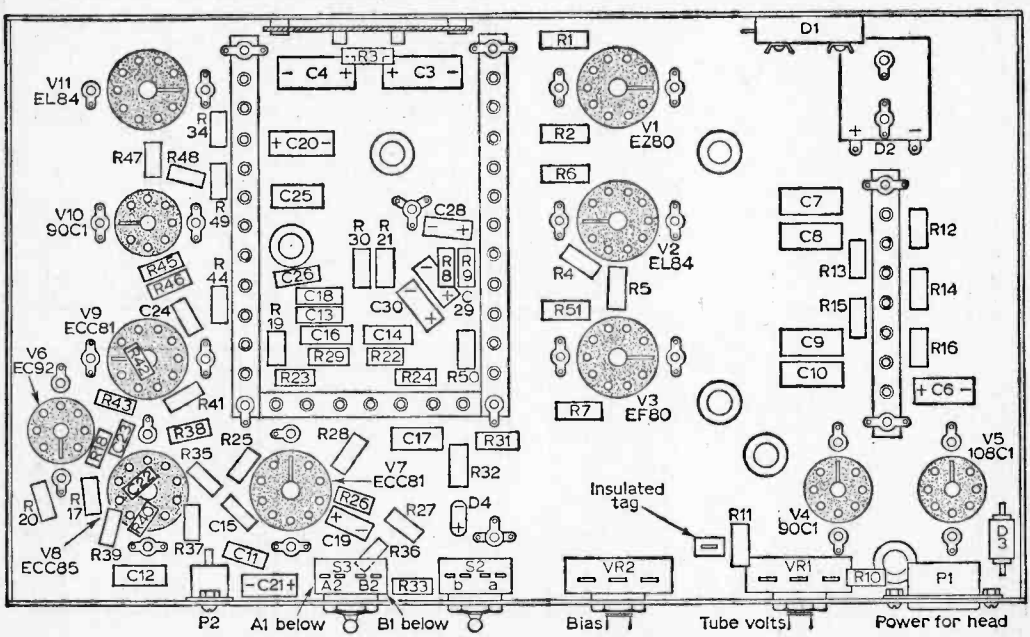


Fig. 2: The layout of components. The frame of chassis connection wires, with numerous cross-connections and earthing points, should be in bare tinned copper wire. Connecting wires on components are cut short at all flying connections.

LIST OF PARTS

Resistors:

R1	100Ω	R27	4·7kΩ
R2	100Ω	R28	27kΩ
R3	2·2kΩ 2W	R29	1MΩ
R4	1kΩ	R30	220kΩ
R5	470kΩ	R31	1MΩ
R6	10kΩ	R32	68kΩ
R7	47kΩ	R33	1kΩ
R8	33kΩ	R34	4·7kΩ 2W
R9	33kΩ	R35	68kΩ
R10	150kΩ	R36	1MΩ
R11	47kΩ	R37	1·8kΩ
R12	2·2kΩ	R38	100kΩ
R13	4·7kΩ	R39	22kΩ
R14	4·7kΩ	R40	220kΩ
R15	4·7kΩ	R41	150kΩ
R16	4·7kΩ	R42	220kΩ
R17	270kΩ	R43	10kΩ
R18	10kΩ	R44	150kΩ
R19	47kΩ	R45	150kΩ
R20	2·2kΩ	R46	1MΩ
R21	220kΩ	R47	10kΩ
R22	1MΩ	R48	150kΩ
R23	47kΩ 2W	R49	100kΩ
R24	47kΩ 2W	R50	27kΩ
R25	27kΩ	R51	1kΩ
R26	4·7kΩ		

VR1 100kΩ lin, VR2 500kΩ lin } and 2 pointer knobs

All carbon, 1 watt, ±10%, unless otherwise stated.

Capacitors:

C1 4μF Oil-paper 750V
C2 4μF Oil-paper 750V
C3 16μF Electrolytic 350V
C4 8μF Electrolytic 350V
C5 0·01μF Paper 500V
C6, C7, C8, C9, C10 } 8μF electrolytic 350V
C11 300pF, C12 500pF, C13 50pF, C14 200pF, C15 56pF, C16 200pF, C17 56pF, C18 50pF } Ceramic, 500V
C19 50μF electrolytic 70V
C20 16μF electrolytic 350V
C21 16μF electrolytic 350V
C22 500pF, C23 56pF } Ceramic 500V
C24 0·056μF, C25 0·056μF, C26 0·15μF, C27 0·01μF } Paper 500V
C28, C29, C30 } 8μF electrolytic 350V (if space, single 16μF in place of C28 plus C30)

Valves, Diodes:

V1	EZ80 Noval	V7	ECC81 Noval
V2	EL84 Noval	V8	ECC85 Noval
V3	EF80 Noval	V9	ECC81 Noval
V4	90C1 B7G	V10	90C1 B7G
V5	108C1 B7G	V11	EL84 Noval
V6	EC92 B7G		

D1 Selenium E250C50 Rectifier
D2 Selenium E250C50 Rectifier
D3 Power Zener Diode, 33V 20mA (ZL33)
D4 Fast Silicon Diode, 350V Inverse, 25mA, 10pF (S36)

Switches:

S1 1-pole ON/OFF
S2 2-pole ON/OFF
S3 2-pole/2-pole ON/ON
} Q.M.B. toggle switches, 250/500V, insulated toggles
(If S3 unobtainable, use 4-pole, 2-way rotary wafer switch)

Miscellaneous

T1 Mains transformer. Secondaries: 340-250-0-250-340V 80mA; 6·3V 1A; 6·3V 3A
L1 Smoothing choke, 15 Henry 1000 ohm 30mA (approx.)
RY1 Digital relay, approx. 1-2k (G.P.O. Telephone-Call Counter)
M1 SELF-STARTING synchronous motor driving digital hours-counter (for 50c/s mains, local voltage)
F1 Panel fuse, mains, 1A slow
LP1 Red pilot lamp for panel, 12volt 0·1-0·2A bulb (see text)
P1 4-pole/500V non-reversible panel-socket
P2 Panel-mounting coaxial socket
Chassis: Aluminium, 10 x 6 x 2in.
Main lead, plug. Connecting wire, tagstrip, sleeving, bolts, etc.; Solder.
Wood and screws for cabinet
Aluminium plate for heat-deflection (see text)
Valveholders: seven B9A and four B7G ceramic with skirt

chassis overheating. In this connection a spaced chain of resistors R12 to R16 was used instead of a single resistor of high wattage rating. This prevents undue localised subchassis heat-production.

These factors cannot be over emphasised, as once one has taken the trouble to produce such a unit as here described, one wants to concentrate on the interesting experiments possible with it, and not have these interrupted by frequent breakdowns. If the points here discussed are carefully attended to, and just that little bit extra spent on really good reliable parts in the crucial positions instead of saving a few pence by using any old junk, the unit described in this article will be found to give long and reliable service.

THE DIGITAL COUNTER

The principles of this circuit have already been discussed in detail in the article "A Digital Counter" by Mr. A. Cole, P.W. Feb.-April, 1962.

The same circuit has been incorporated here with little change. The separate h.t. feed for V11 has already been mentioned. V11 has also received a grid-stopper here, R47, necessary to cure some parasitic instability at first resulting with the different layout and conditions here adopted. It was also necessary to place a grid-stopper, R35, at pin 7 of V8 to cure initial further violent parasitics resulting from distributed inductances of the switch-leads on S3. ***—continued on page 1094***

OUR FREE GIFT

CALCULATOR

FOR PARALLEL RESISTORS AND SERIES CAPACITORS

by F. P. Rozee

THE arithmetical calculations involved in computing the equivalent value of resistors in parallel or capacitors in series, are sufficiently tedious to warrant the employment of some mechanical means of computing.

The calculator enclosed with this month's issue of PRACTICAL WIRELESS has been specifically designed for this purpose. Compared with any other method of computation, even if it be by the use of a slide rule, this calculator can give the answer in a fraction of the time. Furthermore errors are most unlikely. It will be found that the accuracy is far better than the tolerance of practical components, in most cases closer than 2% can be read.

An inspection of the calculator shows that it consists of three scales, "A", "B" and "C", and two pointers. The left-hand pointer is used in association with scale "B", and the right-hand pointer with scale "A".

The answer is read off on scale "C" at the point of intersection.

Resistors in Parallel

The equivalent value of two resistors in parallel is found by setting one pointer to the value of R1 on scale "A", the other pointer to the value of R2 on scale "B", the result Re is then read on scale "C" where the pointers cross.

Examples:

R1	R2	Re
10	15	6
20	5	4
12	6	4
12	4	3

All of the above are easily read on scales "A" and "B". However for those combinations which cannot be accommodated on these scales, it is necessary to divide R1 and R2 by some convenient factor, to bring these values within the range of the scales. The reading obtained on scale "C" is then multiplied by this same factor to give the correct answer.

For example, suppose R1 is 820, and R2 is 2,200. Dividing both of these values by 1,000 will bring these within the range of the scales. Therefore, set one pointer to 0·82 and the other to 2·2. This gives a reading of 0·6 on scale "C" which is multiplied by 1,000 to provide the equivalent value (Re) of 600.

One further example will make quite clear this method of extending the range of the calculator.

R1=56, R2=36.

In this case it is convenient to divide by four and the pointers are set as follows.

Scale "B" 14. Scale "A" 9. This gives a reading of 5·5 on scale "C" and Re is $4 \times 5{\cdot}5 = 22$.

Adjusting Existing Values

It is sometimes required to bring an existing resistor in a circuit to a lower value. The calculator can be used then as follows: Assume the existing component to be 4·7kΩ and that a value of 3kΩ is required. Set the left-hand pointer to 4·7, then move the other pointer until the lines cross on 3 on scale "C", and read off on the left-hand scale, in this case 8·2. Therefore the value of the shunt resistor required is 8·2kΩ.

Capacitors in Series

The method of computing for capacitors in series is exactly the same as for resistors in parallel. The instructions will thus apply equally for resistors or capacitors. The terms R1, R2 and Re have been used for convenience, they can be considered where required as being C1, C2 and Ce.

Widely Differing Values

As most readers are aware, when one component is more than ten times the value of another, the higher value can usually be ignored as 10% or 20% tolerance components are normally used for radio and television work.

Determining the Decimal Position

Values are multiplied or divided by 10, 100, 1,000 etc. as required. There is no difficulty in determining the correct decimal position. The equivalent value of 120kΩ and 56kΩ for instance could not be 3·8kΩ nor 380kΩ; it is obviously 38kΩ.

Similarly a 0·2μF and a 0·05μF could only be 0·04μF. The new value must lay somewhere between the value of the lower of the two components and half the value of the lower.

GEIGER COUNTER DIGITAL REGISTER

— continue —

The value of R37 has also been reduced somewhat in comparison to the corresponding component in the original circuit—a measure by no means essential, yet giving somewhat increased sensitivity at the expense of a little greater interference from any spurious Geiger-kicks from the head (see below for further discussion of this point).

INPUT SWITCHING

The wiring around S3, the direct/scaler change-over-switch, represents the major difference between the present counter and the original circuit.

In the setting "direct", A1 and B1 are closed and A2, B2 open. Thus A1 feeds the input pulses to V8, pin 8 (cathode), via C11, the same as in the original publication, and every one is thus counted. B1 at the same time shorts the grid circuit, to stop interference from pulses also arriving capacitively from V7. V6 and V7 are dead in this position, because A2 is breaking their h.t. supply, although the heaters are on in "standby". The (dead) V6 further serves as a buffer in this position, to stop pulses also coming the wrong way.

CONTINUED NEXT MONTH

semiconductors

by C.M. and E.C.D.

TALKING POINTS ON CIRCUIT PRACTICE

No. 3—Audio Amplifiers

Continued from page 1030 of the March issue

WE have now dealt with transistors under d.c. conditions and explained the necessity for them to be correctly set up to these conditions before they can be used for any purpose at all. Let us now consider them dynamically — as audio amplifiers.

There is no great problem involved in using transistors in audio-amplification configurations. Any of the usual circuits can be tried.

Suppose the circuit Fig. 1 to be intended to amplify a small signal at r.f., imposing a variation of a couple of microamperes or even less on the base. With a gain of 50 in the transistor this will involve a swing of $2 \times 50\mu A$ in the collector= $100\mu A$. A standing collector current of 1mA, with a suitable load, would accept this without bottoming the transistor on one hand or cutting it off on the other.

Suppose now that the stage is intended to be the ultimate or penultimate of an audio amplifier. The base input now will not vary in the order of microamperes but in the order of milliamperes. A change of say 10mA in the base will be 10×50 in the collector $= 500 = \frac{1}{2}$A. We are obviously not going to accommodate this in a standing current of 1mA. Or are we? In order to answer this, we must consider *how* the base input is to be applied, not merely how large it is.

For the moment, for the sake of clarity, we are ignoring the effect of the load resistor in the collector, but this also will limit the capacity of the transistor of course because apart from accommodating the *current* swing the output circuit must not drop so many volts over the load that the voltage limits are exceeded, either.

Now in the average case with the base isolated from its source of drive by a capacitor, the potential on the base will be that at the junction of the potential divider R1, R2 and the applied a.c., assuming a sine wave, will appear upon it as Fig. 2(a), moving the base positively on one half of the wave, negatively with respect to its standing bias on the other.

In an audio amplifier the wave will be in fact d.c. frequency modulated. But in this instant we will assume that it shall appear to the base as a.c.

Assuming this we can draw some conclusions.

CURRENT SWING

The corresponding change in collector current will be an increment in the standing current when the base moves negatively and a decrement in the standing current when the base moves positively. Assuming a standing collector current of 1mA, this can certainly *rise* by 50mA or what-have-you when the base moves negatively (provided the transistor is capable of handling 50mA peak). But since a reduction of 1mA will mean no collector current at all it equally certainly cannot *fall* by 50mA when the base moves positively. In fact the transistor will cut off on the positive half of the drive and will amplify only one half of the input—which might be all right if we wanted rectification but is all wrong when we want linear amplification.

Quite obviously then the standing current in the collector will have to be at least 50mA in order to accommodate a swing of 50 above this *and* 50 below it.

Consider now the base of the transistor driven from a diode, Fig. 3(a). Again we set the standing collector current at 1mA. Suppose the diode to be inserted negativewise—that is, so that it passes only negative current to the base. The sine wave entering the diode is as Fig. 3(b). Leaving the diode the wave is as Fig. 3(c). *Now* the base moves *wholly* negatively on its standing bias, inducing an *increase* in collector current varying according to the modulation as shown in Fig. 3(d). There is no positive move on the base and therefore no *reduction* of collector current. If the base moves 5mA negatively on its standing potentials, at a gain of 50 the collector

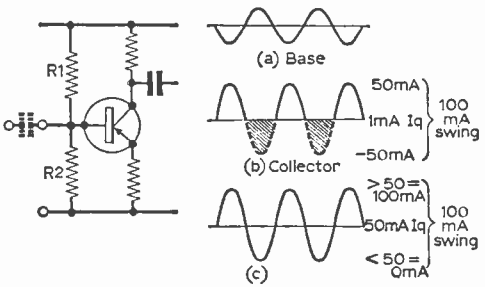


Fig. 1: Common-emitter amplifier.
Fig. 2: Need for adequate collector Iq.

will increase 250mA above its standing or quiescent value but will never drop *below* it. In this case obviously we can safely run the transistor on a quiescent collector current of only 1mA since the variation due to signal drive will be wholly incremental—Fig. 3(d).

Now reverse the diode and connect it positive-wise so that it passes only positive current to the base. Here the signals on the base will be wholly the positive half of the wave, Fig. 3(e); the collector current changes will be wholly *decremental;* the collector current will try to move less than its quiescent value to the tune of 250mA downwards (on peak signal) and the transistor will cut off, Fig. 3(f). The result (and this occurs often enough) will be " no signals ". Raise the standing collector current to a value of some 250 or 275mA quiescent, however, so that a reduction of 250 can be accommodated without cutting off the transistor and once again everything is jake.

IMPORTANCE OF PHASE

Now let us state the rule—namely, that not only the *size* of the incoming signal will have to be considered but also its *phasing,* whether wholly negativewise, wholly positivewise or effectively a.c. If you apply a positive-going signal to the base of a transistor already biased near to cut-off, and the signal is of any sort of amplitude, the transistor will cut off. If you apply a negative-going signal to a transistor already biased so that its standing current is near the maximum either according to published data (when an increment will destroy it) or according to its load so that any increase will cause all the available volts to be dropped, so bottoming the transistor, the result will be no signals.

A wholly negative-going input allows the transistor to be worked at low values of collector quiescent current, a wholly positive-going signal requires it to be worked at a high standing collector current; an a.c. input requires it to be worked at midpoint approximately on its output characteristic so as to accommodate both increment and decrement of the standing Icq.

These considerations do not need to worry us with small signals but in audio amplifiers where the currents and voltages can be considerable it is different. There is a misconception abroad that transistors cannot be used for large currents. Nothing is more mistaken. We have the GEX544, for instance, capable of charging your car battery to the tune of 5A and occupying no more space than a half-crown piece. Normal audio output stages may carry a current of anything from 100mA for the OC81 up to several amperes according to the transistors used; 20W outputs for public address systems can be achieved.

Perhaps we had better get out of possible trouble at this point by introducing Fig. 4 to explain that a wholly positive-going or a wholly negative-going signal on the base does not in practice modulate the base wholly upwards or below its standing bias,

Fig. 4: Shift of standing bias due to input signal.

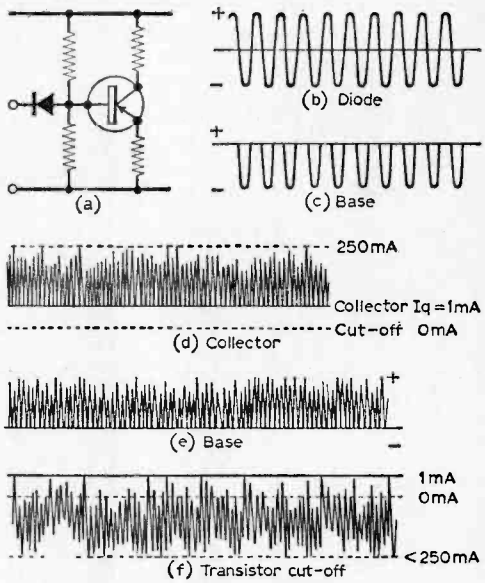


Fig. 3 (a), (b), (c) and (d): Negative-going input; (e) and (f): Positive-going input.

though for practical purposes it is usually enough to consider it so. In fact the standing bias on the base is increased or decreased to a new value by the addition (electrical) of the mean of the applied signal—the figure should make this clear enough —and the base moves about this *new* value. The standing collector current will thus increase or decrease on signal to a new value, moving with the frequency modulation around this; it may need to be calculated or not according to the size of the signals expected to be handled. If we allow ourselves a sufficient margin so that the collector current will never vary sufficiently to be near cut-off *or* bottoming we can ignore this factor.

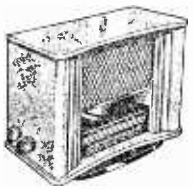
But what we must remember in transistor technique is that the *phasing* of the incoming signal may be important.

PRACTICAL AMPLIFIER CIRCUITS

Since transistors are normally battery operated it is obvious that push-pull circuits worked in Class B will normally be preferred in output stages on account of their saving in battery despite that they compare unfavourably with Class A where fidelity and hi-fi is concerned. A Class B output stage can give five times the output that one transistor would give alone or, put another way, the total dissipation of the two transistors in Class B can be five times that of either, thus enabling an output of 1W (from two OC81s, for instance, paired in Class B) to be achieved without either transistor exceeding 200mW at an efficiency of 80%. (Class A gives only 50% efficiency.)

The principle of Class B operation is that both halves of the stage are biased to cut-off, thus drawing no current under no-signal conditions.

Considering a sinewave input, if we apply the negative half of the wave to transistor A (Fig. 5) the collector current will vary according to the



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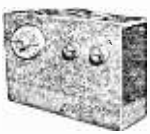

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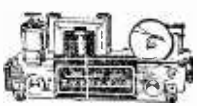

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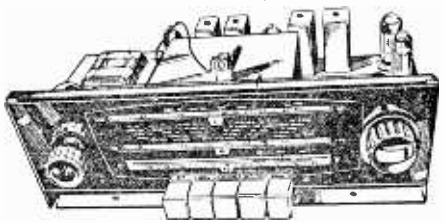

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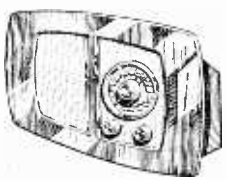

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modulation incrementally from 0V; the positive half of the wave will move the transistor into cut-off and will not be reproduced. If we can now apply the positive half of the wave to transistor B in such a manner that to transistor B it looks *negative*, transistor B will handle it while transistor A remains inoperative. This is achieved by a phase-splitter. It is often a centre-tapped transformer, but to understand the process consider the split-load stage, Fig. 6.

Here the collector load is half in the collector and half in the emitter and we have chosen 1kΩ for each. When the transistor is driven on the base the collector current varies about its quiescent value in the normal manner. Assuming a standing value of 1mA and a line voltage of −9 under quiescent conditions the collector is at −8V and the emitter at −1V. An increase in current will cause the collector to become more positive, say an increase of 0·5mA, then the collector load drops another 0·5V and the collector is at 7·5V, while the emitter moves from −1V to −1·5V. Thus as the collector moves positively the emitter moves *negatively*.

Suppose we connect the collector to the base of transistor A (Fig. 7) and the emitter to transistor B (same figure). *Both* these transistors are biased to cut-off under standing conditions. Neither is conducting. As the collector moves positively transistor A base moves positively and transistor A moves further into cut-off. But the same instant the current in the collector of the phase-splitter is moving the emitter *negatively;* this, connected to transistor B, moves the base of transistor B negatively and transistor B moves *out* of cut-off and amplifies.

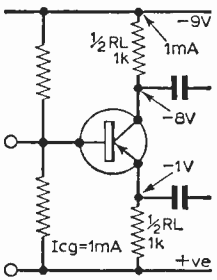


Fig. 6: Split-load stage.

When the current in the phase-splitter is moving decrementally on the positive half of its input the collector is moving negatively. This applied to transistor A brings it out of cut-off and into operation, while at the same instant the emitter of the phase-splitter is moving positively so that transistor B now moves *into* cut-off and becomes inoperative.

So each half of the Class B stage deals with one half of the input wave only.

The comparative transformer phase-splitter circuit is shown in Fig. 8. With the secondary centre tap earthed, when one end of the secondary is moving positively the opposite end will be moving negatively, and vice versa, so our conditions for Class B are fulfilled.

MATCHED PAIRS

The two output transistors must be matched. If the alpha (i.e., gain) of one is more than that of the other then one half of the input wave will receive more amplification than the other with consequent distortion. If response to frequency of the two transistors is not the same then some frequencies will receive more amplification in one

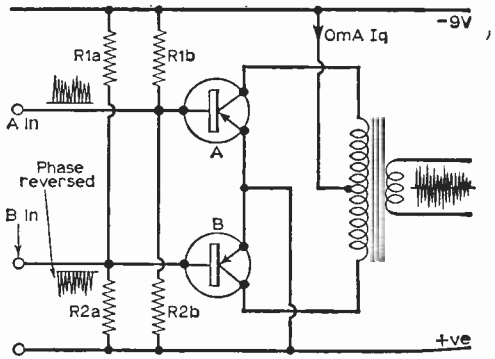


Fig. 5: Class B operation: both transistors biased to cut-off.

than they will in the other, or the cut-off frequency may be different and one may not reproduce at all frequencies which the other is reproducing. Transistors are sold in matched pairs to safeguard against this.

