MARCH 1963

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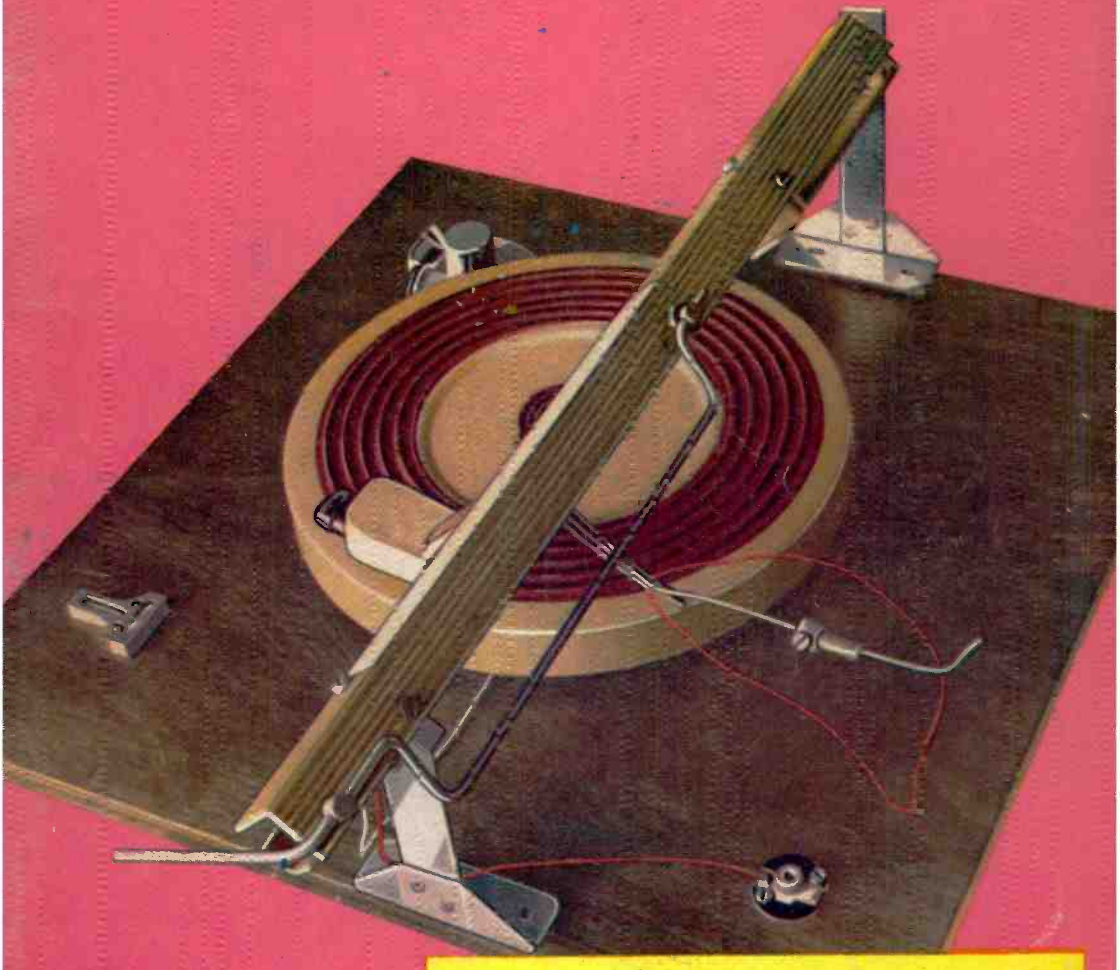

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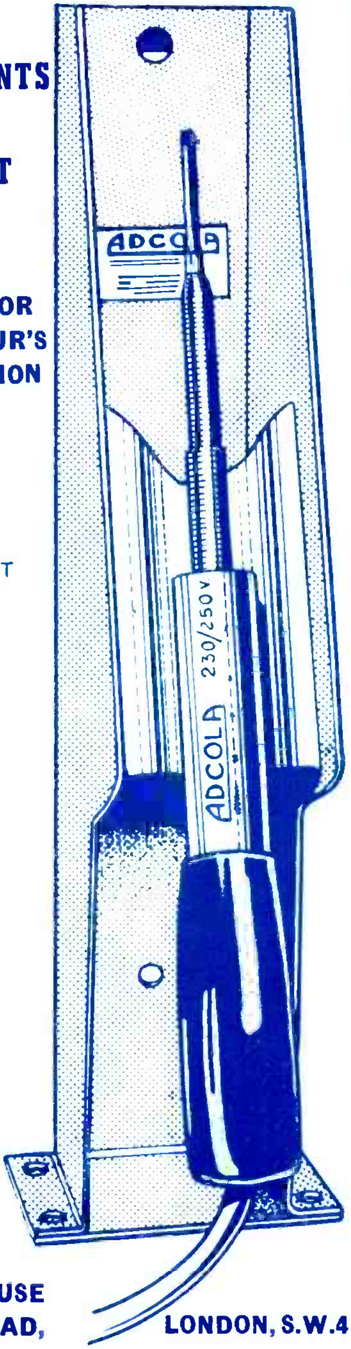