With transistors a phenomenon occurs at the moment when the two transistors are changing over which can cause considerable distortion. In order to get over this transistors in Class B are *not* run at quiescent cut-off; a small forward bias is given to each base allowing each to draw a small current under no-signal conditions. With R1 in each case consisting of a potentiometer the standing bias on each base can be varied within fine limits until the amount of standing current in each transistor is so adjusted that the minimum distortion results.

The circuit shown, Fig. 9, though quite theoretical, has been built and is capable of giving a perfect response at sufficient output to fill a small room and it is quite excellent to experiment with. It will NOT work from a radio receiver because the gain is insufficient to enable it to amplify the small signals from such a source to a sufficient extent. The actual gain of this circuit is round about 30 and we need at least 100 for practical purposes. The additional gain would normally be achieved by having a further "driver" stage either between

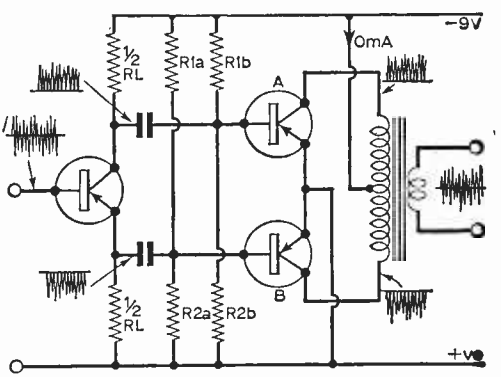


Fig. 7: Phase-splitter driving two output transistors.

the phase-splitter and the output or in front of the phase-splitter. The push-pull driver would be governed by exactly similar considerations to those we have discussed for the output stage except that since it will be handling smaller signals the standing collector currents will be chosen to have different values; the various resistances and loads can be higher as smaller values of current can be used.

SPLIT-LOAD PHASE-SPLITTER

But first let us examine the split-load phase-splitter again for a moment. To begin with it is obvious that with half the load in the collector and half the load in the emitter, each being applied to its own following transistor, the possible gain of this circuit must be considerably less than would be possible with the entire load in the collector. Transformer phase-splitting is, therefore, normally used, even though transformer coupling introduces possibilities of positive feedback and other forms of instability where maximum gain is required.

This transistor phase-splitter, however, is an excellent example of the importance of *phase* of input in transistor work.

Consider a standing current of 1mA through load A and load B, each of 1kΩ with a line voltage of −9. Collector stands at −8 and emitter stands at −1. Consider now the stage driven from a diode connected *positivewise*. The collector current is varied decrementally. A variation of input of 100mA at a gain of 50 produces a change of 5mA in the collector circuit *decrementally*. You cannot reduce the collector current by 5mA when you have only 1mA to start with, so the result is "no signals". The transistor moves into cut-off.

Reverse the diode, connecting it negativewise, and you now have an incremental change in collector current from 1mA standing (leaving out the change in the standing bias for the moment) to 6mA. The emitter moves from −1V to −6V (the 1kΩ load dropping 6V at 6mA); at the same time the collector moves from −8V to −3V. Once again we have "no signals" because we are left with no volts across the transistor at all, the transistor, in fact, is bottomed at peak signals.

If we are to leave on peak signals at least 1V across the transistor so that it does not bottom on peak signal we are left with only 8V of the possible 9V to play with. All the time in transistor work one is up against this question of limited supply volts.

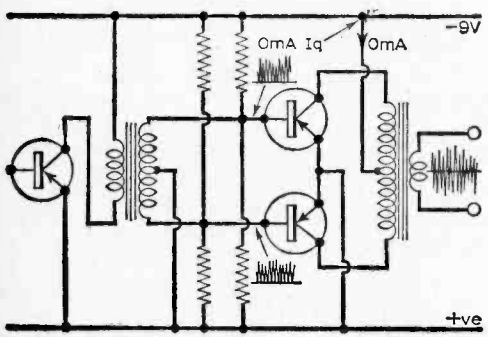


Fig. 8: Transformer phase-splitter.

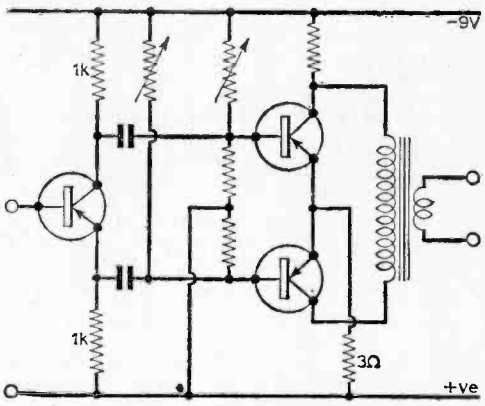


Fig. 9: An experimental circuit.

Each half of the load must, therefore, not drop more than 4V if 1V is to be left across collector/emitter junction on peak signal. 1kΩ will drop 4V at 4mA, so this is the maximum collector current we can allow ourselves on peak signal. With a transistor gain of 50 this means that our peak input must not exceed 4/50mA = 0·08mA = 80μA.

Now consider the phasing of the input. Suppose it is all negative from a diode connected negativewise. The collector current therefore increases. But we have 1mA standing current, dropping already 1V over each half of the load; we can therefore accept only an increase of 3mA before we are dropping our 4V across each half. Suppose the diode is connected positivewise, causing a decrease in collector current; we can accept only 1mA decrease before we reach the stage of no current at all—i.e., cut-off.

Suppose there is no diode and the input is sine-wave a.c. The output will distort on the positive side as soon as 1mA is reached, for there the transistor will cut off while being able to take 3mA on the negative half of the wave before squaring commences as the transistor starts to bottom.

Assuming sinewave a.c. then, we will have to work the transistor at the midpoint with regard to both loads. A value of 2mA standing current will place the emitter at −2V and the collector at −7V. The collector can now move 2V positively to 5V and 2V negatively to 9V, while the emitter can move 2V negatively to −4V and 2V positively to +6V.

Alternatively, assuming a diode and therefore a unidirectional input, if the diode is connected negativewise then the standing bias must be such that the transistor quiescent collector current is almost nil if we are to accommodate the maximum signal amplitude; conversely, if the diode be connected positivewise then the transistor must be biased so as to take nearly the maximum collector current (short of bottoming) if it is to accept the maximum decrement before it cuts off altogether.

SERIES CONTINUED NEXT MONTH

By A. Cole

Quality Amplifier and tuner

Continued from page 1021 of the March issue

THE TUNER

THIS tuner is of a relatively advanced design, and should only be attempted by the experienced constructor. Three i.f. stages are used on f.m. giving unusually high gain. Very high sensitivity and selectivity is obtained on the a.m. channels, one longwave (Light Programme) and three medium-wave (Home, Third, Luxemburg) pre-tuned channels being selectable by a second switch (S1). These positions have individual coils, so the cores may be re-set for any alternative stations.

The high sensitivity and selectivity is obtained by using a high-gain r.f. stage ahead of the frequency changer. A.G.C. operates on three stages and is delayed by about a volt at R38; the action is thus very effective for reception of Luxemburg.

The f.m. tuning head is a *Heathkit* model FMT-4U. This uses an ECC85 as r.f. amplifier and frequency changer. In the circuit diagram only components to be inserted new inside this unit are given reference numbering.

Experienced constructors could attempt to build the r.f. head themselves, but it is very critical. The author initially constructed two home-built designs of this head, both of which worked well, but with sensitivity well below that of the *Heathkit* Unit. It is extremely difficult to get optimum home-built coils for this unit.

Therefore it was finally decided to use a commercial head, to guarantee success to all constructors. No other part of this design should offer particular difficulty.

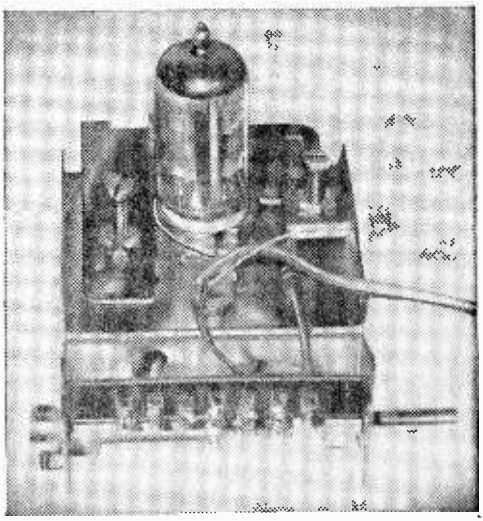
The v.h.f. head must, however, be modified for application of Automatic Frequency Control (a.f.c.). While this would be essential for a home-built head, to prevent oscillator drift, this trouble does not arise with the *Heathkit* unit because it employs accurately matched temperature-coefficients on the relevant capacitors. Its purpose in the present design is to simplify the tuning, so that only a knob directly on the tuning-spindle suffices, slow-motion drives and dials being unnecessary. This permits a clear, simple and "open" panel design characteristic of switched tuners.

The action of the a.f.c. is that, once a station is even partially tuned in, it automatically slips into exact tuning and locks there, even for the moderate displacements of the tuning control. This gives easy tuning while maintaining full high selectivity. It also avoids the extreme distortion experienced when an f.m. tuner is set slightly off a station.

Quality deteriorates with mistuning much more severely on f.m. than on a.m., so that spot-on tuning is required. The a.f.c. circuitry in the present design incorporates a capacity diode, type BA110.

The Capacity Diode

A capacity diode is a semi-conductor device in the form of a small diode operated with a d.c. polarising voltage in the non-conducting direction, i.e. cathode positive to anode. The higher this polarising voltage, the smaller is the effective capacity presented by this diode. The circuit to which the diode is connected thus "sees" merely the equivalent capacity, which can be varied over a large range by variation of the polarising voltage. It is, of course, essential to use "normal" blocking capacitors where necessary to prevent the polarising voltage influencing the other circuitry, such as C1 in the modified r.f. head.



The Heathkit f.m. tuner head, used in the tuner.

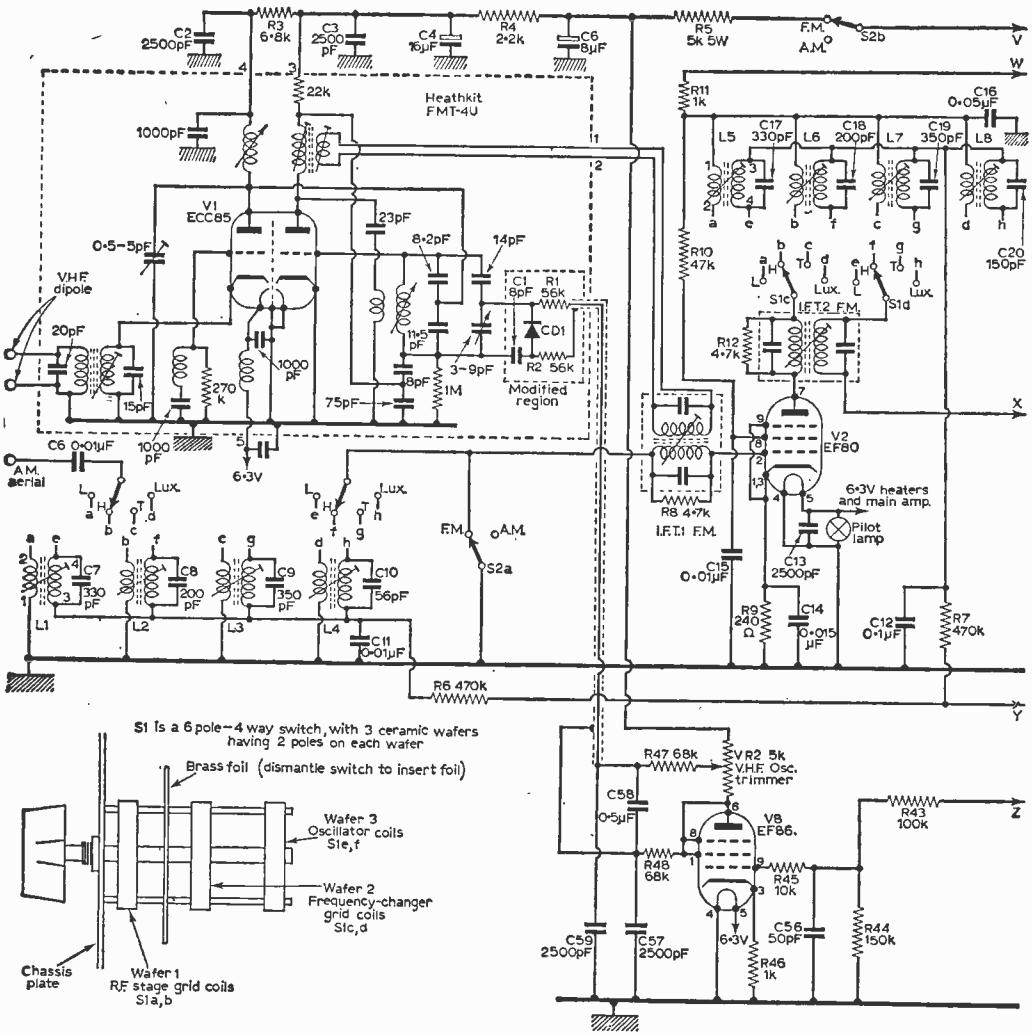


Fig. 9a: The r.f. and a.f.c. stages of the circuit.

The added resistors R1 and R2 serve to prevent loading of the oscillator through the a.f.c. d.c.-control line. The d.c polarising voltage is applied to the far end of these resistors, through a thin screened cable, which can be taken out through the adjusting hole of the i.f. coil. As the screening of this cable is at some h.t. potential, do not connect it to chassis, and use a cable with final external insulation (microphone cable).

In wiring the a.f.c. components in the r.f. head take care to prevent mutual shorting or shorting to the re-assembled outer aluminium casing subsequently. The head is opened by prising off the two end caps, removing the holding screws at the sides, and then bending the outer aluminium casing apart until the internal chassis-unit can be slipped out. Assemble in the reverse order.

Fig. 11 gives details of the BA110 capacity diode, showing the relationship between effective capacity and applied polarising voltage. It is seen that a polarising voltage of some 4V is needed to give about 8pF effective capacity, which together with C1 restores the original capacity of about 4pF of the removed original fixed capacitor.

The polarising voltage is adjusted by VR2 (in the anode circuit of V8) which thus functions as v.h.f. oscillator trimmer. It should be set about a third to half rotation from the anode end. C1 (if necessary) and the oscillator core should then be adjusted during aligning to restore correct coverage (88 to 108Mc/s); the r.f. trimmer may also need re-peaking.

Ratio Detector and A.F.C.

V6 is a conventional ratio detector. At the centre frequency of the passband. voltages induced in the IFT5 secondary are such that the diodes

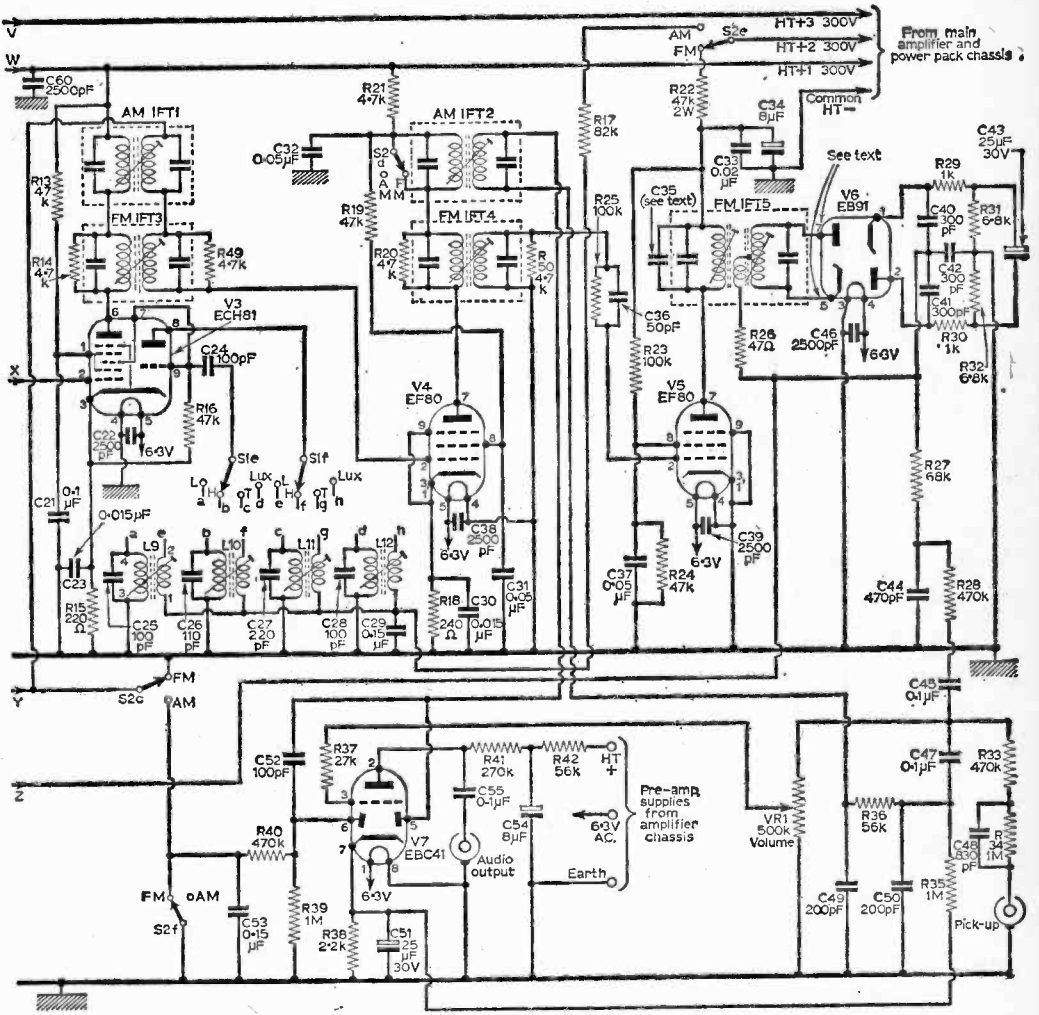


Fig. 9b: The i.f., detector and audio stages of the circuit.

receive equal signals, which appear respectively (rectified) across C40 and C41, and in such polarity that their sum appears across C43.

If the signal frequency deviates from the centre, the phasing in the IFT5 coils is such that the diodes receive different signals and C40/C41 carry different rectified voltages. However, provided that the *amplitude* does not change during the frequency excursions, i.e. provided we have pure f.m., the *sum* of the voltages across C40 and C41 (across C43) remains constant over a wide band. If the alignment is not correct, however, distortion is heavy.

If either a pure a.m. signal is present, or unwanted a.m. together with the wanted f.m., the voltages on C40 and C41 will attempt to follow the rhythm of the amplitude modulation. But they are hindered by the extremely large capacity of C43, which cannot follow so quickly. Thus C43 imposes heavy and variable damping on the circuits of IFT5, through the diodes, shorting out the modulated portion of any a.m. signals. R29 to R32 give this a.m. damping optimum time constant and characteristics.

Although the ratio detector is inherently insensitive to a.m. and does not, basically, require a previous limiter stage, its a.m. rejection is not perfect, and a limiter is still desirable. The final i.f. amplifier V5 is built as a leaky-grid rectifier limiter operating with starved screen voltage to give anode bottoming.

Negative excursions of amplitude are clipped on the grid-base due to the rectified signal bias developed across R25 and C36, and positive excursions are clipped by anode bottoming. The output signal is thus, at the anode, free of amplitude modulation. A point to watch carefully when using this kind of limiter is that it operates as

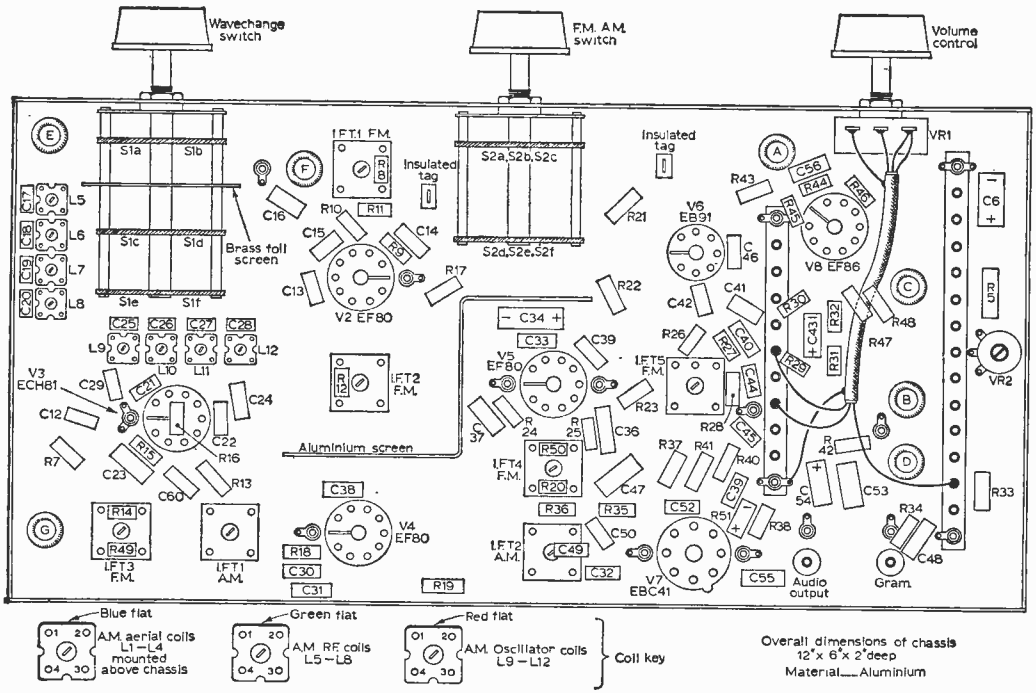
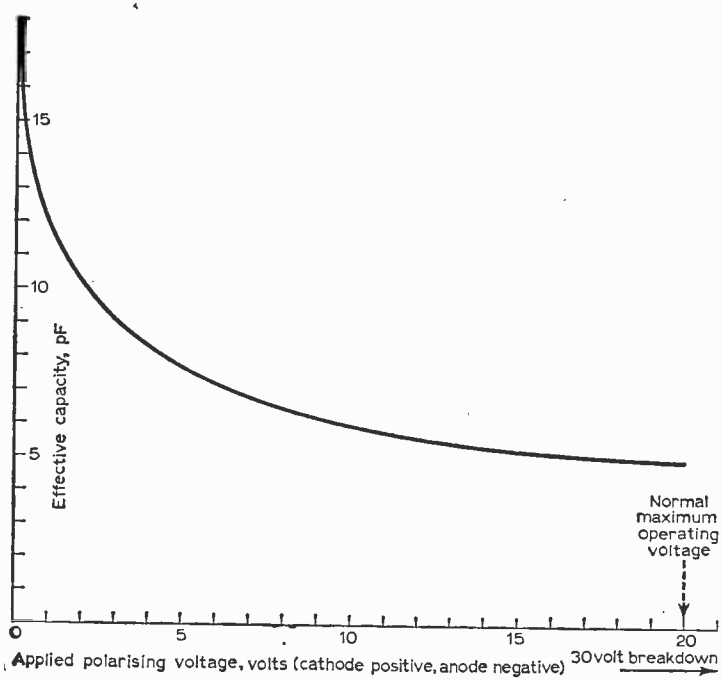


Fig. 10 (above): The layout of components.

Fig. 11 (below): How variation of polarising voltage affects the capacity.



leaky-grid *detector* for any a.m. present, the a.m. which it removes from the i.f. waveform appearing at the anode as *audio*.

Furthermore, if the r.f. head is tuned off to the signal flank the f.m. signal will also deliver an audio output at V5 anode by virtue of "flank detection". If these audio components are allowed to develop, capacitive coupling through IFT5 and out through R26, R27 into the main audio amplifier chain can be appreciable.

Such "stray" audio can reach amplitudes up to 5 or 10% of the wanted signal, and is often extremely distorted. The net result would be an enormous increase of distortion in the audio output. To remove all trace of this effect, C34 is included to short-circuit the anode load (R22) for audio frequency. The small parallel capacitor C33 is still needed to give i.f. decoupling, as electrolytics alone can have far too high an impedance at 10·7Mc/s.

—CONTINUED ON PAGE 1107

The effectiveness of suppression by C34 should be checked by withdrawing V6 from its socket, when no signals should remain audible at any tuning setting. If distorted audio signals exceeding 1% of the normal output amplitude are heard, C34 must be increased in value.

If no signals at all are heard from the finished tuner until C34 is disconnected, and then only weak and distorted signals which remain when V6 is pulled out of its socket, check the valve base connections of V6 as a mistake here is very common.

Audio Output

C43 is balanced to earth by means of the two load resistors R31, R32, the junction of which cannot follow the voltage fluctuations with frequency modulation present at the junction of C40, C41, because of the shunting of C43. Consequently the fluctuations appear across C42 as corresponding detected audio voltages and are fed via R27 to the a.f. stages, de-emphasis being provided by R27, C44.

The A.F.C. Signal

If the i.f. signal should be displaced from the centre of the i.f. passband, due to inaccurate setting of the tuning control on the r.f. head, then the potential of the junction of C40 and C41 is permanently displaced from the earthed junction of R31, R32. The polarity is according to the sense of the tuning error.

The error signal is d.c. coupled through R43 to the grid of V8, functioning as a d.c. amplifier and automatically adding the polarising voltage by virtue of standing anode current drop in VR2. The amplified error signal output from VR2 is thus of a form suitable for application to the capacity diode in the r.f. head, to correct the original detuning giving rise to the error signal.

For the a.f.c. function, V6 functions as a true d.c. discriminator, operating on the tuning of IFT5 as reference standard. It is thus essential that the i.f. transformers in the v.h.f. chain, especially IFT5, are properly aligned. Once the i.f. amplifier begins to "see" the sidebands of an approaching v.h.f. station, it generates a control voltage for the local oscillator to lock the signal immediately on to the centre of the passband and hold it there even after moderate temperature drift.

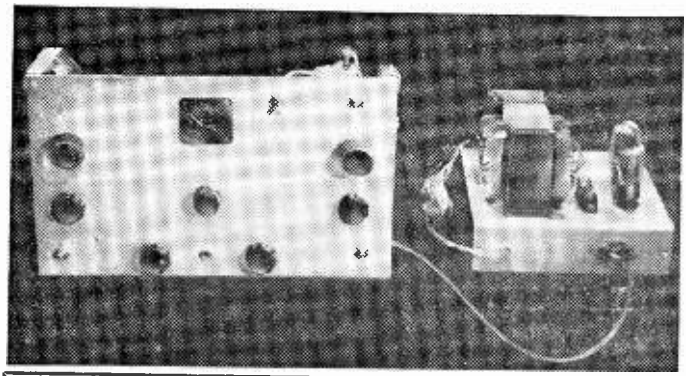
The gain of V8 is not high as the levels at the ratio detector are already ample. Its main purpose is to achieve a simple and stable insertion of the polarising voltage for the capacity diode without back reaction on the ratio detector. Another arrangement *was* tried, using a high-gain double-triode balanced d.c. amplifier with Zener diode stabilisation. This gave such powerful a.f.c. that once a station was locked in, one could not get rid of it again right round the dial, as the a.f.c. control could drag the oscillator round the entire tuning range. The aerial had to be removed momentarily to get rid of the station, and then get another (pure chance which one then, too!).

TO BE CONTINUED

FOUR VALVE TRANSMITTER

For 3·5 and 7Mc/s

by S. F. Appleyard, G3PND



The transmitter described in this article was built before the author obtained his transmitting licence in order to learn more on the subject of transmitters before sitting for the Radio Amateur Examination. The knowledge derived from designing and building the transmitter proved invaluable not only for the R.A.E. but several other radio examinations taken since. If the transmitter is built by someone not at present licensed, they are reminded that they must not put the transmitter on the air even for testing purposes, but there is nothing to stop anyone who is licensed testing it for them.

THE transmitter was intended to be simple and straightforward, operating on 3·5 and 7Mc/s c.w. only. It uses four valves: EF91, EF80, 6V6 and 807; and runs 25W to the final stage. All the parts were out of the junk box except the chassis and front plate which were purchased for approximately £1. As most of the components were already at hand the values of some are not as accurate as might be but nevertheless the transmitter worked extremely well.

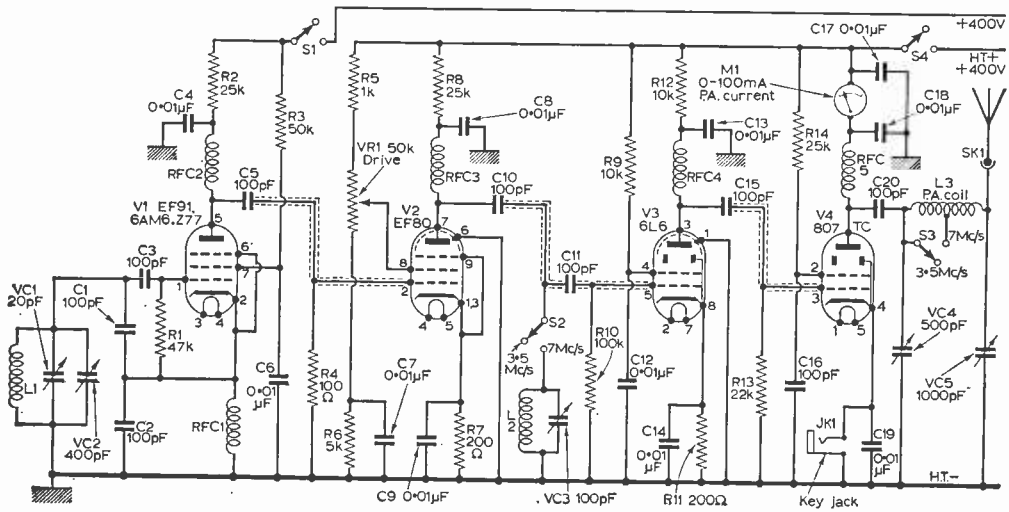


Fig. 1: The circuit diagram of the four-valve transmitter. A suitable power pack for this unit is shown in Fig. 4.

THE CIRCUIT

Now taking the transmitter stage by stage, the oscillator (V1) uses a pentode in a Colpitts circuit. Several circuits were tried and this arrangement was chosen as it did not employ a tapped coil and proved reasonably stable. The frequency of oscillation depends upon the values of L and C where $C=VC2+\left(\frac{1}{C1}+\frac{1}{C2}\right)$. The values of C1 and C2 can be varied to alter the amount of feedback, but it was found to be best when both values were equal. The oscillator provides its own bias, since the valve runs into grid current and charges up C3 which leaks off through R1 during the negative half cycles and holds the grid at a negative potential. Thus if the oscillations were to stop, the cathode current would rise to an extremely high value as the valve would become unbiased.

The variable capacitor VC2 in the tuned L/C circuit of the v.f.o. is 400pF and this was paralleled by a 20pF capacitor VC1 which was used for final adjustment when netting. But this can be dispensed with if a slow motion drive is used in conjunction with the 400pF capacitor.

The coil L1 was wound to resonate with the capacitor on 3·5Mc/s, which is the fundamental frequency of the transmitter. When the transmitter is required to operate on this frequency the signal is fed straight through two untuned amplifiers to the p.a., but when operation on 7Mc/s is desired the second stage (V2) acts as a frequency doubler.

The radio frequency choke RFC2 in the oscillator acts as a high impedance load to valve V1, while C5 acts as a low impedance to r.f. but blocks d.c. C5 also provides class C bias for V2 in conjunction with R4. Bias for this stage is also provided by the cathode resistor R5. When the second stage is used as a harmonic generator (frequency doubler) the tuned circuit L2-VC3 is switched in by S2. This tuned circuit operates on a frequency 2f, which is 7Mc/s.

DOUBLER AND BUFFER

The valve used for this stage is an r.f. pentode again, this time an EF80—but another EF91 could be used providing some modifications were made. The circuitry with this stage, as with the next, is very straightforward but one point worth mentioning is that at this stage the drive is controlled by VR1. This control varies the h.t. applied to the screen of V2 and thus varies the anode current through the valve and hence the gain.

C9 bypasses the cathode resistor and thus prevents any negative feedback which would considerably reduce the stage gain, while the capacitors C5, C8 etc. decouple the h.t., preventing positive feedback and hence instability. The radio frequency choke RFC3 acts as a high impedance load while offering a very low d.c. resistance.

The output from this stage is taken to V3 which always acts as an untuned amplifier regardless as to whether operation is on 3·5 or 7Mc/s. The valve used originally was a 6V6 but it has since been replaced by a 6L6 but not a lot of difference has been noted. During construction at this stage the transmitter was put on the air using a lashed-up π tuning circuit, and with the assistance of a friend

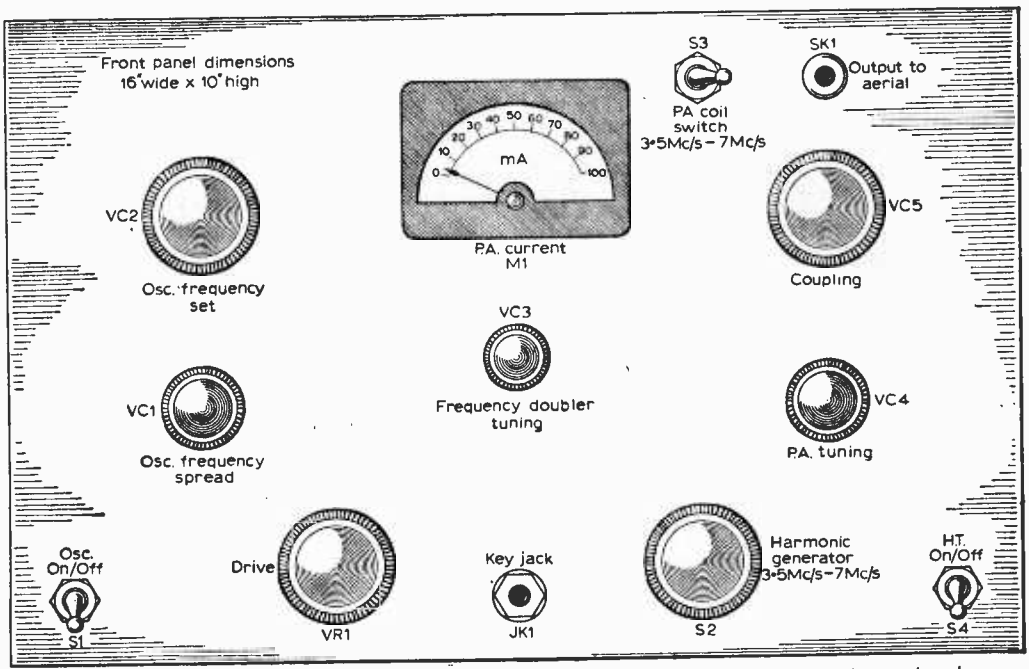


Fig. 2: Front panel layout of the transmitter showing the positions of the controls, switches and sockets.

(a licensed operator), several QSO's were made on 7Mc/s, with good reports.

POWER AMPLIFIER

The output from this stage is fed into the power amplifier and the valve used here is the well known 807. Keying of the transmitter is effected at this stage by the breaking and making of the cathode lead. It can be seen that the only means of bias for this valve is that developed across the grid leak resistor R13—there being no cathode resistor; so the key should not be pressed without the oscillator switched on, or the current flowing in V4 might damage the valve.

In the anode lead of the p.a. is a meter M1 which should have a full scale deflection of 100mA. Each side of the meter is decoupled to earth as the meter leads are fairly long. The two decoupling capacitors C17 and C18 should have their live ends connected as near to the meter terminals as possible. The radio frequency choke RFC5, here again offers a high impedance load to the 807 valve while the capacitor C20 offers a low reactance to the radio frequency signals.

The aerial tuning circuit is the widely used π arrangement. VC4 is the tuning capacitor and VC5 is the coupling capacitor. Directions on how to load up the transmitter are given later.

Now the outlines of the transmitter have been given it is clear that it is simple and straight forward, which is what was intended. The whole transmitter is supplied from one power-pack (see Fig. 4) which supplies 400V at 180mA. V5 is an indirectly heated full wave rectifier type GZ33.

CONSTRUCTION

The chassis measures 16in. x 10in. x 2in. with a front panel 16in. x 10in. L-strips are taken from two top corners of the front panel to the two back corners of the chassis, to hold the front plate rigid.

The layout of components is not too critical as long as the p.a. is at the opposite end of the chassis to the oscillator. The oscillator coil is completely enclosed in a screened box and all oscillator components should be kept away from resistors, as the heat generated by the latter might cause some frequency drift. Components should be securely mounted and all wiring rigid to prevent frequency drift. All leads should be kept short and those carrying r.f. should be screened.

The layout of the valves and tuning capacitors is shown in Fig. 3. The p.a. valve must be screened. In the original, a cocoa tin was used with the lid taken off and the bottom cut out, but the screening can be dispensed with if the valve base is sunk into the chassis about 1½in. so that the electrode leads are below chassis level and are thus screened.

Smaller components were mounter on tag-boards and kept close to their respective valve bases. Power supplies are fed into the transmitter by a 4-core cable, the free end being terminated in a 4-pin plug which fits into the appropriate socket in the power unit.

OPERATION

After the transmitter has been connected to the power-pack and the latter connected to the mains supply, the oscillator h.t. switch S1 should be made

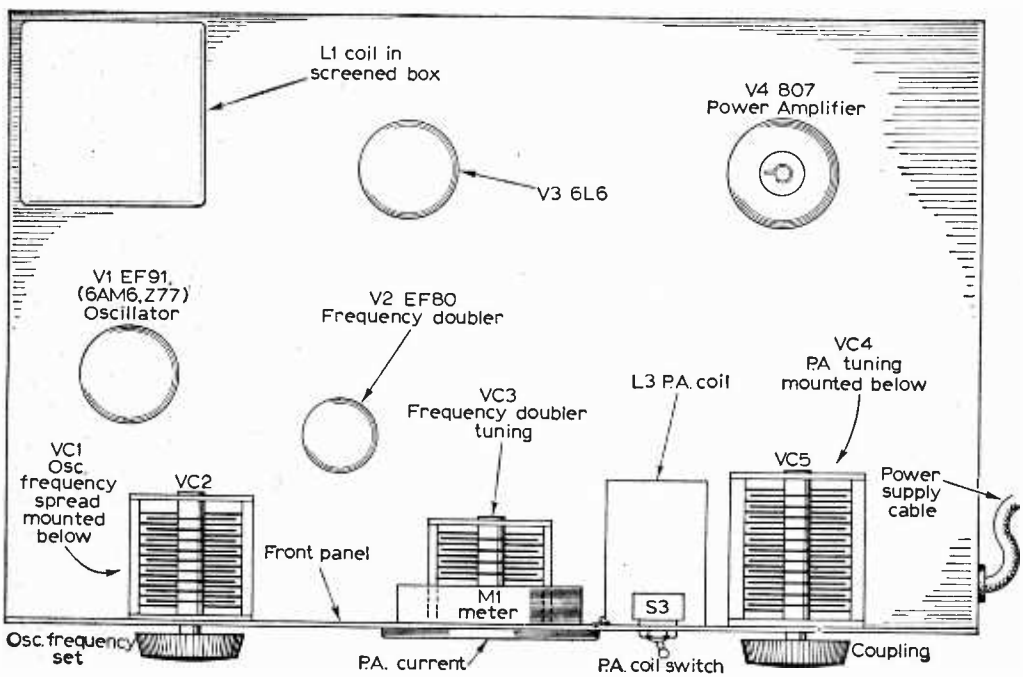


Fig. 3: This is a top-of-chassis layout showing the positions of the major components.

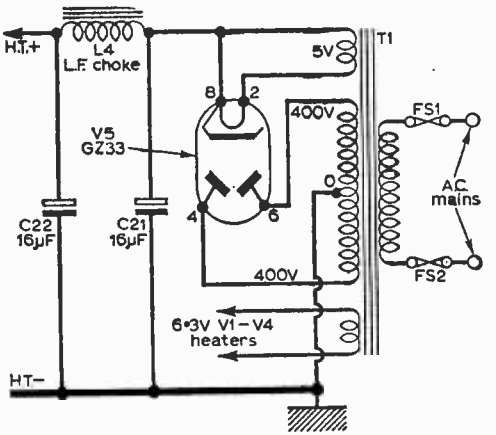


Fig. 4: This simple power pack provides 400V at 180mA and 6·3V a.c. to power the transmitter.

and then the oscillator tuned to the required frequency. Switches S2 and S4 should be set to the required band (3·5 or 7Mc/s) and the drive control set for maximum drive.

The transmitter is now ready for loading up to the aerial which should be already connected. Close switch S4 and press the key. There will now be a reading on the meter and if the output of the transmitter is to be on 7Mc/s the capacitor VC3 should be adjusted to give minimum reading on the meter.

The coupling capacitor VC5 should be originally set for maximum capacitance, i.e. plates completely intermeshed. The tuning capacitor VC4 should be tuned for a dip in the meter M1, this indicating the resonant point. The coupling capacitor VC5 should now be slowly turned until the p.a. current rises until it reaches 60mA, now retuning VC4 for another dip and again increasing the coupling until the p.a. current reads 60mA and finally finish up by retuning once more.

If there is an r.f. meter at hand the aerial current can be noted but if not, a bulb in the aerial lead will give some indication of aerial current.

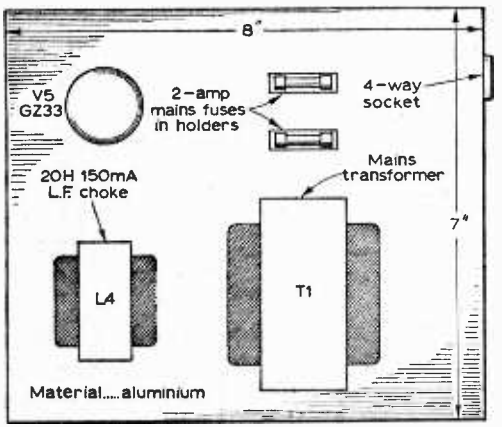


Fig. 5: Layout of the power pack of Fig. 4 showing the positions of components.

AERIALS

Several different aerials were tried at the author's station but the half-size 5RV was found to be the best on 40m and a 160ft long wire on 80m. ■

COMPONENTS LIST

Resistors:

R1	47kΩ ½W	R8	25kΩ 2W
R2	25kΩ 2W	R9	10kΩ 3W
R3	50kΩ 1W	R10	100kΩ 1W
R4	100Ω 1W	R11	200Ω 2W
R5	1kΩ 2W	R12	10kΩ 3W
R6	5kΩ 1W	R13	22kΩ 2W
R7	200Ω 1W	R14	25kΩ 2W

VR1 50kΩ wire-wound potentiometer

Capacitors:

C1	100pF mica
C2	100pF mica
C3	100pF mica
C4	0·01μF paper 350V
C5	100pF mica
C6	0·01μF paper 350V
C7	0·01μF paper 350V
C8	0·01μF paper 350V
C9	0·01μF paper 350V
C10	100pF mica
C11	100pF
C12	0·01μF paper 350V
C13	0·01μF paper 500V
C14	0·01μF paper 350V
C15	100pF mica
C16	100pF mica
C17	0·01μF paper 500V
C18	0·01μF paper 500V
C19	0·01μF paper 350V
C20	100pF mica

Variable Capacitors:

VC1	20pF	VC3	100pF
VC2	400pF	VC4	500pF
VC5	1,000pF (2 x 500pF gang, parallel connected)		

Coils:

L1, L2	see text
L3	16 turns spread over 2in. on 1½in. former. Centre tapped.

Valves:

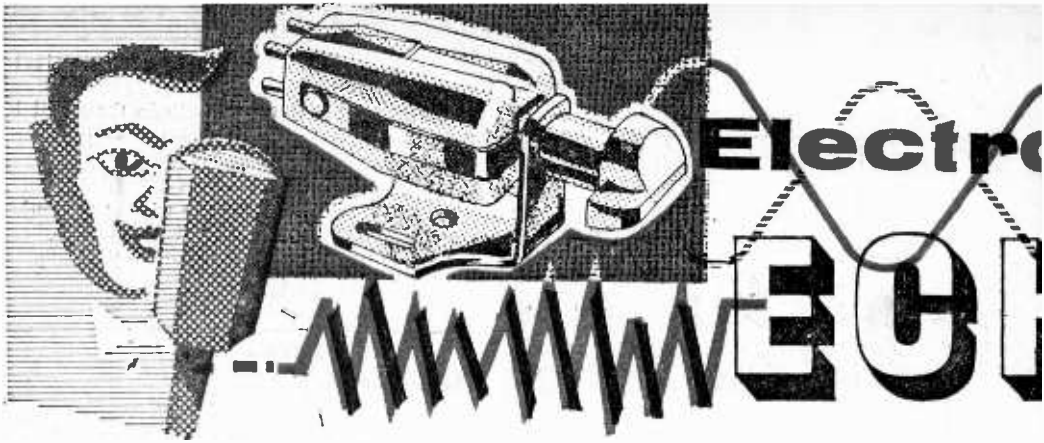
V1	EF91, 6AM6, or Z77	V3	6L6
V2	EF80	V4	807

Miscellaneous:

M1	100mA f.s.d. moving coil meter
RFC1-5	2·5mH r.f. chokes
S1-4	Single-poie single-throw switch
Sk1	Coaxial socket
Jk1	Jack socket

Power Supply Unit:

C21	16μF, 500V electrolytic
C22	16μF, 500V electrolytic
L4	20H, 150mA choke
T1	Mains transformer with tapped primary. Secondaries: 400-0-400V 150mA; 6·3V 2·5A; 5V 2·5A
V5	GZ33
FS1, 2	2A Fuses



THE unit to be described enables the popular reverberation or echo effect to be obtained with any audio signal source in conjunction with an amplifier. The method employed in obtaining this echo effect is rather unusual. insomuch that the device used for delaying the signal is electro-mechanical and does not use the recording technique with magnetic tape which is usual in this type of equipment.