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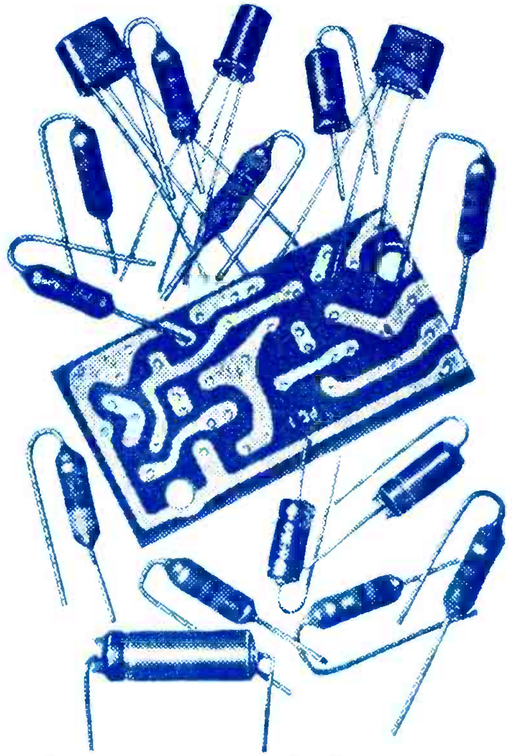

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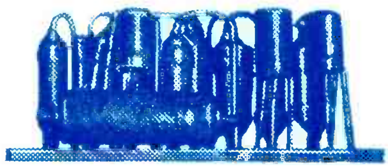

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6F23	6/6	12C8	6/6	DA30	12/6	EL42	8/9	R18	11/-	ZD152	7/9
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6F33	6/6	12K8	11/-	DET19	2/9	EL91	4/-	SP61	2/6	OC45	6/-
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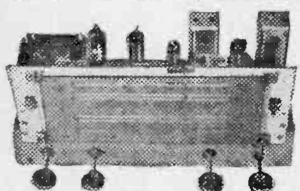

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M.W. 200 m.—550 m. ECH81, EF89, EBC81,
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12-month guarantee.
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6AT6	6/-	12K7	5/-	EY86	9/-	UBC81	9/-
6BA6	7/-	12K8	14/-	EZ40	7/-	UBF89	9/-
6BE6	5/-	12Q7	5/-	EZ80	7/-	UCH81	9/-
6BW6	7/-	25Y5G	9/-	EZ81	7/-	UCL82	10/-
6C4	5/-	35L6	9/-	HABC80	10/-	UCL83	12/-
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6G6	4/-	807	5/-	KT33C	8/-	UL41	9/-
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465 K/s Slug Tuning Miniature Can. 2 x ¾ x ¾in. High Q and good bandwidth. Data sheets.

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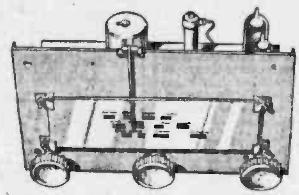
32/450V	3/9	8+8/450V	3/6	32+32/350V	5/-
25/25V	1/9	8+16/450V	3/9	32+32/450V	6/-
25/50V	2/-	16+16/450V	4/3	32+32+32/350V	7/-
50/25V	2/-	32+32/350V	4/6	50+50/350V	7/-
50/50V	2/-			64+120/350V	11/6
				100+200/275V	12/6

COMPLETE RADIO CHASSIS £4.19.6. post free

4 Mullard valves, 5in. speaker.
Superhet Circuit. BRAND NEW.
Size 9 x 6 x 5½in. 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, 150 w. .. 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 × 3½ × 3½in. Weight 6lb. Post 17/6
MAINS POWER PACK. Size 3¾ × 4½ × 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. Multiratio, 7/6. Multi-ratio heavy duty push pull, 10 w., 15/6. Miniature, 384, 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 ammeter 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.

4 TRANSISTOR PUSH-PULL AUDIO AMPLIFIER

Size 3 × 1¾ × 1.
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** 9v. Batt. 2/3, 2½in. Speaker 15/-

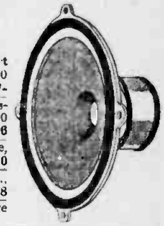
C.R.T. BOOSTER TRANSFORMERS for heater cathode short circuit, or tubes with failing emission. Full instructions supplied, mains input. **Type A optional 25% and 50% boost. 2v. or 4v. or 6.3v. or 10.8v. or 12.6v. State voltage required. PRICE 10/6.**

LOUDSPEAKERS P.M. 3 OHM. 2½, 3, 4in., 19/6, 5in. Rola, 17/6; 8in. Plessey, 19/6; 7in. x 4in. Rola, 18/-; 6½in. Rola, 18/6; 10 x 6in. 27/6; 10in. Rola 30/-; 4in. Tweeter, 25/-; 12in. R.A. 30/-. 13½ x 8in., Double Cone E.M.I. 45/-.

STENTORIAN HF1012. 10in. 3 to 15 ohms, 10 w. 95/-; 35 ohm, 7 x 4in., 25/-; 5in., 22/6; 3½in., 19/6.

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. Baker Ultra Twelve, 20 c.p.s. to 25 kc/s. £17.10.0
15in. Auditorium, 35 w., Bass, 20 c.p.s. to 12kc/s. £18
Details and Enclosure plans S.A.E.



TWIN GANG TUNING CONDENSERS. 365 pF, miniature 1in. × 1½in. × 1¾in., 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% 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 available: 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** sp., 3/6; d.p., 4/6.

CRYSTAL MIKE INSERT, 6/6
Size 1 x 1⅛in., or 1½in. dia.
ACOS MIC. 60, insert 1⅛in. 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.

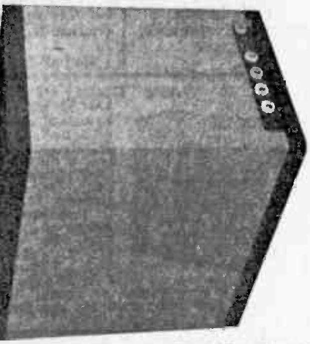
HI-FI AMPLIFIER Ready built. A.C. only. 200-250 v. Valves ECL86 and EZ80. 3 watt quality output. Mullard tone circuits, bass boost, treble and volume controls. Separate engraved front panel with de-luxe finish. Heavy duty output transformer 3 ohm. Quality mains transformer. Stove enamelled chassis size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

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 18,000 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. 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 10-watt GUITAR AMPLIFIER
High-fidelity push-pull output. Separate base 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/-
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.**
S.A.E. for leaflet.
22 Gns. Or Deposit 51/6 and nine monthly payments of 51/6. Carr. 12/6.

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.	.. 25/9	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 1⅞in., 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.

NEW BRANCH OPENING
32 HIGH STREET, LEICESTER
LATE FEBRUARY

EX. GOVT. SELENIUM RECTIFIERS 12v 15 AMP (BRIDGE) F.W. ONLY 19/9

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

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 6¼ x 5¼in.

MULTI-METERS. CABY M1. Sensitivity 2,000 ohms per volt. A.C. and D.C. 54/-. **A.10.** Basic Meter sensitivity 155 micro-amps A.C. and D.C. ranges £4.17.6. **B.20.** Sensitivity up to 10,000 ohms per volt A.C. and D.C. £6.10.0.

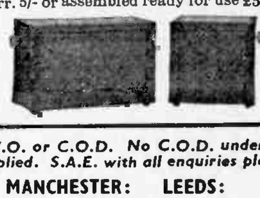
Ex. GOVERNMENT ACCUMULATORS. Size 7¾ x 4 x 2in., 2v. 16 A.H., brand new, 6/9 each. 3 for 15/6.

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 5¼ 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 INTERCOMM. 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.

BIRMINGHAM:	SHEFFIELD:	HULL:	LIVERPOOL:	BRADFORD:	MANCHESTER:	LEEDS:
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	8-10 Brown 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.

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.

BIRMINGHAM: 6 Gt. Western Arcade (Opp Snow Hill Stn) | **SHEFFIELD:** 13 Exchange St. Castle Market Bldgs. | **HULL:** 51 Savile St. Half-day Thurs. | **LIVERPOOL:** 73 Dale St. (8 mins. from Lime St. or Exchange Stations) | **BRADFORD:** 56 Morley St. (above Alhambra Theatre) | **LEEDS:** 5-7 County (Mecca) Arcade, Briggate Half-day Wednesday | **MANCHESTER:** 8-10 Brown St. (Market St.) No half-day

SENSATIONAL STEREO OFFER

A complete set of parts to construct a good quality **(4 Gns.)** Stereo amplifier with an undistorted output total 6 watts. For A.C. mains input of 200-250 v. Including pair matched 6½in. speakers. Sensitivity 130 m.v. Ganged Vol. and Tone Controls. Preset balance control. Full instructions and wiring diagrams supplied. Stereo Pick-up Head **19/9** extra with above only.

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

A highly sensitive Push-Pull high output unit with self-contained Pre-amp. Tone Control Stages. Certified performance figures compare equally with most expensive amplifiers available. Hum level 70 db down. Frequency response ±3 db. 30-30,000 c/s. A specially designed sectionally wound ultra linear output transformer is used with 807 output valves. All components are chosen for reliability. Six valves are used EF86, EF86, ECC83, 807, 807, GZ34. Separate Bass and Treble Controls are provided. Minimum input required for full output is only 12 millivolts so that **ANY KIND OF MICROPHONE OR PICK-UP IS SUITABLE.** The unit is designed for **CLUBS, SCHOOLS, THEATRES, DANCE HALLS or OUTDOOR FUNCTIONS**, etc. For use with Electronic **ORGAN, GUITAR, STRING BASS,** etc. For standard or long-playing records. **OUTPUT SOCKET PROVIDES L.T. and H.T. for a RADIO FEEDER UNIT.** An extra input with associated vol. control is provided so that two separate inputs such as Gram. and "Mike" can be mixed. Amplifier operates on 200-250 v. 50 c/s. A.C. Mains and has output for 3 and 15 ohm speakers. Complete Kit of parts with fully punched chassis and point-to-point wiring diagrams and instructions. If required, perforated cover with carrying handles can be supplied for **19/9.** The amplifier can be supplied, factory built with EL34 output valves and 12 months guarantee, for **14 gns.**

11 Gns. Carr. 10/-

TERMS: DEPOSIT 33/9 and 9 monthly payments of **33/9.**

Suitable microphones and speakers available at competitive prices.

WE STOCK ARMSTRONG, DULCI AND JASON EQUIPMENT GOODMANS AND W.B. SPEAKERS

GARRARD AND GOLDRING T/TABLES

SUPERHET FEEDER UNIT. Design of a high quality Radio Tuner (specially suitable for use with our Amplifiers). Delayed A.V./C. Controls are Tuning, W/Ch. and Vol. Only 250 v. 15 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size approx. 9 x 6 x 7in. high. Simple alignment procedure. Point-to-Point wiring diagrams, instructions and priced parts list with illustrations, **2/6.** Total building cost **£4.15.0.** S.A.E. for leaflet.

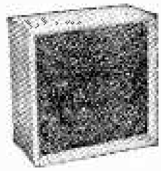
P.M. SPEAKERS. 10in. W.B. "Stentorian" 3 or 15 ohms type HF 1012 10 watts, hi-fidelity type. Recommended for use with our A11 Amplifier. **£4.12.9.** 12in. R.A. 3 ohms 10 watts (12,000 lines). **59/6.**

TWEETERS. Plessey 3Ω **19/9,** 15Ω **25/9.**

Jason FMT1 V.H.F./F.M. Radio Tuner design. Total costs of parts including valves Tuning dial, Escutcheon, etc., **£6.19.9.** Other Jason equipment in stock.