The Delay Unit

This consists of two crystal pick-up units. type "Acos" GP71-3, as used in stereophonic gramophone pick-ups, with a series of metal springs between them. The springs are mounted so that they are coupled to the pick-up units at each end where the gramophone stylus used to be. (This is explained in more detail later in the text.)

If an audio signal is fed into one crystal unit the crystal itself vibrates and this vibration is coupled to the spring. The spring begins to vibrate in sympathy and, due to its mechanical inertia, the vibration takes a short time to reach the far end where the signal is reconverted into an electrical waveform by the other crystal unit. Thus the signal entering the first (or driver) crystal and the signal taken from the second (pick-up) crystal have a time delay between them, the length of the time delay depending entirely on the characteristics of the spring. If these two signals are fed simultaneously to an amplifier the effect heard will be one of depth and space, adding a completely new dimension to the original sound source.

As it stands the effect obtained above has more the characteristics of *reverberation* than "echo", but to simulate the echo effect all that is required is to interrupt the delayed signal at a predetermined rate by a low-frequency oscillator. This gives a repetitive sound to the delayed signal and the overall effect is a repeated echo, the repetition of which can be altered by varying the interrupting oscillator frequency. Fig. 1 shows a block diagram of the complete system and will help the description above to be understood.

Electronic Section

There are three valves used in the electronic section of the unit and these are Mullard ECC83 twin triodes, making six separate functions in all. V1 is a cascode R—C coupled amplifier used to bring the input signal up to a sufficient amplitude to drive the crystal unit on the delay chain. There is no need for a gain control in this amplifier as the signal input is at a low level (i.e., from a microphone or electric guitar pick-up). One half of V2 is used as an amplifier for the pick-up crystal, the remaining section (V2b) is a cathode follower used to modulate the cathode circuit of this amplifier with the output of the low-frequency phase-shift oscillator. One half of V3 is employed as the oscillator and the remaining triode section is used as an amplifier for the direct signal path direct from the input terminals of the unit.

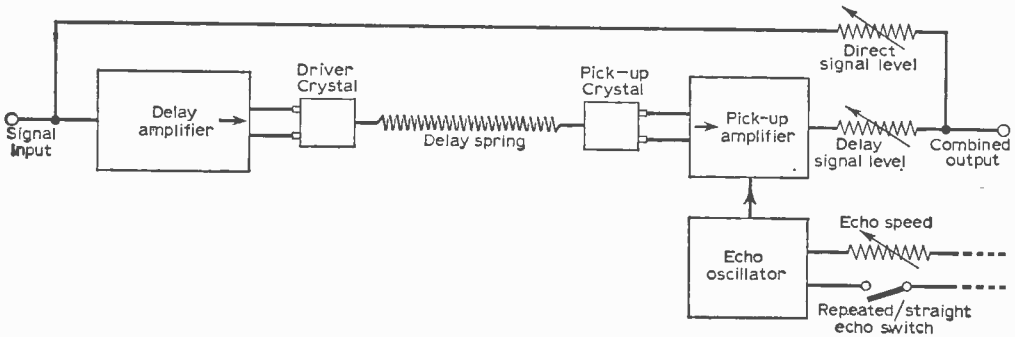
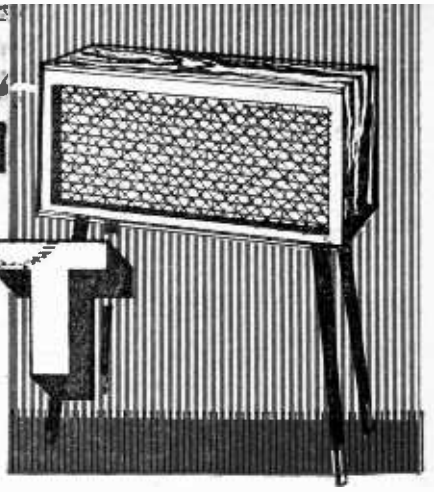


Fig. 1: Block diagram showing the basic requirements of the Echo Unit

mechanical
0 UNIT



BY B. L. PHILLIPS

Any form of power supply may be used, either a complete power pack built in with the rest of the unit or the supplies may be taken from the parent amplifier if they are available.

The requirements are an h.t. supply of 250 volts d.c., smoothed and filtered, and 6·3 volts a.c. for the filaments. The consumption is approximately 20mA h.t. and 0·9A l.t. A diagram is given for a built-in power pack and this method of supply is recommended as it avoids long leads carrying the supplies from an external source.

On no account is an a.c./d.c. type of power unit to be used with this unit. Apart from severe "hum" troubles this form of power supply is dangerous as it is virtually impossible to isolate all input and output leads and controls, etc., from the chassis. Again, if the supplies are taken from the parent amplifier this *must* be an a.c. only type with an isolating transformer incorporated.

Circuit Operation

The twin input jacks are matched for either high impedance microphones or musical instrument pick-ups or a combination of these. At the first grid of V1 the signal is "split" by a voltage divider network, a proportion is fed into V1a, the remainder to the grid of V3b (the direct signal amplifier). The two stages of V1 bring the signal up to a high level where it is fed to the drive crystal on the delay unit. The resulting mechanical vibration is reconverted in electrical impulses by the pick-up crystal and fed into the pick-up amplifier V2a.

The output of this stage is taken via a capacitor network ($3 \times 0{\cdot}005\mu F$) to a gain control, VR3. This network is to remove any low-frequency component present when the echo repetition oscillator is in use; furthermore, the output of the network tends to rise with frequency and so removes any low-frequency noise due to external vibration of the delay unit. The $0{\cdot}02\mu F$ capacitor across this network and chassis is a tone compensating device and may be any value between $0{\cdot}005\mu F$ and $0{\cdot}05\mu F$, depending on the output tone required. Without this component there may be a tendency for the unit to "squeal" similar to a microphone if it is placed too near the loudspeaker in the main amplifier.

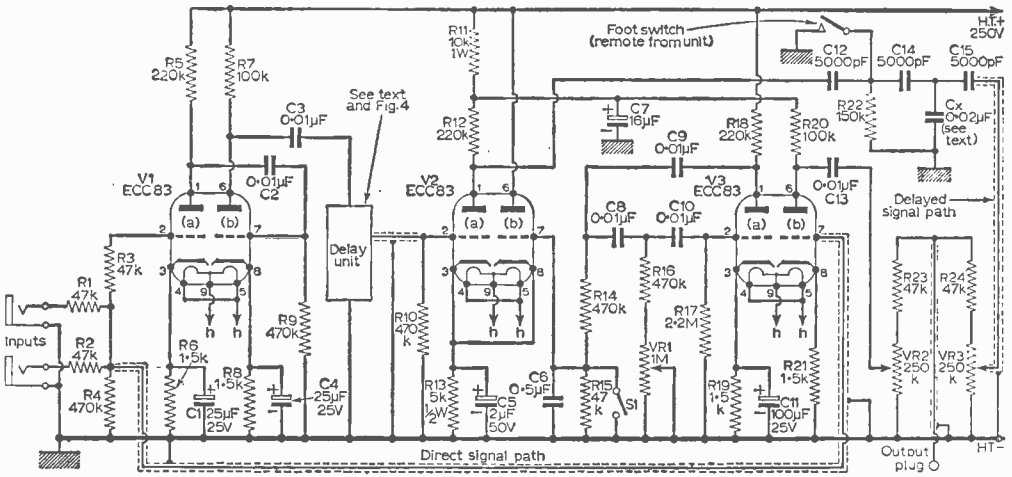


Fig. 2: The circuit diagram of the Echo Unit

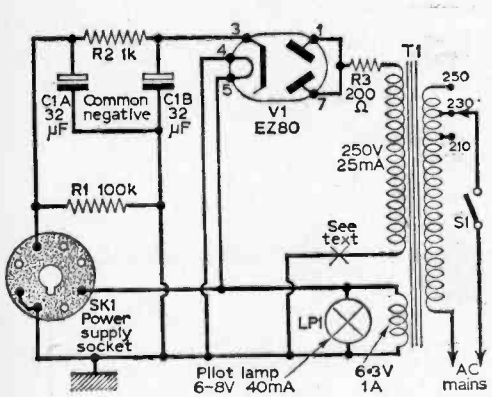
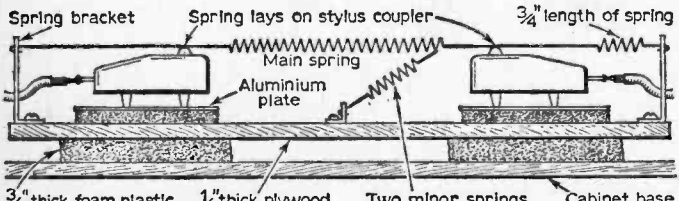


Fig. 3 (above): The power unit.

Fig. 4 (below): Side view of delay unit.



The repetition oscillator is coupled to the grid of V2b. Both cathodes of this valve are strapped together. Notice the value of the cathode decoupled capacitors (2µF); this has a low impedance at the signal frequency but allows sufficient low-frequency component to appear at the cathodes from the oscillator. As this swings the cathode voltage the gain of the pick-up amplifier is varied in sympathy with the oscillator, giving a repetitive effect to the signal. The switch S1 enables straight or repetitive echo to be obtained at will by interrupting the oscillator feed to V2b. The control VR1 sets the speed of repetition between quite wide limits.

The two gain controls VR2 and VR3 set the level of the direct and delayed signals respectively, their outputs being combined and fed to a screened lead and plug for connection to the main amplifier.

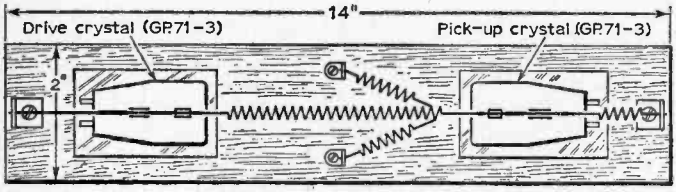


Fig. 5 (above): Top view of delay unit.

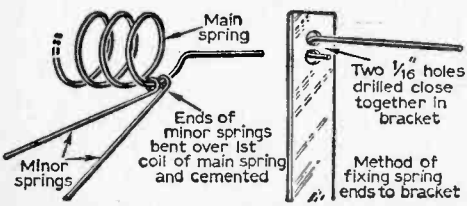


Fig. 6 (left): Spring fixing.

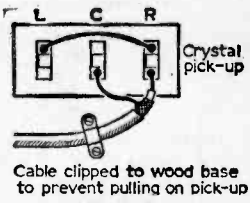


Fig. 7 (right): Pick-up connections.

The entire echo unit can be silenced by placing a shorting switch across the socket marked "foot switch" and suitable switches are available at music shops dealing in electronic musical instruments.

Wiring Details

All connections should be short and direct and as far as possible components should be mounted as close to their respective valve-holders as possible. Screened lead should be used where indicated and the filaments should be wired in thin, tightly-twisted wire run away from the signal circuits. One side of the heaters is earthed to chassis at the mains transformer or power input point. Do *not* earth one side of each valve heater and run a single filament lead as this will cause endless hum and noise problems.

The leads to the delay unit crystals must be screened and the springs themselves, together with the metal plate under the pick-up crystal must be grounded to chassis. It is better to run an earth busbar along the chassis, earthed at the input jacks only, for earth connections. If any signal leads are longer than approximately 1½in. they are preferably screened, but if the recommended layout is followed, little trouble with hum will be had.

Case or Cabinet

This can be made out of any available workable material—i.e., wood, metal or even "Perspex" sheet. A plywood case is recommended for ease of construction, the front panel being metal and containing all controls and jack sockets, etc.

If covered in a "Rexine" or "Vynide" material the design suggested can look really professional, especially with the control panel done in a contrasting colour.

The internal delay unit is protected from mechanical vibration by its own flexible mounting (see *delay unit construction)* but additional protection for the whole unit can be given by placing four rubber feet in each corner of the cabinet.

Delay Unit Construction

Firstly, two small squares of aluminium are cut just larger than the area the pick-ups cover. Each pick-up is attached to the metal base by cementing the three feet to the base with clear "Bostik" glue. When thoroughly dry two pieces of ⅛in. thick foam plastic the same size as the aluminium plates are cemented lightly to the underside of each plate. Then the entire pick-up unit is cemented to the three-ply base so that they rest on the foam plastic

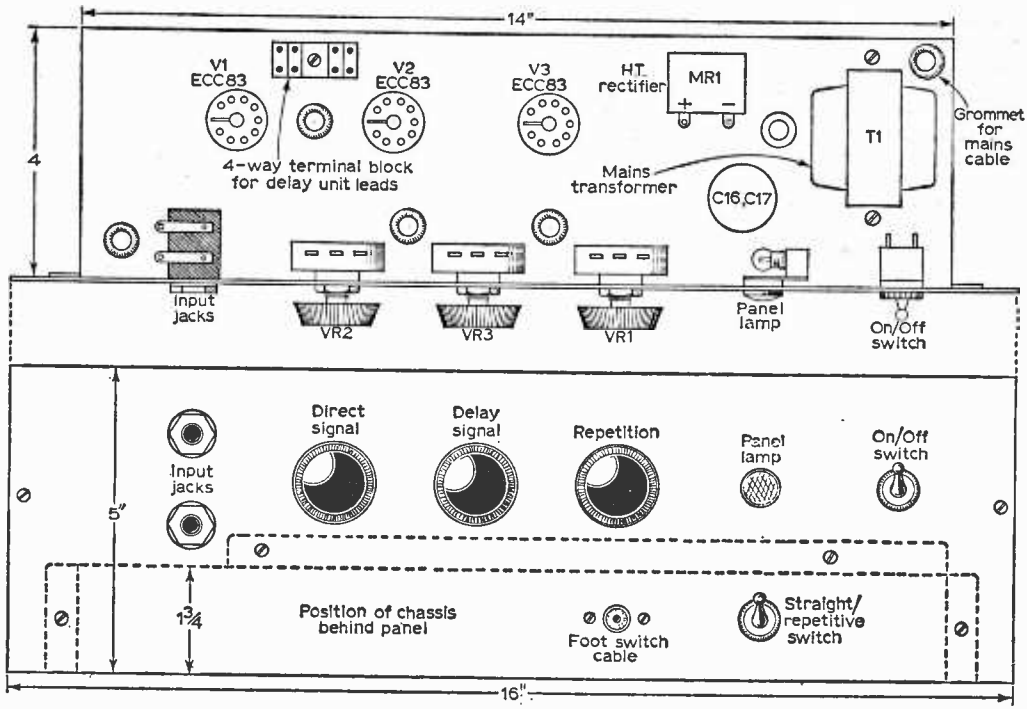
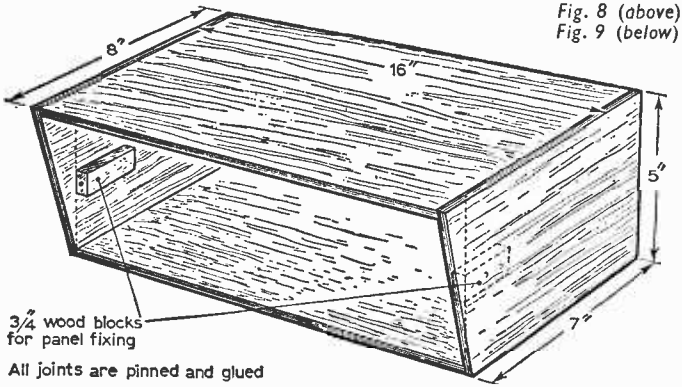
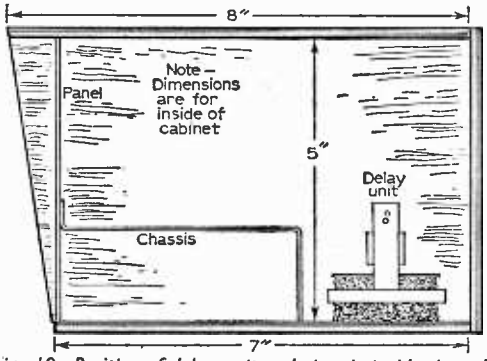


Fig. 8 (above): Top view of chassis and control panel.
Fig. 9 (below): Cabinet details.





ig. 10: Position of delay unit and chassis inside the cabinet.

supports. Allow approximately 1in. clearance between the end of the plywood base and each pick-up unit.

The height between the wood and the top of the stylus couplers on each pick-up should be noted and two aluminium brackets made for the springs, each with two $\frac{1}{16}$in. holes drilled in them at the height where the spring leaves the stylus coupler and attaches to the bracket. Before mounting the brackets to the base remove the stylus on each pick-up by gently pulling the needle holder towards the rear of the pick-ups with a pair of long-nosed pliers or tweezers.

The two small brackets are made in a similar method to the end ones except they are half the height of the former type, and they mount approximately in the centre of the wood base, one near each edge as shown on Fig. 5. Connect two lengths of *thin* single-core screened cable to the pick-up tags as in Fig. 7 and clip this cable to the wood base by means of a small metal U clip or staple, leaving some slack between this and the tags. The springs can now be fitted.

Spring "Doctoring"

The main spring is made up as follows: (1) Unwind about $\frac{1}{2}$in. of one end of the spring and

—continued on page 1122

MAKING A

MUSICAL ALARM

Adapting a clock to automatically switch on a radio set at any predetermined time.

by W. R. Spence

ANY reader who possesses a portable radio and would prefer to be awakened by the sound of soft music rather than the harsh clangour of the traditional alarm-clock may be interested in this device. Neither construction nor destruction is involved, only one straightforward piece of simple wiring being required. This is shown in Fig. 1.

On-off Switch

The on/off switch of the radio is by-passed by having the ends of a length of twin flex attached to the two terminal contacts. The switch must be left in the "Off" position. The circuit should then be checked by touching together the free ends of the flex, when the radio should start to function. Insulated wire, of course, must be used and the ends bared to make electrical continuity.

The idea is to use the hour hand of the clock itself as an automatic switch to operate the radio at any predetermined time.

The end of one of the two wires in the flex is affixed to a convenient point of the casing, e.g., to the winding key. The end of the other wire must then be placed so as to make contact with the moving hour hand as the latter reaches the appropriate point on the dial. There are several

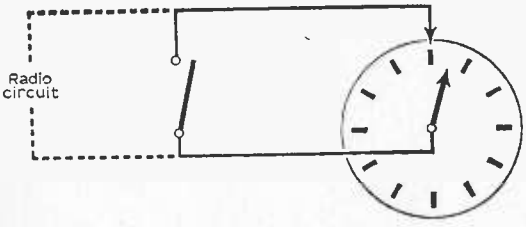


Fig. 1—Showing how the on-off switch of the radio is replaced by the hour hand of the clock. The bottom lead does not need to be connected to the spindle as metallic contact through any part of the frame suffices.

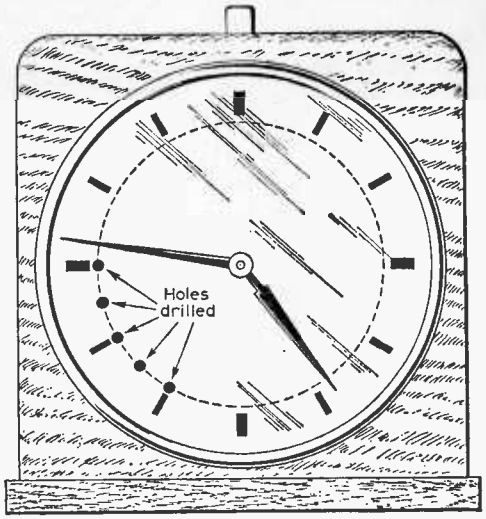


Fig. 2—The inner dotted circle indicates the line to be followed when drilling holes for inserting the end of the insulated lead.

ways of doing this, the easiest being to remove both the glass face and the minute hand. The following method, however, will be found to be both the neatest and the most effective.

As shown in Fig. 2 a tiny hole, the approximate diameter of the wire to be used, is drilled through the dial at hourly and half-hourly intervals. It is best from the point of view of neatness to do this for all 12 hours whether only a few are needed or not. The subsequent appearance of the clock is not affected unless it possesses an extremely short hour hand which does not quite reach the numerals.

Intermediate Positions

The unattached wire is then passed through the clock casing from the back and emerges from the hole nearest the time required. Intermediate positions between the hour and half hour are easily obtained by slightly bending the wire before inserting it and then rotating the wire in the hole until it assumes the position necessary.

Care has to be taken to ensure that the minute hand, which has to travel round the dial every hour, is not fouled by the contact for the hour hand and the correct position should be found by inspection. It is, naturally, important that good electrical contact be made between the hand and the wire as the pressure between them is very feeble. A painted or coated hand should be cleaned with sandpaper at the point where contact is to be made.

Alarm Switch

Although a switch is not essential, as the set will switch itself off after a few minutes as the hand travels forward, it is advisable to fit one. The same time does occur twice in the one day and it could be disconcerting to find the radio unexpectedly coming to life in the evenings. ■

The Twin-Unit Two

PART ONE

A PAIR OF EASILY MADE MATCHING UNITS WHICH COMPRISE A SIMPLE RECEIVER AND A POWER UNIT

by

A. Sydenham

DESPITE the simple circuitry employed, this pair of matching units can, when used together, provide a remarkably wide range of listening enjoyment. As may be seen from the photographs, the units are small physically and both are easy to construct. Either unit may be built independently of the other, for some readers might find Unit "A" of interest, while others do not and vice versa.

Unit "A" is a simple two-stage receiver constructed originally to provide headphone reception of signals transmitted in the bands from 0·5Mc/s to 15Mc/s (20-560m approximately), where much of interest is obtainable, since many amateur bands are contained therein. Tuning is continuous, due to the use of ready-made plug-in coils.

Unit "B" is a simple power unit and although it is intended primarily for use with Unit "A", it can also be used for other purposes if this does not involve heavy current demands.

Although Unit "B" is not generally required if a power pack is already available, beginners might not be so well equipped and the inclusion here makes for completeness. As presented both units are safe to handle at all times, due to the inclusion of a mains isolating transformer, but should the receiver be used with a different type of power supply unit, care should be taken to ensure that it is suitably insulated from the mains supply.

The Receiver

Circuit details are given in Fig. 1 where V1A operates as a grid leak detector-cum-audio amplifier, with V1B providing increased a.f. amplification. Signals are conveyed to the tuned circuit inductively from the aerial, a variable trimmer, TC1, being fitted so that best results can be obtained. Band changing is, as was mentioned earlier, by the "plug-in" method, and coils from the well-known Denco range have been chosen since these conveniently fit a standard Noval valve-holder. The coils are designed to operate in conjunction with a tuning capacitor of 300pF

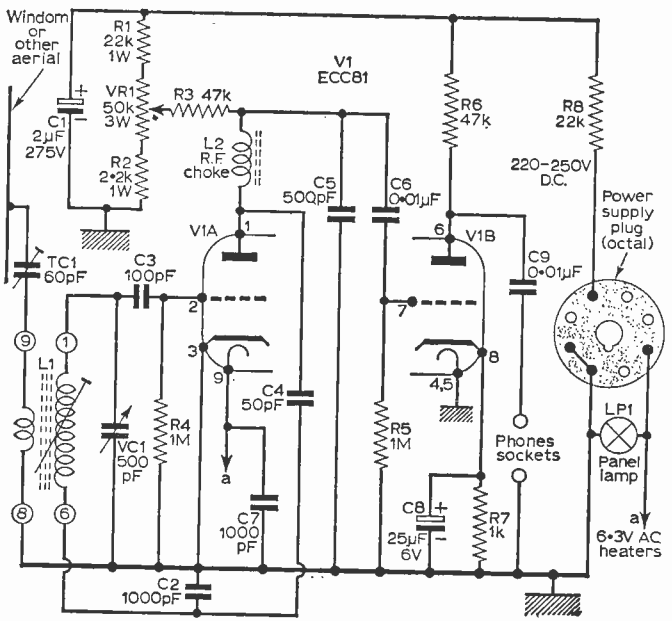


Fig. 1: The circuit diagram of the receiver unit.