LINEAR L45 MINIATURE 4/5 WATT QUALITY AMPLIFIER. Suitable for any record playing unit, and most microphones. Negative feed-back 12 db. Separate Bass and Treble Controls. For mains 200-250 v. 50 c/s. Output for 2-3 ohm speaker. Mullard valves EZ80, ECC83, EL84. Size only 7-5-5½in. high. Guaranteed 12 months. Only **£5.19.6.** Send S.A.E. for leaflet. Terms: Deposit **22/6** and 5 monthly payments of **22/6.**

12in. 10 WATT HIGH QUALITY LOUDSPEAKER

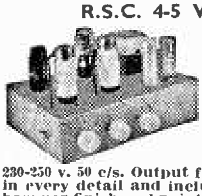


In walnut veneered cabinet. Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only **£4.19.6** Carr. 5/-. Terms: Deposit **11/3** and 9 monthly payments of **11/3.**

12in. 20 WATT HI-FI LOUDSPEAKERS IN CABINETS. Size 18 x 18 x 10in. Finish as above. Terms: Deposit **17/9** and 9 monthly payments of **17/9.** Only **£7.19.6.** Carr. 8/6.

BASS GUITAR LOUDSPEAKER IN CABINET. 15in. 50 watt. highly sensitive unit in rexine covered acoustically lined cabinet. Deposit **£3.7.6** and 9 monthly payments of **£3.7.6.** **29 Gns.** Carr. 15/-

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



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

R.S.C. PORTABLE GUITAR AMPLIFIERS NOW ON PAGE 883.

AUDIOTRINE HIGH FIDELITY REPRODUCERS

THE DUO/10. Consisting of a 12in. 12,000 line Speaker with heavy four layer voice coil, the Audiotrine cross-over unit, and a 4in. Diameter Tweeter Unit incorporated in the extremely attractive Audiotrine Senior Corner Console Cabinet as described below. Matching impedance 15 ohms. Power handling 10 watts nominal, 14 watts peak. Frequency range 40-18,000 c.p.s. Deposit **27/9** and nine monthly payments of **27/9.** ONLY **12 Gns.**

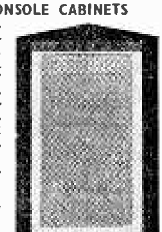
THE DUO/20. Incorporating a 12in. High Flux 20 watt Speaker with 2in. Diameter Speech Coil. (Total Flux 160,000 lines), the Audiotrine cross-over unit, and a highly sensitive Tweeter unit, in the Audiotrine Senior Corner Console Cabinet. Matching impedance 15 ohms. Peak Power Output 25 watts. Frequency range 30-18,000 c.p.s. Deposit **33/9** and nine monthly payments **33/9.** ONLY **14 Gns.**

R.S.C. JUNIOR HI-FI REPRODUCER. The very latest Goodmans Axiette 8 High Fidelity loudspeaker (retailing at approx. 5 Gns.) fitted in a specially designed Bass Reflex cabinet size 12in. x 18in. x 10 in. Acoustically lined and ported and finished in polished walnut veneer. Matching impedance 15 ohms. Frequency range 40-15,000 c.p.s. Power handling 6 watts nominal. Ideal for Stereo. Limited number. ONLY **8 Gns.** Carr. 4/6

R.S.C. BASS REFLEX CABINETS, JUNIOR MODEL. Specially designed for W.B. HF1012 Speaker, but suitable for any good quality 10in. speaker. Acoustically lined and ported. Polished walnut veneer finish. Size 18 x 12 x 10in. Handsome appearance. Ensure superb reproduction for only **£3.19.6.**

STANDARD MODEL. As above but for 12in. speakers. Size 20 x 15 x 13in. Especially recommended for Audiotrine Loudspeaker systems. For vertical or horizontal use. **£5.19.6.** Suitable legs with brass ferrules. **19/6** per set of 4.

R.S.C. CORNER CONSOLE CABINETS



Polished walnut veneer finish. Pleasing design. **JUNIOR MODEL.** Size 20 x 11 x 8in. for 8 x 5in. or 10 x 6in. speakers. **£2.9.9.** **STANDARD MODEL.** Size 27 x 18 x 12in. for 8 or 10in. speakers. **£4.11.9.** **SENIOR MODEL.** Size 30 x 20 x 15in. for 12in. Speaker. Suitable Speaker systems below Only **7 gns.**

AUDIOTRINE HI-FI SPEAKER SYSTEMS. Consisting of matched 12in. 12,000 line, 15 ohm high quality speaker; cross-over unit (consisting of choke, condenser, etc.) and Tweeter. The smooth response and extended frequency range ensure surprisingly realistic reproduction. Standard 10 watt rating **£4.19.9.** Carr. 5/-. Or Senior 15 watt **7 gns.** Carr. 7/6.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all-dry battery eliminator. Size 5½ x 4½ x 2in. approx. Completely replaces battery supplying 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s is available. **Suitable for all battery portable receivers requiring 1.4 and 90 v.** This includes low consumption types. Complete kit with diagrams, **39/9,** or ready to use, **46/6.**

Type BM2. Size 8 x 5½ x 2½in. Supplies 120 v. 90 v. and 60 v., 40 mA. and 2 v. 0.4 a. to 1 amp. fully smoothed. **Thereby completely replacing both H.T. batteries and L.T. 2 v. accumulators when connected to A.C. mains supply** 200-250 v. 50 c/s. **SUITABLE FOR ALL BATTERY RECEIVERS** normally using 2 v. accumulators. Complete kit of parts with diagrams and instructions, **49/9,** or ready for use, **59/6.**

AUDIOTRINE EQUIPMENT CABINETS

Size 36 x 15 x 18in. Beautiful walnut veneered finish. Elegant contemporary design. Robust construction. Uncut removable baseboard Depth above baseboard 5½". Only **12½ gns.** Carr. 15/-

"ROAMER 7" (5 Wavebands)

PERFORMANCE WILL AMAZE YOU!