(nominal) value and this fits in nicely with the arrangements used as will be seen later.

The circled figures associated with L1 in Fig. 1 refer to the coil spills and also coincide with the appropriate pins on the Noval valve base into which they are inserted as required.

Considering the circuitry associated with V1A it will be noted that the cathode of this section is connected to a capacitive potentiometer connected across the coil, the "outers" of which are taken to the grid and anode of the valve. Due to C5 the anode is "earthy" and when operating conditions are suitably adjusted positive feedback results, the r.f. choke L2 assisting the function. Control may be effected by varying the applied potentials and this is done by manipulating the potentiometer VC1, which is inserted on the "hot" side of the anode feed resistor R3. By using the VC1 judiciously V1A may be pushed smoothly to its most sensitive operating point—viz., to the edge of oscillation. Detector sensitivity is thus stimulated and tuning sharpened—but clumsy handling of the control will either (a) ensure low sensitivity or (b) cause unwanted and undesirable oscillation. It may be noted here that in an earlier temporary "hook up" the r.f. choke was exchanged for a 33kΩ resistor in an attempt at economy, but inferior results were obtained.

Tuning Capacitance

The effect of capacitively tapping the coil causes its tuning range to be restricted since the maximum external capacitance across it must always be less than the smallest value used due to the series connection. The problem is resolved here, however, by choosing values of 500pF and 1,000pF for VC1 and C2 respectively, thus reducing the overall maximum tuning capacitance to that recommended by the coil maker. Other types of regeneration circuit are possible, of course, but here the primary winding of the coil is left free for aerial connection purposes.

An alternative method of regeneration is

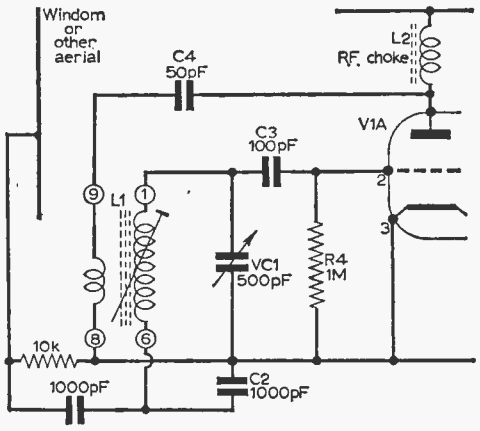


Fig. 2: This shows an alternative arrangement for obtaining regeneration.

depicted in Fig. 2 and here feedback is taken to the coil primary winding, thus necessitating an alternative method of connecting the aerial, which may be taken to the "bottom" of the tuned winding as shown. Another method of controlling regeneration is to adopt the circuitry of Fig. 2 but to make C4 a 500pF (maximum) variable capacitor and in this case VC1, R1 and R2 (Fig. 1) can be omitted, R3 being connected direct to the h.t. line. A variation, and one that confers greater gain at the expense of selectivity, is to ground tag 6 and to feed the aerial via a trimmer to tag 1, but in this case VC1 should be reduced in value to 300pF (nominal). In general, component values relating to Fig. 2 circuitry should agree with those specified for Fig. 1 except where otherwise marked.

The operation of V1B is simple enough to warrant no explanation but it will be noted that the parallel-fed phone outlet provides safety to the

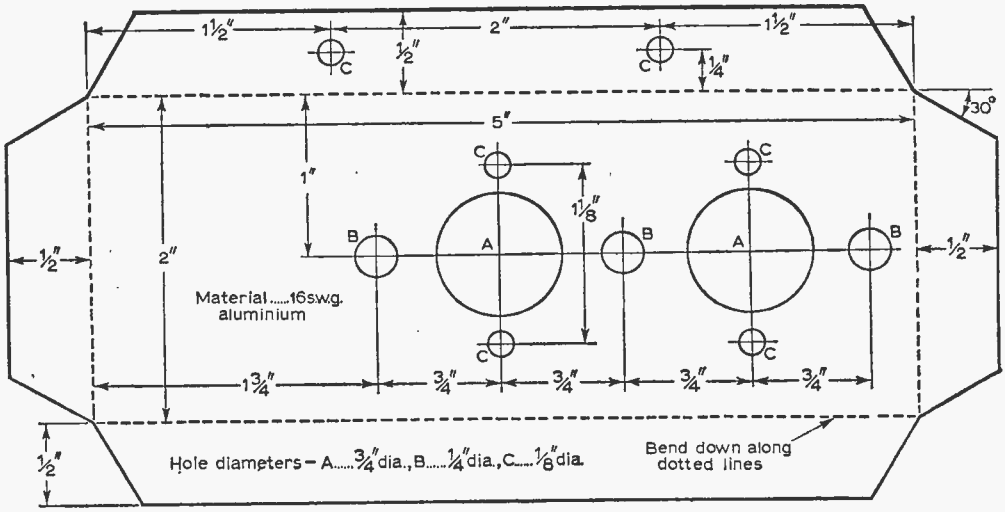


Fig. 3: Chassis drilling details for the receiver unit.

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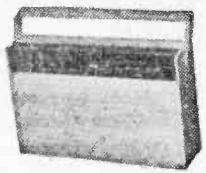

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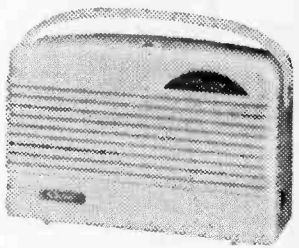

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user since d.c. is blocked off. The receiver is not fitted with an on/off switch since this is contained in Unit "B".

Mechanical and Constructional Notes

The smallness of the unit makes it possible to use a simple aluminium "tray" chassis which is secured to a hardboard panel that carries the simple controls together with a coloured warning lens, reduction drive mechanism and phone sockets. Details of both the panel and the chassis are given in Figs. 3 and 4 respectively and are self-explanatory, although the actual panel should be cut ⅛in. smaller than the horizontal dimension given and ⅛in. shorter than the vertical dimension because the ⅜in. quadrant which is glued as a frame to the panel edges is allowed to overlap to form a rabbet for the simple cabinet side and top members; the quadrant should be mitred at the corners, of course, and the bottom section routed out to receive the phone sockets. Metal cooking foil glued to the inside of the panel and in contact with the chassis prevents unwanted hand effects from interfering with operation. Although the trimmer TC1 and the aerial socket may be mounted on the chassis rear flange these are affixed to the cabinet back in the prototype and fitted with a flexible lead.

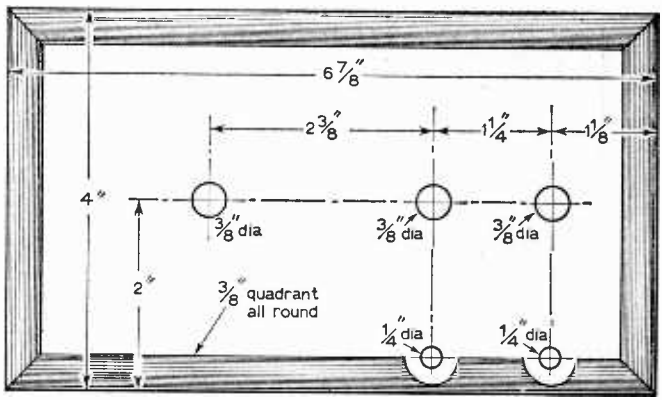

Fig. 4: Details of the panel of the receiver unit.

Diagrams showing the above and below chassis layout and wiring are given in Figs. 5 and 6 respectively and show that modern miniature components are fitted to prevent congestion. L2 is also physically slim and mounted not as shown in Fig. 5 (so drawn to assist clarity) but turned through 180deg. with the connections close to the chassis.

Power Cable

It is convenient to obtain the voltage supplies via a three-core cable terminated with a standard octal plug to fit a socket provided for it on Unit "B" (to be described later) and the idea is shown diagrammatically in Fig. 5, where it can be

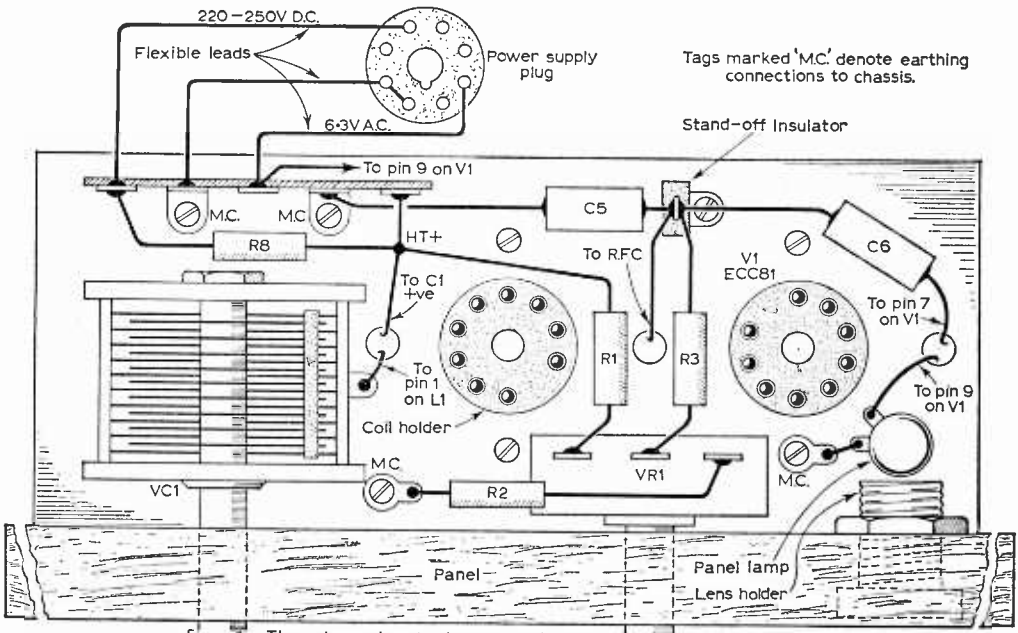

Fig. 5: The above-chassis layout and wiring of the receiver unit.

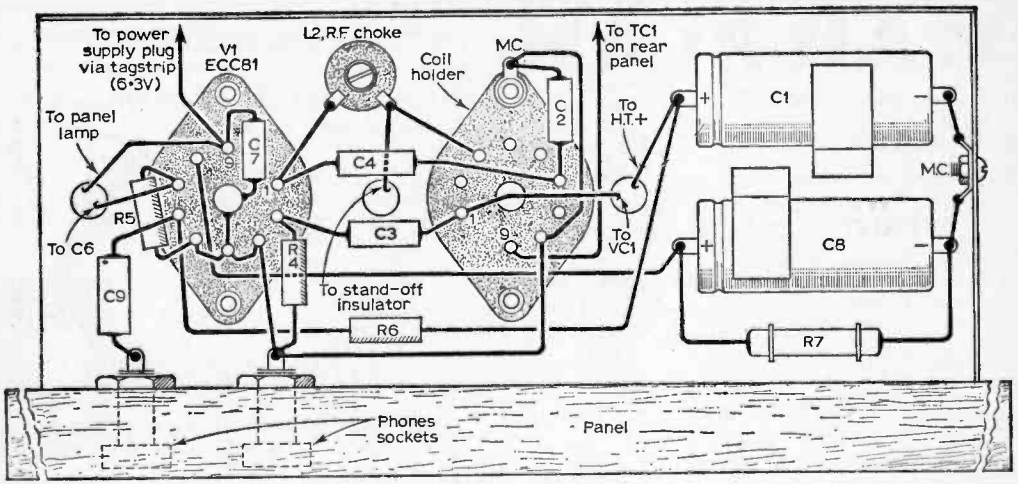

Fig. 6: The under-chassis layout and wiring of the receiver unit.

seen that the receiver end of the cable is connected to a simple tag strip to which the various feeds are connected. A suitable plug can be obtained by placing an unwanted octal-based valve in a strong paper bag to obviate flying glass splinters and tapping it smartly with a hammer!

The orientation of the valve bases permits short wiring and a spare tag on the coil-holder is utilised as an anchor for the choke L2, this item consisting—since it needs to be physically small—of a miniature dust-cored long waveband coil sawn off to the length of the core and with the primary winding removed.

Part Two next month will describe the power unit and testing.

ELECTRO-MECHANICAL ECHO UNIT

—continued—

pull it straight, make a small hook on this straight piece and carefully insert through the holes in the bracket at the pick-up crystal end. Pull the spring gently straight over the pick-up (without stretching it too much) and note where the spring meets the rear of the pick-up. Leaving about ½in. of coiled spring between the bracket and the rear of the pick-up, unwind sufficient wire so that a straight length appears over the length of the pick-up—over the stylus coupler. Allow enough to clear the pick-up at each end by about ¼in.

(2) Now hold the spring (still attached to the bracket) over the drive crystal and again note the position on it about ½in. from the edge of the drive crystal. From this position to past the other bracket straighten out the coil so that another straight length of wire appears over this pick-up and stylus coupler. Insert this straight end into the bracket holes and after pulling just enough to keep the spring from sagging too much in its centre make fast on the bracket.

(3) The two small springs are made in a similar way, leaving enough straight wire where they join the main spring so that the small springs do not touch the main one along their length. The tension on these springs should be very low, in fact just enough to hook them over the main one so that they don't pull on the small ½in. coil at the pick-up crystal end and cause it to foul the end of this pick-up.

(4) Making sure the main spring lays in each stylus coupler, a small dab of clear cement will hold them in place. Another dab of cement keeps the small springs in place on the main one.

To reduce hum it is advised that one spring bracket and the plate under the pick-up crystal be returned to chassis via the screening on the pick-up lead. Small solder tags bolted to these and connections made with thin flex will suffice.

The type of spring material used in the prototype consisted of an electric fire element obtained on a card in any electrical shop. The lightest one available should be used, the gauge being about 36 s.w.g. The more highly tempered the spring the better will be its characteristics—but it must be light and have a very close coil arrangement.

Operation of Unit

Connect any convenient signal source to one of the input jacks and couple the output lead to the input of the main amplifier. Set the volume of this amplifier roughly to mid position. Set VR2 (direct signal gain) until the volume is adequate and with the straight/repetitive switch in the "straight" position increase the setting of VR3 until the reproduced signal sounds "echoy" or hollow. This is the reverberation effect. If the echo sound is rather shrill or "toppy" increase the valve of CX (Fig. 2) until it sounds satisfactory. Switching to "repetitive" will introduce the staccato effect to the delayed signal, giving a pleasing "true" echo sound. By reducing the direct signal level it is possible to use the echo signal alone for added effects. ■

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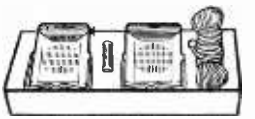

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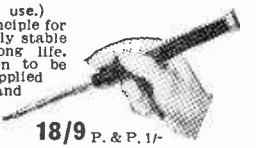

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Checks Beta gain (Current gain under DC conditions).

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Specially designed for all receivers using PNP Transistors.

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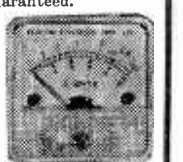
All models Individually Boxed and Fully Guaranteed. P. & P. 2/6 each.



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TEST GEAR techniques

PART 3 - THE VALVE VOLTMETER

H. W. Hellyer

THE high sensitivity voltmeters that have been discussed in previous articles are quite suitable for taking measurements where the power drawn from the circuit under test is only a minor proportion of the power available in that circuit.

But even a meter movement taking such a low current as 10μA for full-scale deflection, as used in an instrument with a sensitivity of 100,000Ω per volt, can have an appreciable effect on a circuit with a high impedance.

Damping Effect

For example, if we apply the test probes of our meter to a battery we should expect to obtain an accurate reading because the internal resistance of the battery is very low compared with the resistance of the meter.

Similarly, measuring the grid bias of an amplifying valve by applying the meter across the cathode bias resistor should also produce accurate results. But if we now apply the meter to the true grid circuit it is unlikely that the test would be successful; the grid leak resistor may be as high as 1MΩ and we are shunting it with a meter resistance comparable in value if we use the 10V range of our meter to give us a readable deflection.

Switching the multimeter to a higher voltage range reduces the shunting effect but limits the swing of the pointer to a small sector of the scale.

A.C. Errors

Similarly, small voltage measurements in an a.c. circuit of high impedance, such as the detector circuit of a radio receiver, can be even more misleading. Indeed, the connecting of a meter across many such circuits is sufficient to upset their operation and thus render our readings useless.

As we have noted, the sensitivity of the multimeter built around a basic moving-coil movement is considerably less for its a.c. ranges. Also the waveform of the voltage under test and its frequency will affect the accuracy of the reading.

Where a.c. measurement is obtained by rectification and subsequent d.c. movement—the normal method—the non-linear characteristics of the rectifier unit must be taken into account.

The higher the frequency being measured the more is the by-passing effect of the meter rectifier and the less accurate the reading. Also, as most meters are calibrated in terms of the root-mean-square value of the applied voltage or current, any deviation from a sinusoidal waveform will alter the ratio and a square wave will give what is almost a d.c. reading, whereas a "spiky" waveform will cause the meter to read low.

The answer to the problem is a meter having negligible loading effect on the circuit under test and with only a very small capacitative loading that would tend to shunt the higher frequencies. Such an instrument is the valve voltmeter.

Principle of the VTVM

The basic principle is the application of the test voltage to the grid of a valve which is part of a bridge circuit with a meter reading the "out-of-balance" current of the bridge. Thus the applied voltage is "looking into" the very high impedance and small capacitative shunting effect of the input grid.

The bridge is first balanced, the meter "zeroed" and the resulting change of conditions from the application of the test voltage causes an unbalance and a proportionate meter reading.

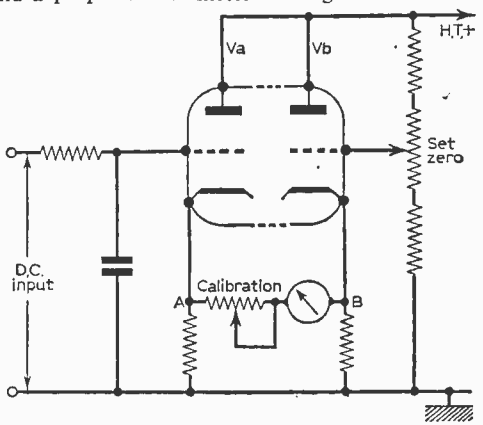

Fig. 10: Basic circuit of a valve voltmeter.

As shown in Fig. 10 this is a d.c. function. The valve is connected as a cathode follower amplifier with each half passing the same current when no test voltage is applied, the set zero control being used to regulate the bias of Vb under these conditions. Then the voltages across the cathode resistors of Va and Vb will be the same and the meter will not deflect.

Applying a test voltage to the terminals, with negative polarity to chassis, will cause Va to conduct greater current, producing a greater voltage across the cathode resistor. Thus point A is now of higher potential than point B and the meter pointer will deflect in proportion to this voltage difference.

A calibrating resistor acts as a multiplier to keep the meter reading within limits of the change in bias voltage. Correct choice of components to match the valve characteristics will result in linear calibration.

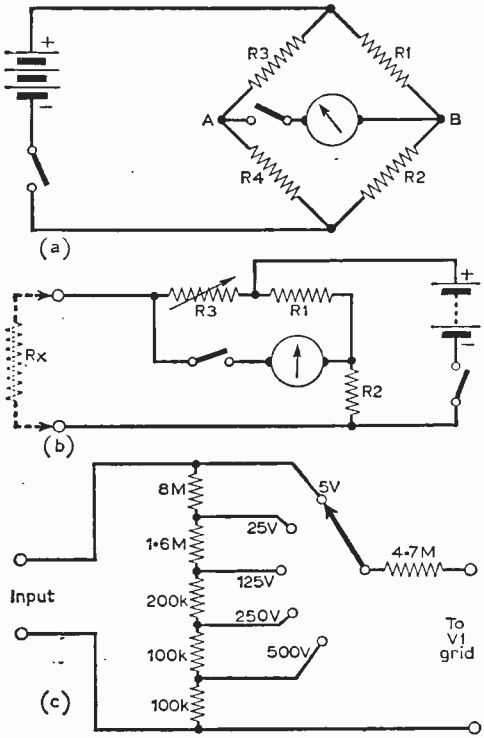

Fig. 11: Bridge circuits (see text).

Experienced readers will now prepare to jump on me for over-simplification. The foregoing is a basic explanation of the operation of the circuit. A more explicit answer to the question "What happens when a voltage is applied?" requires the addition of a few notes on bridge characteristics.

Talking of balanced and unbalanced bridges is a waste of time unless we define our terms and the understanding of bridge circuitry will prove handy later when we come to consider some applications of signal generators and oscilloscopes and a.c. bridges proper.

The Wheatstone Bridge

If four resistors of equal value are connected across a supply voltage as shown in Fig. 11(a) and a meter linked to the midpoint of each arm there would be no deflection of the pointer.

This is because the current flowing in each arm of the circuit—that is, through R1+R2 and R3+R4—is the same; therefore the voltage dropped across R1 and R3 is the same and points A and B are at the same potential. So the meter does not record and the bridge network is said to be balanced.

If we now substitute R4 with a resistor of unknown value—and if that value differs from the original—the condition of balance will be upset and there will be an indication on the meter. If R3 is now made variable and its resistance is measured, then by adjusting R3 until the balance is restored, and the meter again shows no deflection, we have a method of determining the value of the unknown resistor Rx.

Fig. 11(b) shows the circuit in a different form —principally to demonstrate that bridge circuits are not always immediately recognisable by that characteristic diamond shape of the resistor network.

Bridge-type circuits are widely used in radio work and it is not always obvious at a glance that the form of the circuit is indeed the familiar bridge. One must mentally translate the draughtsman's work to recognise circuits.

The Unknown Resistor

The formula for determining the value of the unknown resistor when the bridge is balanced is:

$$Rx = \frac{R2 \cdot R3}{R1}$$

In practice $\frac{R2}{R1}$ would be a constant and the value of Rx would be that constant multiplied by the resistance of R3 required for balance. This application will be more useful to us when we consider bridge-type instruments. In the meantime it is only necessary to remember that our meter is reading an "unbalance" current.

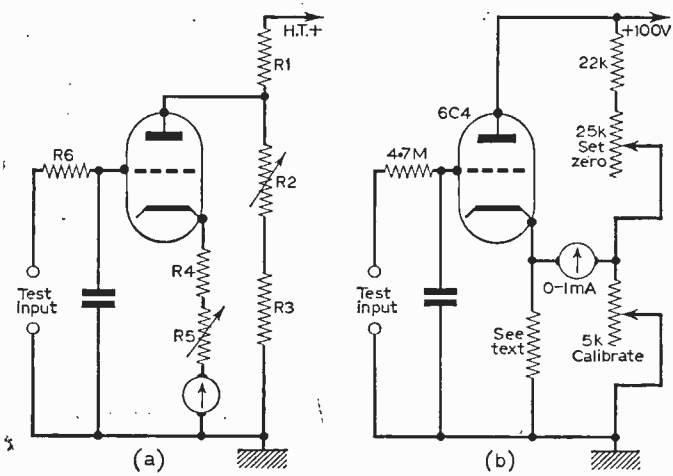

Fig. 12: The use of a valve to amplify an applied voltage and give a meter indication.

Now let us substitute R3 with a valve and feed our test voltage between its grid and cathode. First, by disconnecting the input terminals and adjusting the set zero control, we arrange that the bridge is balanced and the valve acts as one resistive arm of the bridge.

Now we apply a d.c. test voltage, the valve's anode current changes and thus its Ra value. The resistance of our substitute R3 has thus changed and the meter will give an unbalanced indication proportional

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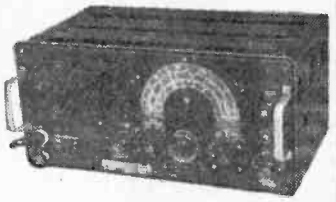

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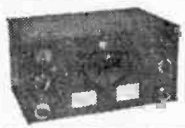

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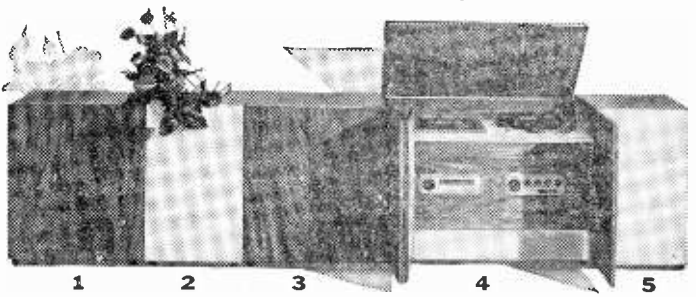

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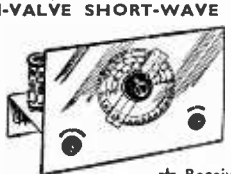

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to the change in R3 or the input volts.

Anode Current Meter

This type of circuit is very little different from the "old-fashioned" idea of using a valve to amplify the applied voltage, with a meter indicating the change in anode current. A circuit of this type is shown in Fig. 12(a). The anode of the triode valve is fed from a tapping on a potentiometer across the h.t. consisting of R1, R2 and R3.

The centre resistor is made variable and acts as a set zero control. R4 and R5 in series with the meter provide standing bias, with R5 variable to give a measure of calibration and R4 a fixed value, limiting the current to the straight portion of the valve characteristic.

The limitations of this device are obvious and Fig. 12(b) shows a development that more nearly approaches the bridge circuit. This is a useful

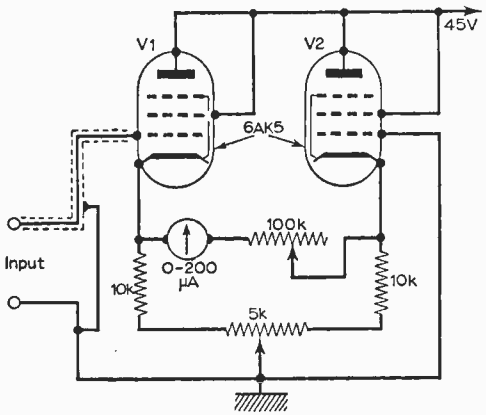

Fig. 13: Practical valve voltmeter circuit.

circuit that can be built easily around a valve such as the 6C4, 6C5, EF91 or EF80. The cathode resistor would have to be chosen to give a linear indication for the particular valve in use.

The range of voltages that can be measured by this method may be selected by a switched potentiometer input such as in Fig. 11(c). The input resistance is equal to the total of the potentiometer, usually 11MΩ, on d.c. ranges.

An important point is that this load on the circuit being tested remains practically constant for all ranges, a further limiting resistor of high value, between 1 and 5·5MΩ, being connected in series with the input to the valve grid. See R6 in Fig. 12(a).

In the commercial instrument these resistors forming the potentiometer are high-stability components specially formed to give accurate proportion of network resistance and not generally of preferred values. The experimenter wishing to make up a circuit such as Fig. 12(b) may find it better to compromise with a 10MΩ input using valves as indicated.

High Input Impedance

Some valve voltmeters have input impedances up to 25MΩ on the d.cs. ranges. Going even higher, the interesting circuit of Fig. 13 gives an input impedance higher than 100MΩ, high enough for accurate measurement of small voltages across the high resistors found in modern equipment.

This was first described in the January, 1957, number of *Radio and Television News* and is an American design by D. G. Shankland. The important factor is the use of valves with a very low grid current. The 6AK5 valve of Fig. 13 has a grid current of $10^{-4}\mu$A. The voltage difference between the cathodes of the two similar valves is read by the 200μA meter.

The test voltage is applied to the grid of V1 via a probe with a series resistor in the "live" lead of not less than 10MΩ and the grid of V2 is returned to chassis. Under these conditions, with no signal input, the 5kΩ preset resistor is used to set zero to compensate for slight differences in valve characteristics, supply voltages, etc.

Full-scale deflection of the meter indicates an input of 20V. The relevant cathode voltage is expressed by $1/(1+\frac{1}{\mu})$V where μ is the amplification factor of the valve, a high figure in this case, and V the input test voltage.

The provision of a calibrating resistor of 10,000Ω in series with the meter helps to compensate for the $1/\mu$ term and, provided care is taken in construction to avoid leakage across the input, very accurate voltages can be read.

Normal practice is to take the input lead through the casing of the instrument to the grid of V1 via a porcelain feed-through insulator.

A.C. Applications

Mention of a probe in the last description brings us to the important question of the measurement of alternating voltages. Here there are several restrictions. The instrument must again impose as small a load upon the circuit as can be obtained—and the standard multimeter has severe limitations on a.c. as noted in the previous articles.

But in addition to a high input impedance the valve voltmeter, or electronic testmeter, must have a small shunt capacitance and be capable of handling a wide frequency range. Although one or more valves may be used as buffers between the input signal and the point of measurement, connecting circuits themselves tend to restrict the frequency response by capacitative and inductive leakage. It is necessary, therefore, to rectify the a.c. signal as near the test source as possible and feed the resultant d.c. to the meter proper. Consequently much research has gone into probe circuitry and construction and a number of ingenious devices are on the market. It is possible to rectify a few millivolts at frequencies up to 200Mc/s, amplify the resulting signal sufficiently to load the input to the main meter and obtain readings of remarkable accuracy. Fig. 14 shows typical examples of these probes with both valve and crystal rectification.

Crystal Rectifier

The simplest type, which can be built into a handy casing such as a discarded fountain-pen holder, consists of a crystal rectifier, its charge capacitor C1 and filter components R1, C2 as in

(a). Slightly more elaborate is the circuit of (b), which has a crystal connected in opposite sense, giving a negative-going output suitable for feeding a transistor amplifier.

Note that the charge resistor R1 has a high value, the time constant of the C1, R1 combination being carefully chosen to give the most accurate results over a wide frequency range. This is usually decided by the function of the instrument and an alternative probe with a smaller value of C1 may be provided for r.f. measurement. For example, in the AVO electronic testmeter C1 is 0·05μF for the audio ranges and 470pF for radio frequency measurement. The Taylor 171A uses 0·01μF and 1,000pF, with a leak resistor of 20MΩ.

Both of these commercial instruments have valve rectifier probes in their original versions and

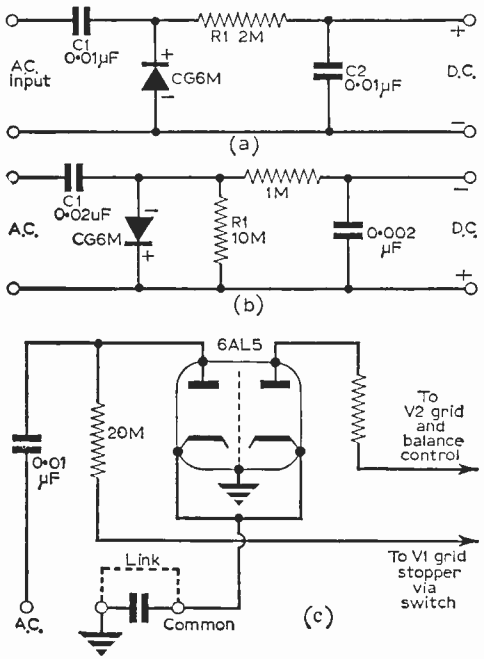

Fig. 14: Typical examples of crystal and valve probes.

the probe circuit of the latter is chosen to illustrate the typical valve method at Fig. 14(c). One interesting point is the use of a double diode valve, with one diode connected back to the control grid of the second triode in the bridge. The rectifier is a 6AL5 (EB91) and the double triode a 12AU7 (ECC82). The purpose of this circuit is the correction of a.c. set zero, which is adversely affected by "contact potential".

Electro-Chemical Action

As the name implies, contact potential is the effect of electro-chemical action due to the physical construction of the valve and its base and connections at the higher frequencies. A small voltage is developed across the load even when no external test voltage is applied. This needs to be backed off, or neutralised, to avoid the annoyance of a

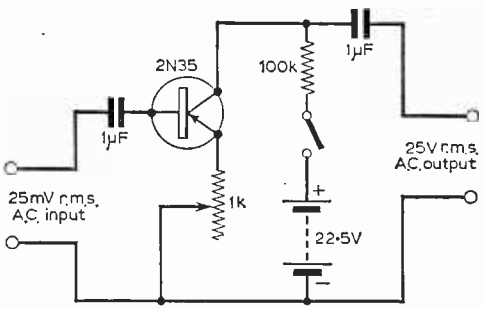

Fig. 15: Transistorised a.c. probe.

small standing deflection of the instrument pointer when the a.c. ranges are used. Thus by using a second diode and circuitry in such a manner that the contact potentials of the two sections of the valve cancel out, and biasing the valve by returning the leak resistor to a slightly positive point, an accurate set zero can be made on the a.c. ranges.

To further compensate for the non-linearity of the diode a preset control in this feedback circuit, called the diode balance, gives a small shift on the lowest range. The AVO model has a rather different arrangement, but with the same purpose, and allows a 0·07V standing reading on the lowest a.c. range, which is quite normal. From this it can be readily understood that the instrument is sensitive to very small a.c. voltages and therefore certain precautions are necessary in its use.

Short Connections

On the Taylor 171A, for example, using a 2·5V a.c. range, an absorption of only 25μW from an external field will give full-scale deflection. Connections to the source must be kept as short as possible. The low-level connection should be bonded to the chassis or low-level point of the apparatus under test (making sure when checking a.c./d.c. equipment that the chassis is at neutral potential, not live).

An external shorting link is often provided for protection where the low-level connection of the instrument is not bonded to its own casing and should be used where applicable. There should not exist a high potential difference between the negative terminal and the chassis. It is often advisable, for instrument protection, to make the negative connection first before applying the probe to the circuit under test and to keep the input terminals short-circuited on the low-voltage ranges until the tests are to be made. This danger of stray pick-up and sudden meter deflections is not so marked on the modern instruments but should be avoided as a matter of course.

Similarly, the strictures given before about commencing test measurements on the highest voltage range and resetting to the appropriate range also apply to the valve voltmeter.

When measuring voltages with waveforms that may not be sinusoidal special care is required. Meter deflection is generally proportional to peak values of the a.c. input, although the scale of the meter may be calibrated in r.m.s. values. Reference to Fig. 14(b) makes this clearer.

—Continued on page 1133

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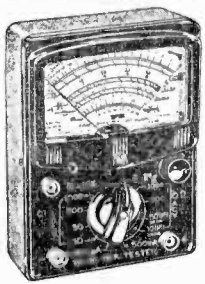

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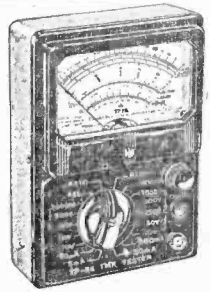

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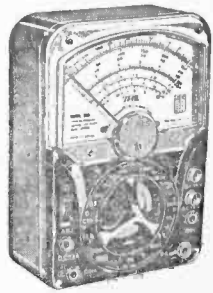

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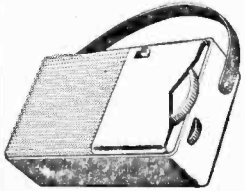

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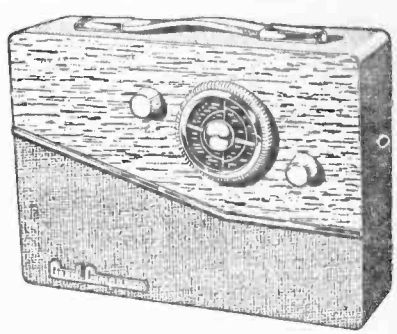

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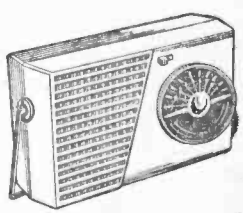

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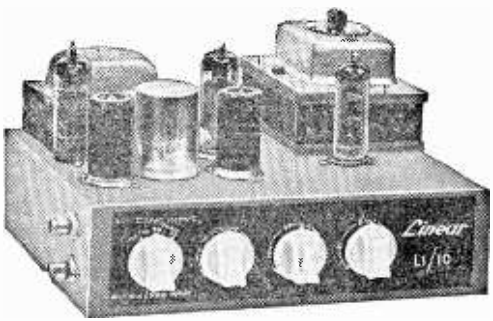

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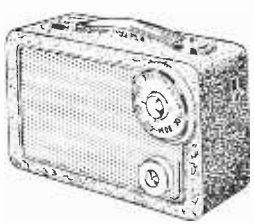

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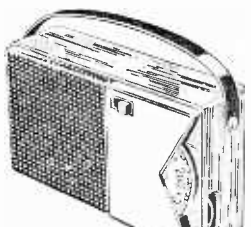

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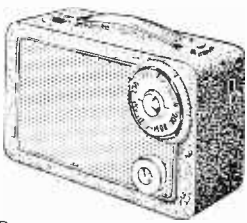

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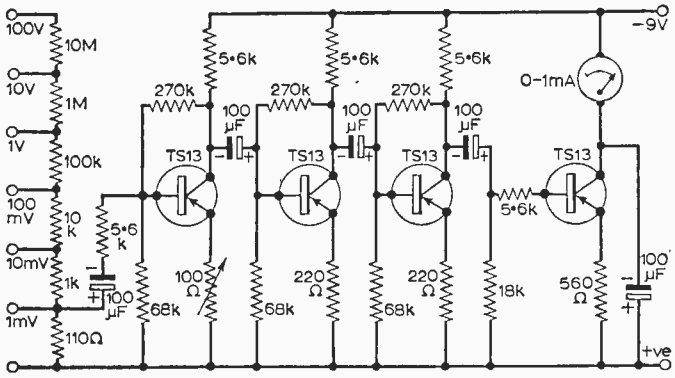


Fig. 16: The Brimar transistor voltmeter.

When a.c. is applied to the probe the rectifying action charges up C1 to the value of the peak voltage. During negative half-cycles the charge tends to leak away, but the time constant of C1 and R1 is such that, even at the lowest frequency to be handled, the next peak charges C1 before the previous charge has time to leak away.

The result is that after filtering by the 1MΩ resistor and 0·002µF by-pass capacitor a d.c. voltage tending to follow the peaks is applied to the meter. But the "averaging" process of peak reading is such that accurate calibration in r.m.s. values only applies when a truly sinusoidal waveform is being measured. Peak voltage is then 1·414 times the indicated r.m.s. When a non-sinusoidal input is being probed the rectified d.c. will be an average of the peaks and not always a trustworthy indication of potential.

For this reason, when testing an a.c. voltage that may not be a sine wave, check for "turnover error". This is the effect of, say, a large positive peak and a small negative peak such as an asymmetric waveform would produce. Reverse the probe connections and the meter polarity and note that readings though opposite should be similar in value. As a further precaution make a series of spot readings before and after reversing the connections and compute an average result. Check the set zero control both before and after the test and whenever the range switch is changed.

For measuring small a.c. voltages switch to the lowest range and short-circuit the probes before zeroing to eliminate the risk of false readings due to stray pick-up. Many commercial instruments have facilities for meter polarity reversal; constructors will find that the little extra trouble and cost of fitting a double-pole switch is well repaid.

Millivoltmeters

A good-quality instrument will measure quite small voltages but for really accurate low potential readings a valve millivoltmeter may be necessary. This is a slightly different instrument in that it has a wide-band amplifier incorporated. The a.c. input is fed through several stages, often cascode coupled and with heavy negative feedback to improve stability and retain response.

Typical of such instruments is the Advance 77, which has a full-scale deflection of 1mV and gives a useful indication down to 100µV. In instruments of this type the amplifier may also be used independently, making a very versatile piece of equipment, especially for audio work, where the millivoltmeter finds a special usefulness as a decibel meter. An example would be the use of the millivoltmeter amplifier as a Y-amplifier for scoping particularly small voltages to obtain a usable trace.

Another very popular example is the Heathkit model AV-3U, which has a full-scale deflection of 10mV on the lower range and a scale that gives a trustworthy indication down to a millivolt. The input impedance is 1MΩ at 1,000c/s and the circuit consists of a cathode-follower input stage feeding a cascode amplifier which drives another cathode-follower and an amplifier into a bridge rectifier across which the meter is balanced.

Transistor Instruments

Because of the amplifier facility this type of instrument is suitable only for alternating voltages. Some interesting developments have been made by the use of transistors for amplifier probes to extend ranges of low-volts/high-impedance meters. One such example is seen at Fig. 15 where a single transistor gives a gain of 1,000 in a simple circuit that can be built in a probe.

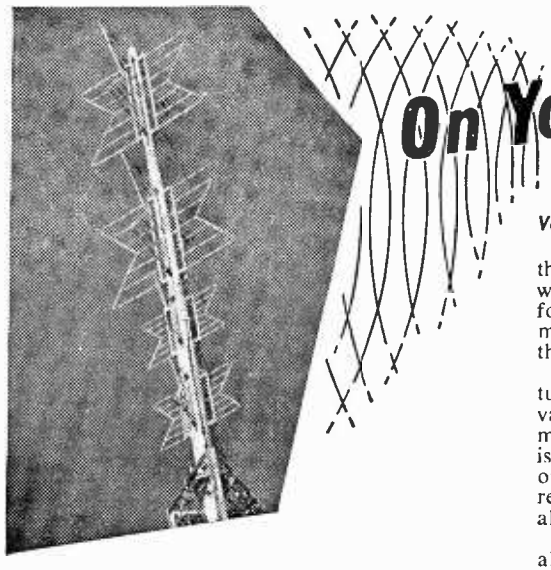
More ambitious, yet quite straightforward in circuitry, is the Brimar Transistor Voltmeter illustrated in Fig. 16. Six ranges between 1mV and 100V feed a three-stage amplifier of conventional common emitter mode, driving an output transistor whose variation in collector current is measured to provide an indication. Input impedance is better than 11MΩ on the top volts range.

Another interesting circuit is that of the sensitive d.c. transistorised voltmeter originally published in the Mullard book *Transistors for the Experimenter.*

This instrument has four OC71 transistors, two connected in common collector and two in common emitter fashion, with the input voltage applied between the bases of the former pair. A 20mV input gives full-scale deflection of the 100µA meter movement and the input impedance is 1MΩ per volt. To extend the range of this device series resistors would be required.

It should be remembered that the virtue of transistor circuitry is that from a low-impedance input, with grounded collector giving a linear characteristic, the emitter current is proportional to the input voltage (and to α' times the input current—which in this case is between half and 1·5µA). This output can be applied to the common emitter pair having the normal low-impedance input characteristic, giving an unbalance reading on a microammeter connected between collectors proportional to the applied d.c.

PART 4 OF THIS SERIES APPEARS NEXT MONTH



On Your Wavelength

By THERMION

I HAVE already received a number of letters regarding my comments in last month's issue on old sets. One point which has been raised concerns the loudspeakers which were used in my conversion, but this has brought to light one of my pet moans concerning the radio industry—one which I have before mentioned, and which has been with me for as long as I can remember.

Unmarked Components

Those of you who have a fair sized spares box I ask to go through it and see how many items carry any indication of the value or the maker. 1% or even less, I guarantee. Look at all the variable capacitors you have, either the old large-size type or the more modern midget components, and you will not find any indication as to the maximum capacity.

How many loudspeakers have you? Do you know the impedance, or even the maker? Yet, in view of the importance of these two items, not to mention the many others that there are, one would expect such information to be clearly marked somewhere. The end plate could be stamped on the capacitors and the impedance could easily be stamped on the frame or the magnet of the loudspeaker.

One would have thought that makers would have been only too willing to print their name or trademark on their products (if they are proud of them).

The greatly increased use of the transparent sticky tape should have led to a protected form or marking and this I now do in many cases with bits and pieces which I put in my spares box, and where the size permits I endeavour to include some data concerning previous use. This naturally is in the form of a code but it helps when going to use the item again.

Valve Substitutes

Looking through a batch of readers' queries for the past year, it is surprising how many readers were interested in finding valve substitutes—either for a set of early vintage which they were modernising, or because they had stocks which they wished to use in place of a specified item.

The modernising of an old set, by the substitution of modern midget valves to replace the older valves, is one which often leads to disappointment, mainly because it is found that the modern valve is a much more efficient component than the old one, and this leads to the necessity for some circuit re-arrangement, and this sometimes amounts almost to a re-build of the set, to keep it stable.

One type of replacement which I have found almost faultless is the use of ECC82's (12AU7's) in place of 6SN7's, and ECC83's (12AX7's) in place of 6SL7's. In no circuit where the latter types have been specified have I found it impossible to use the former, but there is no other valve replacement of this type which I have found so definite and effective.

If you are thinking of making a valve substitution of this type try and make it a general rule that the modern midget is a much more efficient item than its old time large counterpart—although the characteristics appear more or less the same.

Modernising an Old Set

Another point which seems to crop up rather frequently is the modernising of the old type of set which had a line cord and was of the midget type at one time very popular in America.

The output valve in these sets consisted of a double valve—output pentode plus half-wave rectifier. This type of valve no longer seems available and with the difficulty of the line cord a conversion worth considering is to fit a half-wave metal rectifier and use the a.c.-d.c. technique. It is essential, however, to make sure that the control knobs are properly insulated (the case is usually moulded bakelite), the mains lead properly anchored and if necessary any grub screws in the knobs filled with wax.

A small piece of wood will hold the rectifier, either bolted to the chassis or wedged between the chassis and the cabinet, and then an ordinary output pentode may be used with the wiring adjusted as necessary.

If you consider this type of conversion, however, bear in mind that this type of set is essentially portable and may be carried from room to room, and if the cardboard back of the cabinet has become lost or badly damaged make a new one from hardboard or thin plastic and take every precaution to guard against fingers etc. coming into contact with any metal on the set. This includes the end of the throw-out aerial with which these sets are usually provided.

Letters to the Editor

The Editor does not necessarily agree with the opinions expressed by his correspondents

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying commercial or surplus equipment. We cannot supply alternative details for receivers described in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. If a postal reply is required a stamped and addressed envelope must be enclosed with the coupon from page iii of the cover.