★ (7 Transistor plus 2 Diode designs)

★ Med/Long Waves, Trawler Band and 2 S.W. to approx. 17 metres.

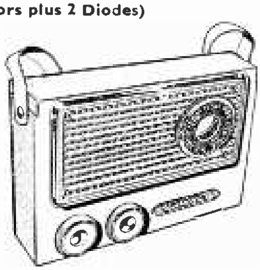
★ Rich-toned 5in. Speaker.
★ Sockets for car radio use.
★ Telescopic aerial for S. Waves.
★ FERRITE ROD AERIAL FOR M/L.
★ Full After Sales Service.
★ Air spaced gauged Tuning Condenser.
★ Uses latest Mullard Transistors.

Total cost of parts **£7.9.6** P.P. 5/6.

★ Push-Pull output for room-filling volume.
★ Two tone Cabinet with gilt trim.
★ Case size 12 x 8½ x 3½in.
★ Parts price list and data 3/-.

THE SUPER SEVEN

★ ★ (7 Transistors plus 2 Diodes)



★ 2 R.F. STAGES.
★ Mullard and Surface Barrier Transistors.
★ Coverage of Medium, Long Waves, Trawler Band.
★ Use as domestic radio, car radio or fit with strap for carry-about.
★ No aerial required.
★ 3-inch speaker but will drive a larger speaker.
★ 400 milliwatts output stage.

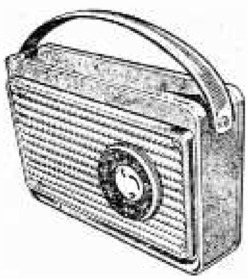
May be built for **£5.19.6** plus 3/6 post, etc. SIZE: 7½ x 5½ x 1½in.

PARTS PRICE LIST AND EASY BUILD PLANS 2/-

NEW TRANSONA-6

★ (6 Transistors, plus 2 Diodes)

★ M/L & T. BAND



400 Mw Mullard push-pull output Transistors, Powerful magnet 3in. high grade speaker. Push-pull transformers. This is a top performing receiver. Many stations listed in one evening including Luxembourg loud and clear. A pleasure to listen to. **FERRITE ROD AERIAL.** All parts sold separately, including pale blue gleaming polystyrene case with duo-diffusion grilles in red. Uses 9 volt battery. Sockets for car aerial.

Total building cost **£4.19.6** P.P. 3/-. Size 6½ x 4½ x 1¼in.

"Agreeably surprised with Trawler Band reception. Luxembourg as loud as local. Your easy build diagram helped a lot . . . my first attempt."—H. S., Penzance, Cornwall (poor reception area).

PARTS PRICE LIST AND EASY BUILD PLANS 1/6

All components used in our receivers may be purchased separately if desired.

AFTER SALES SERVICE

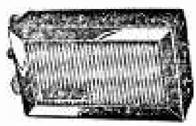
Radio Exchange Co.

27 HARPUR STREET, BEDFORD

Phone: 2367
Closed 1 p.m. Sat. Opp. Co-op.

BEGINNERS POCKET 5

(MW/LW and TRAWLER BAND) (7 Stages)
(5 Transistors, plus 2 Diodes)

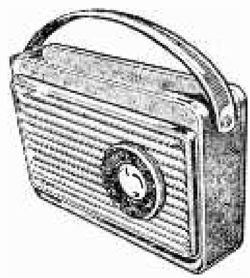


Designed round supersensitive **FERRITE ROD AERIAL** and 3in. moving coil speaker. Attractive case in black with speaker grille in red. On test Home, Light, Radio Luxembourg and many Continental stations were received. Miniature earpiece free. Alternate larger case 6½ x 4½ x 1½in. for easier assembly.

Total cost of all parts **£2.19.6** P.P. 3/-

EASY BUILD PLANS AND PARTS PRICE LIST 1/6

"THE MELODY 6"



★ Ferrite rod aerial.
★ 6 new type transistors and top quality components. Attractive case in blue and red and carrying strap with gold trim.
★ 3in. Speaker.
★ M.W./L.W.
★ No aerial required

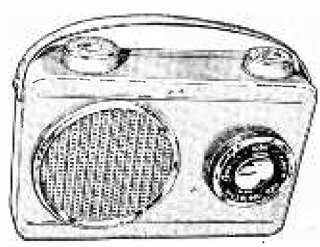
£3.19.6

P.P. 3/-
Price list and plans, 2/-.

"ROAMER-6"

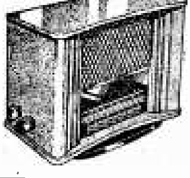
PUSH-PULL OUTPUT

5 Wavebands (M/L, T.B. and 2 S.W.)



Uses 6 top grade transistors plus 2 diodes. 3in. Speaker. Ferrite rod aerial for sensitivity. Telescopic aerial for short waves. Handsome case with gilt fittings size 6½ x 4½ x 1½in. approx. Listen to stations half a world away.

Total cost of parts **£6.9.6** Post & Packing 3/-
Plans, Parts price list 3/-.



Complete FM (V.H.F.) AM RADIO FOR £11.11.0

(carr. paid)

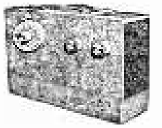
Brand new set, in superb walnut cabinet (size 19 x 8½ x 14½in. high). Covering 80-100 Mc/s. 16-49 M. and 200-500 M. Mains trans. 200-250 v. with 2 tappings. Ferrite rod aerial for A.M. Controls: volume on/off, tone tuning, w/change. Gram and ext. speaker position provided Valves 12AT7, 12AH8, 6BJ6, EABC80, 6BW6 and metal rectifier. Fully guaranteed. Today's Value, £20.

TAPE—TOP QUALITY BOXED—GUARANTEED, 4in.—600ft., 12/6; 5in.—1200ft., 30/-; 5¾in.—900ft., 15/-; 1200ft., 17/6; 1800ft., 35/-; 7in.—1200ft., 17/6; 1800ft., 26/6; 2400ft., 45/- (all plus 1/- post, 6 or more post free).

THE "MILAN" 6-TRANSISTOR AND DIODE PORTABLE

COMPLETE KIT FOR ONLY

£6.12.6 (post 3/6)



500mW push-pull output. Ferrite rod aerial. Car aerial socket and coil. M.W. and L.W. full coverage. Operates on two 4.5v. cells. Printed circuit board 8½ x 2¾in. All holes drilled and component positions marked. Instructions 2/6 for 16 p. (refunded on purchase of kit). Size 9 x 3¾ x 7in. 8 x 2¾in. P.M. high quality speaker. Attractive Vynair covered cabinet, two tone. Two batteries 5/6 the pair (Ever Ready 126). Mullard transistors OC44, 2 x OC45, OC81D, and 2 x OC81. Top grade Weymouth Radio coils and transformers. Alignment service if required 17/6 (inc. post). Write for list of prices. All parts supplied separately. Built in two hours.

BUILD YOUR OWN RECORD PLAYER Price £11 carr. paid

Fully built 2-valve amplifier

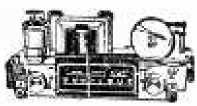
B.S.R. 4-sp. autochanger, case 17 x 15 x 8½in. Assembled in 15 mins. Similar cabinet for tape recorder with plain board only £3, carr. paid. Attractive colours.

3-valve amplifier 15/- extra

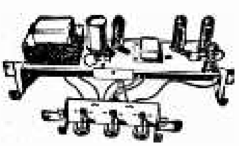
AUTOMATIC RECORD CHANGERS—LATEST MODELS. 4 SPEED CRYSTAL CARTRIDGE. All 5/- extra carr. B.S.R. UA14, £6.10.0. Garrard Slimline, Mono £7. Stereo, £‥5.0. Motor Board for UA8, UA20, UA14, Slimline, 5/- (post 1/6) or 3/6 post paid when purchased with Autochanger.

TELEFUNKEN STEREO AMPLIFIERS. 2 ECL82—2 x 2½ watts, 12 x 9 x 2in. piano keys, £7, post paid. Complete with power.

SELF-POWERED VHF TUNER CHASSIS Covering 88-95 Mc/s. Mullard permeability Tuner. Dims. 10½ x 4½ x 5in. high ECC85 and 3—EF91 and 2 diodes. Metal Rectifier, Mains transformer. Fully wired and tested. Only £7.7.0 (carr. paid). Some tarnished chassis otherwise O.K. £6.6.0.



Vynair Cabinet included. Room dipole 12/6. Feeder, 6d. yd.

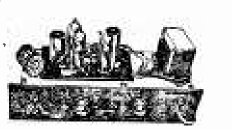


PUSH-PULL AMPLIFIER £5.5.0

(5/- Carr.)

Brand new 200-240 A.C. mains. Bass, treble and vol. controls. With valves EZ80, ECC83 and 2-EL84 giving full 8 w. Chassis. 12 x 3½ x 3½in. With o.p. trans. for 2-3 ohm speaker. Front panel (normally screwed to chassis) may be removed and used as "flying panel." Stereo version 2 x 4 w, same price.

TAPE RECORDER AMPLIFIER



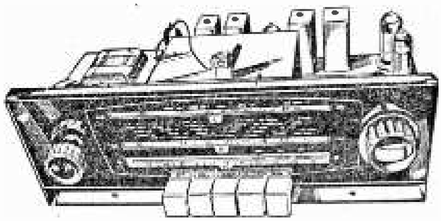
Type TR1. Fully built, high gain, low noise, printed circuit. Attractive grey and gold front panel 13 x 3in. Height 5½in. overall. Front to back 5½in. Vol. and on/off tone. Mike, radio and ext. speaker jacks. Valves ECC83 ECL82, EZ80. Mains trans. Ready to bolt to B.S.R. Deck. Complete with switch wafer wired. Our Price ONLY £5.15.0 (6/- Packing and Carr.). Also available for Collaro Deck at 5/- extra.

Transistor Set Battery Eliminator. Converts your 6 transistor receiver to mains operation. With flex lead and battery charging attachment. For Miniature Sets, size 1¾ x 1 x ⅝in. Price 18/6. For Larger Sets, 3 x 1½ x ⅝in. Price 24/6.

TRANSISTOR COMPONENTS

M.W. and L.W. ferrite rod aerial, with car coupling coil. For 208pF condenser, 8/-; Osc. coil; 1st. 2nd and 3rd I.F.'s. all 5/6 ea.; Driver trans.. 7/6; min. 64mF 10v; 10mF 16v; 30mF 6v; all 1/9 ea; Tuning cond. 208mF + 176pF 8/6; post 9d. on all orders.