WHAT ABOUT THE LONE-WOLVES?

SIR,—As a reader of P.W. for some years now I would like to air some views arising from reading the article "Coronation Street or CQ.ZL" on the Club News page of the February issue.

The good advice therein obviously must apply expressly to prospective "ham" transmitters and the sentiment in reference to lone-wolves truly describes their possible position while not being members of a club. But what of the vast number of lone-wolves who have no desire to become licensed operators, but have a lively interest in the greater, more varied and ever advancing general application of associated electronics.

They too, of course, should join a club and quickly ascertain whether their own particular needs can be fully realised. For them I venture to suggest the name "Radio Club" can be somewhat misleading in many instances of the smaller local organisations, where it may be found that the dominant moving spirit is always around these members who are active operators, while all other functions are apt to take on a much lighter and subsidiary character.

Typical music-hall jokes on golfers, anglers, motorists, etc., in the pursuit of their respective hobbies are no more humorous than the spectacle of tangled multi-arrays, rhombics, ground planes and doubtful looking towers; much of which represents a laborious effort to keep up with the Jones's of radio when the "rig" can be described as so many hundred feet of wire fed with a lamentable low power stipulated in the terms of the licence. Included will be a receiver the purchase price of which runs into three good figures in the pounds column.

Upon hearing such a "run down" the possessors of less ambitious equipment must sometimes feel like changing over to Bingo for relaxation. To them should go a clarion call "take heart" and to you chaps with the banks of "813's" in parallel, raise your hats to some lone-wolf who is working a diminutive transistor "rig", emitting a few milliwatts on centimetric frequencies.—P. ASHDOWN (Newton-le-Willows, Lancashire).

SOMETHING UNIQUE

SIR,—May I take this opportunity to thank you for publishing the article "Electronic Metronome", which appeared in the February issue. This instrument used only a very simple circuit and for a not very musically-minded person like myself had little practical use, but personally, I found this tiny unit had great value in the fact that here, for once, was something different, something almost unique, which provided a most welcome change from the usual receivers, oscilloscopes, amplifiers, etc., etc.

In the same issue was another such article. I don't suppose I shall ever want or make an echo chamber, but I must confess that I read B. M. Jeffery's article on this subject, twice and found it full of interest both times.—A. M. HEADLEY (Bradford, Yorkshire).

HI-FI FANATICS

SIR,—I have followed the correspondence on Hi-fi Fanatics with interest and I can only wonder why Mr. Maitland and the other enthusiasts do not treat themselves to a stereo tape deck and pre-amplifier.

It has always struck me that the present popular disc method of reproduction is a most unfortunate evolution of the horn and sound box era. The quality of a good commercial stereo tape recording has to be heard to be believed; its life is almost infinite; there is no falling off of quality towards the end of the recording (as with disc records) and dust and cleaning worries can almost be forgotten, except for occasional wiping of the tape head.

The main disadvantage is, of course, that the commercial stereo tape recordings are expensive by comparison with disc, but this is largely because of limited demand.

As a matter of interest, I built my own stereo-tape equipment for about £40 and I consider it gives superior reproduction to a friend's disc equipment costing over £150.—R. C. HAWKINS (Ramsgate, Kent).

GOING MOBILE

SIR,—It is some years now since I first started operating my own rig and for most of this time my wife has held a grudge over my transmitter, receiver and ancillary equipment which—because we live in a flat of restricted size—I have to keep and use in the bedroom. Her main objection is that the units cannot be moved as a whole and by virtue of the fact that most of them are connected by cables, they cannot be moved individually. This situation used to present a problem when cleaning and dusting operations were in progress, until recently I found the solution by utilising a metal tea-trolley as a mobile workbench-cum-operating desk. My only worry now is, should I apply to the GPO for a mobile licence?—J. WILLIS (Liverpool).

CLUB NEWS

BURTON-UPON-TRENT AND DISTRICT RADIO SOCIETY
Hon. Sec.: H. Harrison, 38 Baker Street, Burton-upon-Trent, Staffordshire.

A recent lecture on the "Radio Control of Models" was given by Mr. Arthur Fallon.

At the main meeting for February, held on the 13th, W. Hazelden, the Society's chairman, gave another talk on "Single Sideband".

Potential members and visitors are invited to meet members of the Society at the Stapenhill Institute on Wednesday evenings.

DERBY AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: F. C. Ward, G2CVV, 5 Uplands Avenue, Littleover, Derby.

On Sunday, February 3rd, members had a race against time to make as many contacts as possible in the G5YY Trophy Contest. Three days later the Annual General Meeting was held, when amongst other things, the Society Officers for 1963 were elected.

On February 13th members attended a Hi-fi demonstration and all those who attended on the 16th spent an enjoyable evening at the Annual Dinner and Dance.

The last meeting in February was especially for the junior members and was devoted to a demonstration of simple measuring equipment.

March began with a sale of surplus equipment held on the 6th.

Future Event:

March 13th—"Car Radio Interference Problems" by R. Barrell.

LOTHIANS RADIO SOCIETY
Hon. Sec.: W. T. Sutherland, GM3JWS, 47 Great King Street, Edinburgh 3.

The evening's entertainment for the meeting of February 14th took the form of a "Brains Trust". On February 28th the Rev. W. Ferrier chose "2-metre Aerials and Progation" as the subject of his lecture.

NORTHERN HEIGHTS AMATEUR RADIO SOCIETY
Hon. Sec.: A. Robinson, G3MDW, Candy Cabin, Ogden, Halifax, Yorks.

The evening of February 13th was spent in an informal atmosphere with members enjoying a ragchew. On the 27th, however, G3ADG gave a formal lecture on the problems of "TVI and BCI".

Future Event:

March 13th—Spares sale.

PURLEY AND DISTRICT RADIO CLUB
Hon. Sec.: E. R. Honeywood, G3GKF, 105 Whytecliffe Road, Purley, Surrey.

Early in February Mr. B. Wynn (G8TB) gave an interesting talk entitled "Why be Afraid of Transistors", and on the 15th a constructional contest, which was open to all members, was held and judged.

READING AMATEUR RADIO CLUB
Hon. Sec.: R. G. Nash, G3EJA, "Peacehaven", 9 Holybrook Road, Reading, Berkshire.

The only meeting held in February was on the 23rd and was devoted to a talk and demonstration of "Transistor Gear for 160m" which was given by G3OLA.

ROTHERHAM AND DISTRICT RADIO CLUB
Hon. Sec.: M. Parkin, 51 Far Lane, East Dene, Rotherham, Yorkshire.

At the recent Annual General Meeting, held at the new clubroom, a new committee of officers was elected.

A spares sale was held on February 15th and it is intended to operate the Club transmitter (call-sign G30AM) on most club nights.

SLADE RADIO SOCIETY
Hon. Sec.: D. D. S. Williams, 117 The Boulevard, Wylde Green, Sutton Coldfield, Warwickshire.

On February 8th, members had the opportunity of airing their views on the subjects of d.f. and the Club station, both of which play important parts of the Society's activities. Visitors were welcome at the Society's annual auction sale of surplus equipment, held on February 22nd.

Future Event:

March 9th—Film show.

(Continued on page 1142)

"HAMS CAN'T LIVE ON BREAD ALONE"

THE letter received in the PRACTICAL WIRELESS offices the other day from Roger Barker was not the only one of its kind we have received within recent months. It seems as though there are a number of people around the country who, like Mr. Barker, are eager to start an amateur radio society in their own locality. This is, of course, a very laudable desire, as there are, no doubt, many amateur radio enthusiasts who still have no local club to provide for their special needs; but anyone setting out to fulfil such a desire must not underestimate the difficulties involved.

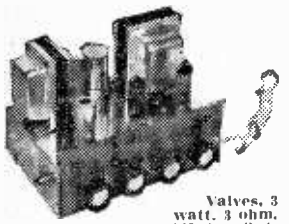
We would point out for a start, that the first essential of a radio society is *not* a 100W transmitter, nor a specially designed club tie, nor even a club-room, but, undeniably, it is enthusiastic members who provide the foundation of a club, and it is the degree of enthusiasm and the number of members that will decide whether the new club will prosper or die. This seemingly obvious fact is one that will easily be overlooked by anyone starting a club. Indeed, a few of the clubs who regularly send reports to P.W. are despairingly short of members, and seem in danger of petering out altogether; and in the knowledge of the fact that a few dozen more members would ensure an energetic society doing valuable work in educating youngsters in the ways of radio, we feel a deep sense of pity for those few enthusiastic people who must have existed at the inception of each of these clubs.

So for the potential founder members of radio societies, it is essential that they *always* strive to increase the membership, and *never* allow the number to drop to less than a certain minimum—the exact number becoming obvious with time—below which the club could not possibly survive.

This, then, is the prime consideration of people like Mr. Barker. Another point worthy of note, however, is that the radio enthusiast, like anyone else, needs some "side-shows" to keep his mind from becoming weary of the "main attraction". In other words, the club organiser must make sure that meetings are not always devoted entirely to radio subjects and that the social side is not neglected. It is true to say that "hams can't live on bread alone", so try to break the diet of d.f. contest and morse practice with the occasional bar-b-que or outing.

Roger Barker is only 17 years old and he is going to need a few hard-working lieutenants and many supporters to make his venture succeed and so we print his address in the hope that anyone interested will get in touch and that yet another amateur radio society will emerge:—*67 Balvernie Grove, Southfields, London, S.W.18.*

MULLARD 3-3 Hi-Fi AMPLIFIER



Valves, 3 watt, 3 ohm, and 15 ohm. Output. A really first-class Amplifier giving Hi-Fi quality at a reasonable cost. Mullard's latest circuit. Valve line up: EF86, EL84, EZ81. Extra HT and LT available for Tuner Unit addition. This is the ideal companion Amplifier for FM tuner units.

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Recommended Speakers—WB HF1012 95/-. Goodmans AXIOM 110 £5, etc.

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SPECIAL BARGAIN OFFER. Comp. Kit only Carr. 12/6. **£25.0.0**

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£12. 19.6 P. & P. 10/-.

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Collaro "Junior"	75/-
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Collaro "C 60"	£7.7.0
B.S.R. (UA14)	£6.19.6
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Volume Controls—5K-2 Meg-ohms, 3in. Spindles Morganite Midget Type 1½in. diam. Guar. 1 year. LOG or LIN ratios less Sw. 3/-. DP. Sw. 4/6. Twin Stereo less Sw. 6/6. DP Sw. 8/-.

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JACK PLUGS. Standard 2½" Igranic Type, 2/6. Screened Ditto, 3/3. Miniature 1¼". 2/3. Screened Ditto, 2/6.

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Ersin Multicore Solder 60/40 3d. per yard. ¼lb. 2/6. etc.

Condensers—Silver Mica. All values. 2pF to 1,000pF, 6d. each Ditto. Ceramics 9d. Tub. 450V T.C.C., etc., 0.001 mfd. to 0.01 and 0.1/350V., 9d. 0.02-0.1/500V. 1/-. 0.25 Hunts 1/6. 0.5 T.C.C. 1/9, etc., etc. **Close Tol. S/Micas**—10% 5pF-500pF 8d. 600-5,000pF 1/-. 1% 2pF-100pF 9d. 100pF-500pF 11d. 575pF-5,000pF 1/6. **Resistors—Full Range** 10 ohms-10 megohms 20% ½ and ¼ W 3d., ½ W 5d. (Midget type modern rating) 1W 6d., 2W 9d. **Hi-Stab** 10% ¼W 5d., ½W 7d. 5% ¼W 9d., 1% ¼W 1/6.

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Osc. Coil—M/W. 9/16in. dia. 5/3
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Kit consists of 3 sub assemblies already wired. Grub screw connections between Units only necessary—absolutely no soldering.

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3in. L.P. 225ft. 4/9, 3in. D.P. 30 ft. 6/6.
Plastic Tape Reels .. 3in. 1/3, 5in. 2/-, 5½in. 2/-, 7in. 2/3
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20 yd. 9/-. P. & P. 1/6.
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TRS Est 1949

Trade News

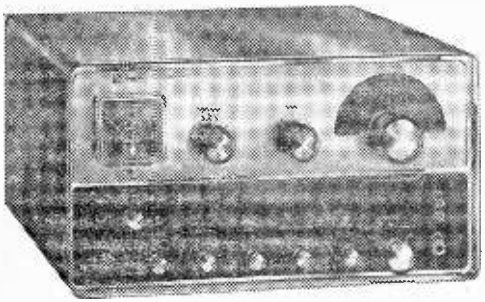
150W TRANSMITTER KIT

THE American firm of electronic kit manufacturers, Knight Kit Electronics, has recently announced a new addition to its range—the T-150 a.m./c.w. transmitter kit. This transmitter operates with 150W peak a.m./c.w. input on 80m through 10m, and 100W peak a.m./c.w. on 6m.

The made-up instrument features a specially designed v.f.o., which provides highly stable frequency control on all bands, and also an adjustable π-network output circuit that matches 40 to 600Ω aerial impedances.

Another noteworthy feature is the frequency spotting selector-switch position, which allows tuning of the transmitter before switching on the final amplifier. This offers the advantage for the operator to zero-beat an incoming signal without placing the transmitter on the air.

The exporters of Knight Kit Electronics products in Britain are *Ad. Auriema Ltd., 414 Chiswick High Road, London W.4.*



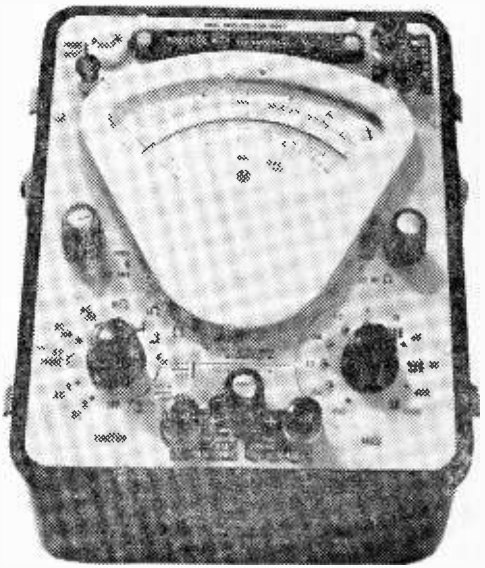
The new transmitter kit from Knight Kit Electronics.

TRANSISTORISED MULTIMETER

AT the recent Physical Society Exhibition, Avo Limited exhibited three of their latest developments. One of these was a transistorised multimeter which has included in its design the facility for the measurement of low a.c. and d.c. voltages.

This instrument, designed around a "chopper" amplifier having a full-scale sensitivity of 10mV, may be used for the measurement of d.c. voltage, d.c. current, a.c. voltage, a.c. current and resistance. The use of a probe enables r.f. voltages between 10mV and 4V to be measured at frequencies up to 1,000Mc/s.

One of the features of this multimeter is a "battery check" facility, included to ensure that the supply voltages do not fall below the limit required for satisfactory operation. The hermetically sealed movement has a scale length of 5in. and incorporates an anti-parallax mirror. The manufacturers of this instrument are *Avo Limited, Avoset House, 92/96 Vauxhall Bridge Road, London S.W.1.*

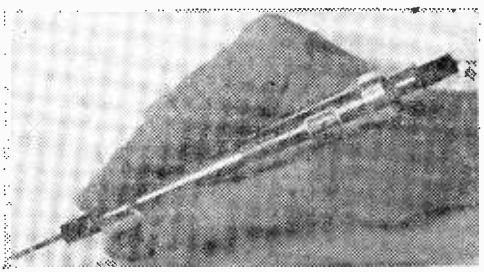


Avo Limited's transistorised multimeter.

HIGH GAIN SIGNAL TRACER

THE latest addition to the range of test equipment made by Controlled Electronics is a pocket-sized signal tracer, known as the 670. The complete instrument comprises a high gain signal tracer and detector.

Two plug-in input probes are provided; one for a.f. and the other for detecting modulated r.f. signals. The 670 is a useful servicing aid in all manner of circuits, for locating hum, noise and signal breaks, etc.



The pocket-sized signal tracer made by Controlled Electronics.

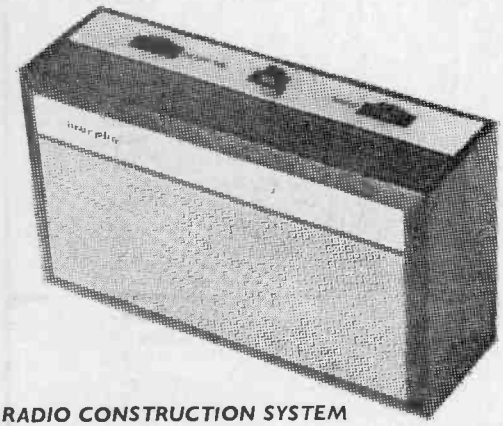
The output is obtained through a miniature earpiece, and the price of the complete instrument is £6 19s. 6d. The makers are *Controlled Electronics 62 High Street, Croydon, Surrey.*

CONTINUITY TESTER

A NEW instrument, specially designed for rapid continuity checks in all electrical equipment, has been brought on to the market by M.P.E. (Finchley) Ltd. The unit is called the MPE Trantest and when used, gives an audible indication of continuity and will quickly detect such things as dry joints and the effectiveness of anodised plating on metal surfaces.

Advantages of the Trantest are that it will not indicate continuity through inductive or capacitive impedances and that it cannot damage semiconductor devices.

The price of the Trantest, complete with probes, is £4 10s. and it is made by *M.P.E. (Finchley) Ltd., Dollis Park, Finchley, London N.3.*



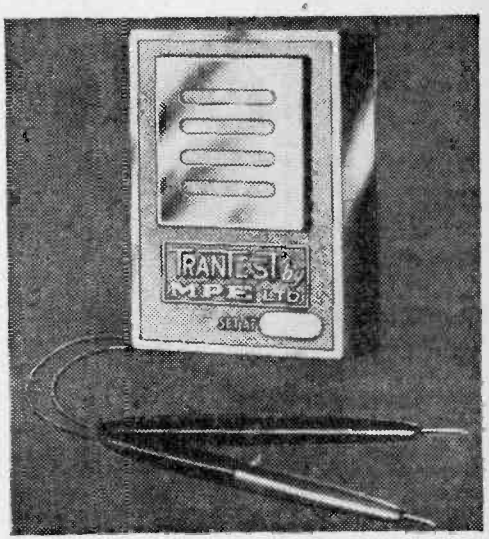
RADIO CONSTRUCTION SYSTEM

A METHOD of constructing electronic circuits, in step-by-step stages, has been brought on to the market by Radionic Products Ltd.

From a simple radio receiver, the circuits progress to a six transistor set capable of receiving long and medium wave broadcasts.

All the components are attached to plastic mounts which are fixed in position on a Perspex "chassis" which is perforated with holes at regularly spaced intervals. On the other side of the chassis brass strips can be attached to join components, and in effect, act as the wiring. As the "chassis" is transparent, the whole circuit can easily be followed through and checked, even by a complete beginner to radio construction.

Four of these Radionic sets are available, each set varying in complexity and price. The prices range from £6 12s. 6d. to £16 14s. 6d. and the makers are *Radionic Products Ltd., Adastral House, Nutfield, Redhill, Surrey.*



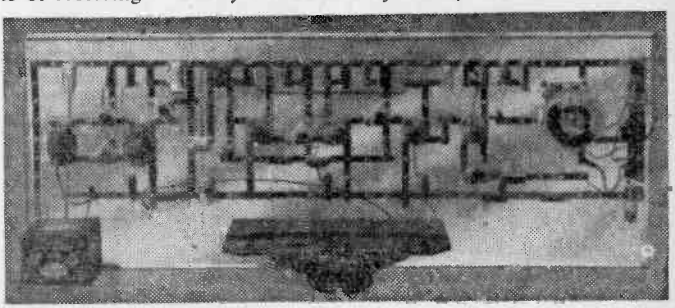
The MPE Trantest Continuity tester.

Left: A new seven-transistor receiver made by Murphy Radio Ltd.

7-TRANSISTOR PORTABLE RECEIVER

A SEVEN-TRANSISTOR radio—weighing only 2lb—is the latest model to be put on to the market by Murphy Radio Limited. This receiver is the model B801 and is a portable model capable of tuning over the whole of the medium and longwave bands. Its dimensions are 6¼in. x 3½in. x 2in., and its price is 12½ guineas. A separate carrying case is also available at 25s.

The B801 is made by *Murphy Radio Limited, Welwyn Garden City, Hertfordshire.*



A view of a 6-transistor receiver, made up from a Radionic Kit.

CLUB NEWS *(continued from page 1138)*

SPEN VALLEY AMATEUR RADIO SOCIETY
Hon. Sec.: L. A. Metcalfe, 1A Moorlands Road, Birkenshaw, Bradford, Yorkshire.

The subject of the lecture given by T. H. A. Withers, on February 7th, was "Converters, Receivers and Transmitters", and S. Marsden's talk on "What's New" was well received by his audience at the meeting on the 21st.

On March 7th, Mr. J. Belcher lectured on the subject of "Direction Finding".

WESSEX AMATEUR RADIO GROUP
Hon. Sec.: G. J. Fowle, 138 Surrey Road, Branksome, Poole, Dorset

The Annual General Meeting was held on February 4th this year.

At the meeting held on March 4th, members held a talk on "Electronics".

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ECL80	5/9	EZ40	6/6	PY81	7/-
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RECEIVERS & COMPONENTS
(continued)

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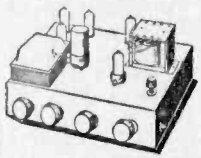

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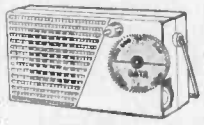

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Transformer to suit the above: Input 200-240 A.C. Output 12 volt A.C. 36 watt. **16/6.** P. & P. 2/6. Input 200-240 A.C. 12 volt A.C. 60 watt. **22/6.** P. & P. **3/6.**

Set of 4 colours **FLUORESCENT Paint.** Red, Yellow, Green and Blue in ¼ oz. tins ideal for use with the above Ultra Violet Bulbs. **9/6.** P. & P. 1/6.

BUILD AN EFFICIENT STROBE UNIT FOR ONLY 37/6.

The ideal instrument for workshop, lab, or factory. This wonderful device enables you to "freeze" motion and examine moving parts of stationary. We supply a simple circuit diagram and all electrical parts including the NSP2 Strobe tube which will enable you to easily and quickly construct a unit for infinite variety of speeds, from 1 flash in several seconds to several thousands per minute. New modified circuits bring price down to **37/6** plus 3/- P. & P.

NSP2 CV2296 STROBOTRON FLASH-TUBE made by Ferranti, brand new, I.O. base. Price **15/-.** P. & P. 1/-.

MAGNETIC COUNTERS 10 IMPULSES PER SECOND

Very latest **High Speed** type ex P.O., guaranteed perfect, type No. 100B, coil 2,300 ohms, for 48 volt D.C. operation (will work on 36 volt), overall size 4 x 1 x 1in. Also available, type 101A which can be used as an interesting accessory with our Strobe unit. Either type price **15/-.** P. & P. 1/6.

Variable Voltage Transformer

Input 230 v. A.C. Output 0—260 v. at 2.5 amp. Fully shrouded. New. **£5.19.6.** inc. carriage. Also available from stock, 5, 8, 10 and 20 amp. Write for details.