BRAND NEW AM/FM (V.H.F.) RADIOGRAM CHASSIS AT £12.12.0 (Carriage Paid)



A.C. ONLY. Chassis size 15 x 6¾ x 5½in. high. New manufacture. Dial 14½ x 4in. in 2 colours, predominantly gold.
Pick-up, Ext. Speaker, Ae., E., and Dipole Sockets. Five push buttons—OFF, L.W., M.W., F.M. and Gram. Aligned and tested. O.P. Transformer. Tone Control. 1000-1900 M.; 200-500 M.; 88-98 Mc/s. Valves EZ80 rect.; ECH81, EF89, EABC80, EL84, ECC85.
Speaker and Cabinet to fit chassis (table model). 47/6 (post 4/-).
9 x 6in. ELLIPTICAL SPEAKER, 20/-, to purchasers of this chassis.
TERMS: (Chassis) £3.10.0 down and 5 monthly payments of £2.
Cheap Room Dipole for V.H.F., 12/6. Feeder 6d. yd. Circuit diagram 2/6.

"SCALA" 6-TRANSISTOR and DIODE KIT FANTASTIC VALUE

£6.5.0 (Post 3/-)

All Brand New Parts—attractive cabinet—choice of 6 colours: 8½ x 2 x 5½in. high. Ferrite aerial, printed circuit, good styling, 3¾in. speaker, fully tunable L.W. and M.W., 400 M.W. push-pull output. All parts supplied separately. Write for Price List. Construction Book and Circuit, 2/6 (refunded when kit purchased). Or fully built at £7.10.6 (battery 2/6).

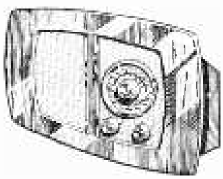


TABLE MODEL TRANSISTOR SET £7.14.0 (carr. paid)

6 transistors and diode, 5in. speaker, superhet circuit. Cabinet 13 x 7¾ x 4½in., battery included. Fully tunable L.W. and M.W. Polished walnut front. Cabinet 13 x 7½ x 4in.

SUPERIOR GRAMOPHONE AMPLIFIER

Valves UY85, UF80 and UL84. Mains trans. 200-240 a.c. Covered baffle 13½ x 7½in. (6½in. speaker) or 11 x 7¾in. (8 x 5in. speaker). 3 front controls bass, treble, on-off/vol. 74/- (post 4/-) either type. Rexine cabinet to fit, with carrying handle, and lid (detachable) 14in. or 12 x 8½ x 5in., 16/- extra.

GRAMOPHONE AMPLIFIER. With 5in. SPEAKER Baffle 12½ x 6in. ECL82 and Rectifier, Tone and Volume. On/off switch. Useful for Stereo, 57/- (post 4/-).

5 WATT AMPLIFIER

Our price ONLY 56/- (post 4/-); NEW MANUFACTURE; valves EF91 and EL84 with metal rectifier; 6 x 4 x 1¾in. high (5in. over EL84). Mains trans. and o.p. with vol. and tone controls; on-off; co-ax input.

COLLARO STUDIO TAPE TRANSCRIPTOR, 3 MOTORS, 3 SPEED. 1⅞, 3¾ and 7½ I.P.S. Push buttons, £10.7.6 (10/- carr.) inc. spool.

BATTERY ELIMINATOR

For 4 Low Consumption Valves (96 range) 90v. 15 mA and 1.4v. 125mA, 45/- (2/6 post). 200-250v. A.C. Also for 250mA, 1.4v. and 90v. 15mA at same price. Two separate units to replace existing batteries.

BATTERY RADIO

Valves DK96, DF96, DAF96, DL96. Two Short Wavebands 16 to 49 M and 25 to 75 M. Size 10½ x 4½ x 5in. £4…6, carr. paid. M.W. and S.W., £4.11.6 carr. paid.

ALL ITEMS ARE NEW AND FULLY BUILT UNLESS OTHERWISE STATED. TESTED BEFORE DESPATCH.
Terms Available on Items over £5. Send 6d. (stamps will do) for 20-page illustrated catalogue. Delivered by return. C.O.D. 2/- extra.

ALL ITEMS GUARANTEED 12 MONTHS VALVES 3 MONTHS

GLADSTONE RADIO

"SCALA", CAMP RD., FARNBOROUGH, Hants.

(Farnborough 3371) and at 247 New Road, Copnor, Portsmouth.

FARNBOROUGH CLOSED SATS.—PORTSMOUTH WEDS.

Practical Wireless

Vol. XXXVIII No. 673 MARCH, 1963

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Changing Pattern

FROM time to time we hear the opinion expressed that radio construction is a dying art, that the modern enthusiast is more an assembler than an experimenter, that the profusion of easily obtainable components and sub-assemblies makes things too easy, that—in short—Fing's ain't what they used to be!

Well, of course, they are not. They never were! But we see the reasoning behind this sort of argument. In the early days, a great deal of ingenuity was necessary in order to build *anything* at all. The professionals knew very little more than some amateurs —often less! Parts were scarce, and so was money. In fact many constructors had to make some of their own components, either through financial or practical necessity.

As interest grew and the numbers of amateur enthusiasts increased, so did the quantity and range of components available. During the 30's, amateur radio was a rapidly developing market and manufacturers did their best to meet the demands. However, most enthusiasts of that time were still mainly experimenters since they usually designed their own equipment or modified published designs to suit their own personal requirements.

But in the immediate post-war years, vast quantities of war surplus equipment flooded the market. While much of this could be stripped down to obtain a wealth of components at almost "give away" prices, some of it was, with slight modification, ready for use as workable items.

This claim the cynics, was the death knoll of true amateur radio construction. For perhaps the first time, amateur transmitting stations, for example, went on the air using not only ready-built receivers and transmitters but also using professionally built accessories such as frequency meters.

In terms of convenience and economy, converted surplus equipment was a wonderful opportunity. But on the other hand it provided the temptation to take the easy way out. The trend has continued and many amateur transmitters could more aptly be called operators than experimenters.

Although there have always been kits, the radio constructor of today has "never had it so good", with a profusion of all kinds of kits for specific designs and a wealth of components. This, it is suggested, leads to a more dependent attitude than that of past years, when the constructor had to be much more self-reliant.