ORP 60 MULLARD CADMIUM SULPHIDE PHOTOCELLS

With mounting and leads including circuit for making light sensitive switches. **7/6.** Post paid.

SIEMENS H.S. RELAY. Very latest type, sealed. H96E. 1,700 ohms plus 1,700 ohms, single C/O contacts. Price **16/6** each, plus 1/- P. & P.

Miniature LEDEX Switch. 24 volt D.C. operation. Two bank 11 position plus Homing Contact. A miniature and compact form of uniselector. Ex brand new equipment. **32/6.** P. & P. 2/-.

500 MICROAMP SUB-MINIATURE M/C METER. 1¼in. diameter, flush mounting, single hole fixing. Scaled 0-1 mA. Supplied with Resistor for use as 1mA if required. **29/6** plus 1/- P. & P.

230 VOLT A.C. GEARED MOTORS Type B16G 80 r.p.m., .26 lb. inch, **£1.19.6.**, P.P. 2/-. Type D16G 5 r.p.m., 1.7 lb. inch, **£2.9.6.**, P.P. 2/6. Type D16G. 13 r.p.m., 1.45 lb. inch. **£2.12.6.** P.P. 2/6.

12 v. D.C. Reversible Motor with tremendous power weight ratio. 3 position switch. Weight 2.1 ounces. Size 1⅛ x 1⅛in. dia. Speed 7,000 R.P.M. Self lubricating. **15/-.** plus 1/-. P. & P.

AVO METER MODEL 7. Individually tested on all ranges and guaranteed. Inclusive of Test Leads. **£11.0.0** each. P. & P. 5/-. Case **20/-.**

MINIATURE LEAD ACID ACCUMULATORS. (Brand New.) 2V. 1.5 A.H. Size 4 x 1½ x 1in. Wt. approx. ¾ lb. **16/6** for 3. P. & P. 1/6. 12V. 0.75 A.H. Size 4 x 3 x 1½in. Wt. approx. 2 lb. (can be used as double 6V). **15/6** each. P. & P. 1/6.

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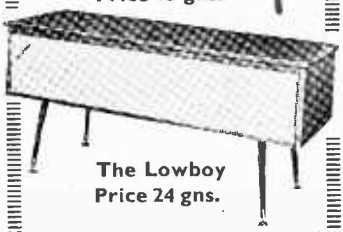

The Lowboy
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PICK-UP CARTRIDGES—SPECIAL OFFER

B.S.R. TC8M (Mono) 19/6; ACOS GP67/2 (Mono) 12/6; RONNETTE 165S (Stereo/Mono) 27/6. All post free. All Brand New and complete with fixing brackets.

ILLUSTRATED LISTS

Illustrated lists are available on LOUDSPEAKERS, TAPE DECKS, TEST GEAR, GRAMOPHONE EQUIPMENT, AMPLIFIERS. Any will be sent free upon request.

STEREO COMPONENTS

Morganite ganged potentiometers as specified for the Mullard circuits. ★ Log/Anti-Log, 500k, 1 meg., 2 meg. ★ Log/Log, 50k, 250k, 1 meg., 2 meg. ★ Lin/Lin 250k, 500k, 1 meg. All **10/6** each.

TRANSISTORS

MULLARD. Reduced prices. Current production types, not rejects. All in makers' boxes. Postage 3d. on each.
OC44, 9/3; OC45, 9/-; OC70 and OC71, 6/6; OC72, 8/-; OC72 Matched Pairs, **16/-**; OC78, 8/-; OC81, 8/-; OC170, **9/6**; OC171, **10/6.**

AMPLIFIER KITS

We have full stocks of all components for the Mullard 510, Mullard 3-3, Mullard 2 and 3 Valve Pre-amp, Mullard Stereo, Mullard Mixer, GEC 912 Plus. Fully detailed list on any of these sent upon request.
Instructional Manuals: All Mullard Audio Circuits in "Circuits for Audio Amplifiers", **9/5.** GEC912, **4/6.** All post free.

TRANSISTORISE YOUR CRYSTAL SET

We have two new designs for Transistor amplifiers which can be used to greatly improve the signal from any crystal set. RLD4 Kit, one stage 12/-; RLD5 Kit, two stage 21/-; both post free. The kits are easy to build and very detailed instructions are supplied. Leaflet available.

CLOSE TOLERANCE CONDENSERS

Radiospares first grade Silver Mica. Tolerance—up to 39pf. ±1pf. 47pf. up ±1%. 4.7, 10, 15, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 100, 120, 150, 180, 200, 220, 250, 270, 300pf. All **9d.** each.
330, 390, 470, 500, 556, 680, 815pf. All **1/-** each.
1000, 1500, 1800, 2200, 2700, 3600, 4700, 5000pf. All **1/9** each.
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RESISTORS

All preferred values from 10 ohms to 10 meg. ½ watt rating. List of values available.
Carbon. Size ¼ x 3/16in. 10% tol. **5d.** each.
High Stability Size ¼ x 3/16in. 5% tol. **9d.** each.
Miniature Wire Wound. 5 watt. 5% tol. Size ¼ x 1in. 15, 25, 30, 39, 50, 68, 75, 100, 125, 150, 180, 200, 220, 250, 270, 300, 350, 400, 470, 680, 750, 820 ohms. 1k. 1.2k., 1.5k., 1.8k., 2.2k., 2.7k., 3k., 3.3k., 3.9k., 4.7k., 5.6k., 6.8k., 8.2k. All **1/6** each. Postage extra on all above.

NEW MULLARD CONDENSERS

We now stock the following range of the new Mullard Miniature Foil and Polyester condensers as used in the latest TV and Transistor sets. Fully detailed list available giving full technical information and dimensions.
Miniature Foil. 30 volt working for Transistor sets. .01mfd. 7½d.: .022mfd. 9d.: .047mfd. 9d.: .1mfd, **11d.**
Polyester Tubular Capacitors. Moulded outer case designed to withstand accidental contact with the soldering iron. Tolerance 10%. 125v. range: .01mfd, .022mfd, .047mfd, all **9d.** each. .1mfd. **1/2**; .22mfd. **1/3**; .47mfd. **1/6**; 1mfd. **3/-.**
400v. range: .001mfd, .0022mfd, .0047mfd, .01mfd, .022mfd, all **9d.** each, .047mfd, **1/2**, .1mfd, **1/3**, .22mfd. **1/6**, .47mfd, **2/5.** Postage extra.

TAPE RECORDING EQUIPMENT

TAPE DECKS

ALL CARRIAGE FREE	Cash Price	Deposit	Hire Purchase Mthly/Pmts
B.S.R. TD2	**£8.19.6**	**£1.16.6**	12 of 13/7
Latest COLLARO Studio	**£10.19.6**	**£2.3.6**	12 of 16/4

TAPE AMPLIFIERS

We now stock the **Martin Recorder Kits.** These are partly assembled kits for complete tape recorders. The Amplifier Printed Circuit Panels are completely wired, but the assembly of this and external components is left to the constructor. Very complete instructions are supplied. Send for leaflet.
MODEL C for Collaro Studio Deck, **£11.11.0.**
MODEL B for BSR TD2 Deck. **£8.8.0.**
CARRYING CASES. Smart carrying cases are available to take the above amplifiers and decks. Fitted with speaker.
For Model C Amplifier and Collaro Deck. **£5.5.0.**
For Model B Amplifier and BSR Deck, **£4.4.0.**
H.P. Terms available for amplifiers, cases and decks.

TAPE PRE-AMPLIFIERS

MULLARD TAPE PRE-AMPLIFIER. We stock complete kits and all components. Send for list.
MARTIN. Pre-amp kit for Collaro Studio Deck. **£8.8.0.**

"BRAND FIVE" RECORDING TAPE

Post free.
Long Play: 900ft. (5"), **18/6**; 1200ft. (5½"), **23/6**; 1800ft. (7"), **35/-.**

JASON F.M. TUNER KITS

Kits supplied complete with every item needed including instruction manuals. Fully detailed list available. Separate items supplied, ask for price list. H.P. Terms available on any kit.
FMT1, £6.12.6; FMT2 (less power), £7.15.0.
FMT2 (with power), £9.12.6; FMT3 (less power), £9.9.6.
FMT3 (with power), £11.7.6. Mercury 2, £10.14.6.
JTV/2, £14.12.6.

P.W. STRAND, MAYFAIR & SAVOY UNITS

We stock parts for the P.W. Strand Amplifier, Mayfair Pre-Amplifier and Savoy FM Tuner. Detailed price lists are available.

LATEST TEST METERS

	Cash Price	Deposit	Hire Purchase Mthly/Pmts.
AVO Model 8 Mark II	£24. 0.0	£4.16.0	12 of £1.15. 2
AVO Model 8 with leather carrying case	£27.18.0	£5.12.0	12 of £2. 0.11
AVO Model 7 Mark II	£21. 0.0	£4. 4.0	12 of £1.10.10
AVO Multiminor	£9.10.0	£1.19.0	12 of 14/4
AVO Multiminor with leather carrying case	£11. 9.0	£2. 5.0	12 of 17/-
TAYLOR MODEL 127A	£10.10.0	£2. 2.0	12 of 15/8
CABY A-10	£4.17.6	£1. 7.6	3 of £1. 6.8
CABY B-20	£6.10.0	£2. 0.0	3 of £1.13.4
CABY M-1	£2.14.0	—	—

Full details of any of the above supplied free on request.
The AVO Models 7 and 8 are both latest models from current production—not to be confused with Government Surplus!

OUTPUT TRANSFORMERS

GILSON: W0896A, W0696B, **50/6**, post 2/6. W0710, **55/6**, post 2/6. W0892, **62/3**, post free. W0767, **27/-**, post 1/6. W01796A, **57/6**, post 2/6. W01932, **84/-**, post free.
PARTRIDGE: P3667, **75/-**; P4131, **65/-**; P5202, P5203, **£5.18.6.** All post free.
PARMEKO: P2829, **47/6**; P2642, 45/-; P2643, **47/6.** All plus post. 2/9. P2641, **29/6**, post 2/-; P2929, 16/-, post 2/-; P2932, 41/-, post 2/6.
ELSTONE: OT/ML, 45/-, post 2/9; OT/3, 25/-, post 2/6.

MAINS TRANSFORMERS

GILSON: W0741A, **63/-**, post free; W0839, **48/9**, post 2/9; W01328, **58/6**, post 3/6; W01288, **58/-**, post 3/6; W01566, **80/-**, post free; W01341, Choke, **36/-**, post 2/-.
PARMEKO: P2631, **35/**, post 2/9; P2630, **54/9**, post 3/3; P2644, **76/6**, post free; P2930, **41/-**, post 3/-; P2931, **56/9**, post 3/3.
ELSTONE: MT/MU, **45/-**, post 3/3; MT3/M, **35/-**, post 3/-; MT/510, **42/-**, post 3/3.

MARTIN STEREO AMPLIFIER KITS

Printed circuit, already wired and tested. Only requires wiring to mains and output transformers. Complete kit with plastic escutcheon and full instructions. **£6.6.0.**

GRAMOPHONE EQUIPMENT

ALL LATEST MODELS
ALL POST FREE

	Cash Price	Deposit	Hire Purchase Mthly/Pmts.
RECORD CHANGERS			
GARRARD AUTOSLIM (Mono PU)	£7. 2.6	£1. 8.6	12 of 11/2
GARRARD AUTOSLIM De-luxe (AT6 Mono PU)	£11. 9.0	£2. 6.0	12 of 16/11
GARRARD AUTOSLIM De-luxe (Stereo/Mono PU)	£12. 5.4	£2. 9.4	12 of 18/-
B.S.R. UA14 (TC8 Mono PU)	£6.19.6	£1. 7.6	12 of 11/-
B.S.R. UA14 Monarch (TC8S Stereo/LP/78)	£7.19.6	£1.11.6	12 of 12/4
B.S.R. UA16 (TC8 Mono PU)	£7.19.6	£1.11.6	12 of 12/4
B.S.R. UA16 (TC8S Stereo/LP/78)	£8.19.6	£1.15.6	12 of 13/8
SINGLE RECORD PLAYERS			
B.S.R. TU12 (TC8 Mono PU)	£3.17.6	£1. 4.6	12 of 13/8
B.S.R. GU7 (TC8 Mono PU)	£4.18.8	£1. 8.8	3 of £1.6.8
GARRARD SRP10 (Mono PU)	£5. 9.11	£1.12.11	3 of 29/-
TRANSCRIPTION UNITS			
GARRARD 4HF (GC8 PU)	£16.12.6	£3. 6.6	12 of £1.4.5
PHILIPS AG1016	£12.12.0	£2.10.0	12 of 18/6

Many of the above can be supplied for stereo working. See our Gramophone Equipment List for details.

LOUDSPEAKERS

GOODMANS: Axiette 8in., £5.5.7; Axiom 10in., **£6.5.11**; 12in., Axiom 201, £10.7.0; 12in., Axiom 301, £14.10.0; 12in., Audiom 51 Bass, **£8.14.0**; 12in., Audiom 61 Bass, **£13.14.0**; Trebax Tweeter, £6.4.0; X05000 Crossover unit, **£1.19.0.**
WHITELEY: HF106 10in., **£7.0.0.**; HF1012 10in., **£4.7.6**; HF816 8in., £6.0.0; T816 8in., £5.13.6; T10 Tweeter, £4.8.3; T359 Tweeter, £1.10.6; CX3000 Crossover unit, £1.11.6; CX1500 Crossover unit, £2.0.0. H.P. Terms available on all speakers.

★ TERMS OF BUSINESS
Cash with order or C.O.D. We charge C.O.D. orders as follows: Up to £3, minimum of 3/2. Over £3 and under £5, 1/6. Over £5 and under £10, 1/8. Over £10, no charge. **Postage extra on CASH orders under £3 except where stated. Postage extra on overseas orders irrespective of price.**

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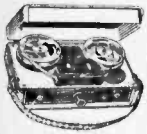
★ HIRE PURCHASE TERMS are available on any item. Repayments may be spread over 3, 6 or 12 months. Details as follows: Three months: Deposit 6/- in the £. Service charge 5 per cent. but minimum charge of 10/-. Six and Twelve months: Deposit 4/- in the £. Service charge 10 per cent. but minimum charge 20/-.

Tape Recorders



One of the easiest ways to learn anything is to "tape" it and then keep playing it back. Try this new technique—you will be amazed. The industrious Japanese have really gone to town on tape recorders this year and many bargains are on offer. It is the writer's opinion that there is bound to be a big demand for them, so there is a good reason why you should buy your tape recorder immediately. **KIT OF PARTS £4.19.6** or ready assembled model **£4.19.6**, plus 5/- Carr. & Ins.

Limited Quantity Only

Waterproof heater wire. 16 yds. length. 70 watts. Self-regulating temperature control. 10/-, post free.

Building A 'Scope?

3in. oscilloscope tube, American made type No. 3FP7. 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.

Miniature Circuit Breaker

(Or repairable fuse)

You will have experienced the annoyance of having to repair a fuse especially in the middle of an experiment or repair job. Save yourself this bother by installing a simple circuit breaker. All you have to do then (if you touch the wrong wires together) is to re-set (push in) the circuit breaker. Offered with instructions at 15/- each. (Will save its cost in time and temper in no time).

All Purpose Auto Transformer

Ministry reference 10K/143. This will convert 230 v. to 110 v. or 230 v. to 460 v. Use it also as a filament transformer 230 v. to 6.3 v. 5 amps. or 230 v. to 12.6 v. 3 amps. Price **12/6**. Post and packing 2/6.

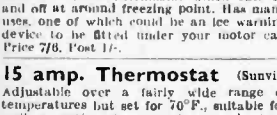
Ice-Stat

This is a small thermostat which cuts on and off at around freezing point. Has many uses, one of which could be an ice warning device to be fitted under your motor car. Price 7/6. Post 1/-.

15 amp. Thermostat (Sunvic)

Adjustable over a fairly wide range of temperatures but set for 70°F., suitable for wall mounting to control room heaters. Exceptional bargain at 9/6, plus 1/- post and ins. Crackle finish and calibrated case, suitable for mounting this (only minor adjustment), 5/- extra.

Adjustable Thermostat



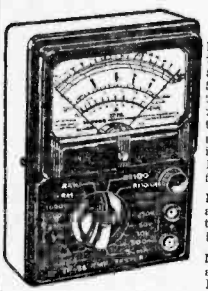
Suitable for Industrial or domestic purposes, such as controlling furnace oven, immersion heater etc. Can also be used as a flamestat or fire alarm. Made by Sunvic these are approximately 17" long and adjustable over a range 0 °o 550°F. The contacts are rated at 15 amps., 230 volts, and the adjustment spindle, which comes to the top, can be fitted with a flexible drive for remote control or just a pointer knob for local control. Listed at £3 or £4 each, these are offered at only **12/6** plus 2/6 postage and insurance.

THIS MONTH'S SNIP!

CABINET & PICK-UP

Made for a famous company intending to make a Battery Record Player but changing their minds. This is an extremely fine looking cabinet, must have cost at least £2 to make. It is complete with handle and fasteners as illustrated. Also included in the parcel is a Cosmocord pick-up with crystal cartridge and sapphire stylus. Both items new and perfect. Only 19/6, plus 4/6 post and insurance.

MULTI-METER BARGAINS



MODEL TPS5. (Illus. on left). 20,000 ohms per volt. D.C. volts, 5 ranges up to 1,000; A.C. volts, 5 ranges up to 1,000; resistance, 2 ranges up to 10 meg.; capacity, 2 ranges up to .1 decibels —20 to 26. One switch control. really beautifully made precision instrument, size only 3½ x 5½ x 1¾in., price only **£5.19.6**. Post free.

MODEL TP10. Similar in size and appearance to TP85, but sensitivity 2,000 ohms per volt. Price **£3.19.6**. Post free.

MODEL 500. Similar size to above but 30,000 ohms per volt. Price **£8.19.6**. Post free.

The 'Good Companion' Mk.II using Transfilters

In the 'de-luxe' cabinet as illustrated it costs **£10.19.6** to build — but What a set! Scan these pages: you will find nothing to compare with its specification. It uses transalters instead of I.F. transformers, has variable feedback as well as all the usual features. A.V.C., Push-pull output. Ferrite Aerial. Slow Motion Tuning, etc., etc., and is a very powerful Medium & Long Wave set, conservatively rated at 750mW. Every component used is by a famous maker, such as American Philco MADT R.F. transistors—Mullard A.F. transistors—Jackson Brothers' tuning condensers—Rola-Celestion loudspeakers—Dubilier—T.C.C.—Morgamte resistors and controls. Also full after-sales service available.

You will definitely be doing the right thing if you buy a 'Good Companion'.

DO YOU EVER FORGET?

This Pocket Secretary could eliminate the trouble (often embarrassment) your forgetfulness causes you—she will stay in your jacket pocket and as fast as you can think she will capture and store—ideas—notes — formulae — appointments — anything you can say or sing! then at your command she will play them all back to you.

Undoubtedly one of the smallest precision tape recorders made. Entirely controlled by push buttons, you can record and play back with the instrument in your pocket. It is a full-function machine using standard ¼" tape and easy to replace batteries. Speaking and playing back is from the same (crystal) microphone.

Specifications: Dimensions: 6¾ x 2¾ x 1¾ in. weight: 14 oz. recording time: 12 mins., rewinding time 4 mins., recording system: D.C. Bias, erasing system: Magnetic erasing, wow and flutter: within 2%, and frequency response: 500-1,200 c/s (within —6db).

NOW ONLY **£9.19.6** Complete ready to work.

Speaker Bargain

12in. High-fidelity loudspeaker. High flux permanent magnet type with standard 3 ohm speech coil. Will handle up to 12 watts. Brand new by famous maker. Price 27/6, plus 3/6 Post and Ins.

Hi-Fi Snip—Infinite Wall Baffle

Nicely veneered and polished. Corner fitting (attaches to picture rail). Takes up no floor space. Gives really fantastic results with only low-priced 8in. speaker. Fitting for tweeter. Only 45/- each. Carr. and ins. 3/6.

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 insurance. State whether 15 ohm or 3 ohm.

Gramophone Motor

E.M.I. 4-speed with turntable and pick-up on control board **£4.5.0**, plus 5/- post and ins. Plinth for mounting same in cupboard or drawer, **12/6**. Post free if ordered with motor.

Infra-Red Heaters

Make up one of these latest type heaters ideal for bathroom, etc. They are simple to make from our easy-to-follow instructions—uses silica enclosed elements designed for the correct infra-red wavelength (3 microns). Price for 750 watt element and instructions. 15/6, plus 2/6 post and ins.

Fluorescent Light Bargain

Kit of parts comprising: choke two lamp holders, starter holder and starter. 40 watt., 19/6; 80 watt., 27/6. Plus 2/6 post and insurance.

Yaxley Switches

All new, first class condition.

1 pole, 2 way	1/6;	1 pole, 3 way	2/8
1 pole, 4 way	1/9;	1 pole, 5 way	2/6
1 pole, 7 way	3/-;	1 pole, 9 way	3/-
1 pole, 11 way	3/-;	1 pole, 12 way	3/3
2 pole, 2 way	2/-;	2 pole, 4 way	2/8
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5 pole, 6 way	7/6;	5 pole, 12 way	14/6
6 pole, 2 way	3/6;	6 pole, 3 way	3/6
6 pole, 6 way	8/6;	6 pole, 11 way	16/6
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PRACTICAL WIRELESS, APRIL, 1963

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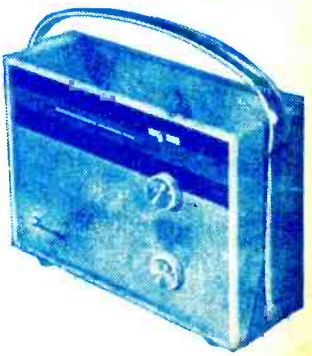

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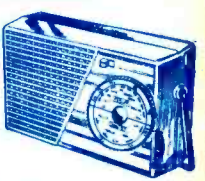
POCKET RADIO

5-Transistor plus Diode. Medium and Long Wavebands.



● Improved 5-transistor with diode 7-stage **medium and long** wave pocket radio. Now features more output, greater sensitivity and quality. Printed circuit clearly marked with component positions, carded components and matched transistors. Features full volume control, marked dial, airspaced tuning, push-pull speaker output, car aerial socket, phone/record socket.

● Guaranteed results, with no station overlap, including Radio Luxembourg. Simple to build with carded components and fully detailed illustrated instructions (free on request).

TOTAL COST OF ALL PARTS **79/6** P.P. 2/-. **PLANS FREE ON REQUEST** **Amazing Performance** Size 5¼ x 3 x 1¼in.

'TRANSFIVE' PORTABLE RADIO

Total Cost of all Parts

£5.19.6

P.P. 2/6.

A 7-stage push-pull output printed circuit portable radio of attractive appearance. Features 5in. speaker, clearly marked printed circuit panel, ferrite aerial, carded components and fully detailed and illustrated building instructions. Size 8½ x 6½ x 3½in.

★ Plans Free on Request ★

"RANGER 3"

Size 4¾ x 3 x 1¼in.

59/6 P.P. 1/6

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

P.W.-6 SUPERHET **£7.19.6.** P.P. 2/-.
P.W. "MERCURY" **£9.10.0.** P.P. 2/6.
And all other P.W. Designs.