On the other hand, there are nowadays many times more actively interested than even ten years ago. This may mask the enthusiasts who still design their own equipment and experiment with unusual circuits and applications.

From the hard practical viewpoint there is less incentive these days to do things the hard way, for the amateur can no longer vie with the professional—highly trained and with modern laboratory facilities. The days of major break-throughs by amateurs are, perhaps, gone for ever.

Nevertheless, while there will always be a great number of constructors who prefer to build from existing designs, there will always be those who like to work everything out themselves.

Our next issue dated April will be published on March 7th.

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 November, 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.

	Total
London	624,774
Home Counties	577,542
Midland	419,491
North Eastern	440,472
North Western	379,779
South Western	341,809
Wales and Border Counties ..	191,473
Total England and Wales	2,975,340
Scotland	312,542
Northern Ireland	107,208
Grand Total	3,395,090

World's Fastest Cable-laying Ship

THE C.S. "Mercury", the world's fastest cable-laying ship with a speed on passage of 17½ knots, sailed from London shortly before the New Year on her first commission—the laying of a 1,000-nautical-mile section of the 8,000-mile Commonwealth trans-Pacific (COMPAC) telephone cable.

She was built for Cable and Wireless Ltd., owners of the British share in Commonwealth telephone cable, and was completed in September last year. Later in the year she completed loading 1,200 nautical miles of cable and 49 repeaters in a day-and-night operation lasting three weeks.

The ship cost £2,000,000 to build and the total value of the equipment she now carries is in excess of £2,500,000. Each of the submerged repeaters (or valve amplifiers) costs £20,000.

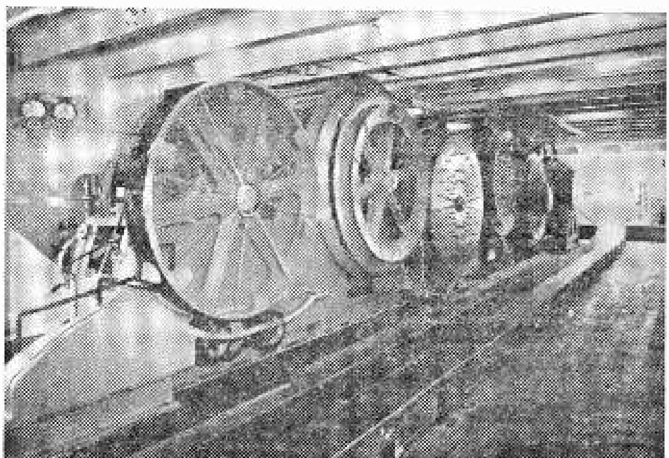
British Equipment in use at Goonhilly and New Jersey

IMPORTANT communication equipment built by Standard Telephones and Cables Limited came into service recently on both sides of the Atlantic with the launching of the N.A.S.A. Project Relay satellite from Cape Canaveral.

At Goonhilly Downs in Cornwall, a powerful STC transmitter links the British Post Office radio station with the satellite. At Nutley, New Jersey, the ITT-Federal Laboratories use STC multiplexing equipment which combines the 12 telephone circuits used in the RELAY experiments into one complex broadband signal.

The National Aeronautics and Space Administration (N.A.S.A.) has appointed STC's associate company, ITT-Federal Laboratories, as the prime contractor for the complete series of telecommunication tests to be carried out using RELAY. Besides its main radio station at Nutley, some nine miles west of New York, ITT-Federal have designed and built a complete "packaged" ground station, the first of which has been set up near Rio de Janeiro in Brazil.

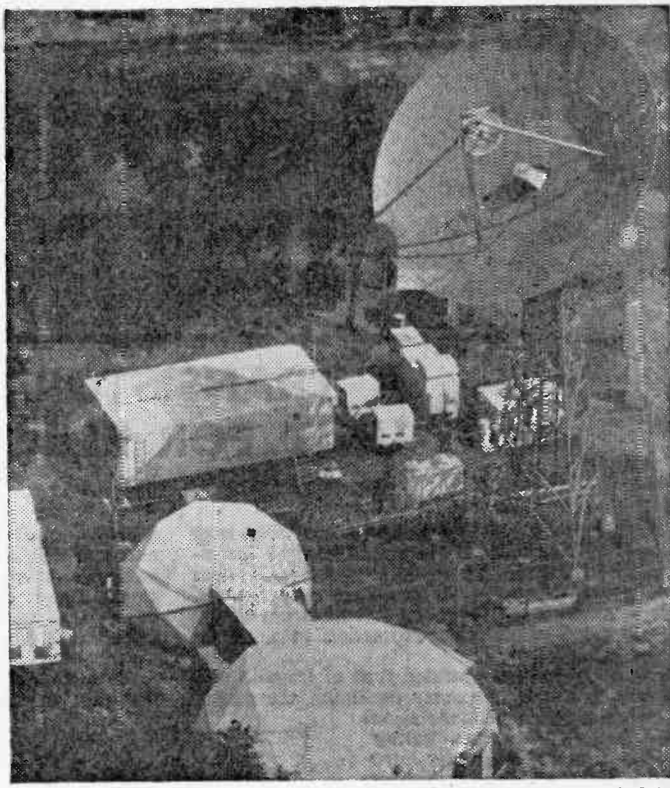
The GPO's Goonhilly station will play an important role in this series of experiments using satellite radio propagation paths between Nutley and Goonhilly, and also between Rio and Goonhilly.



The after cable-laying machinery on C.S. "Mercury" looking aft. The foreground shows the splaying stool and diverter bar for the by-passing of repeaters.

The STC transmitter at Goonhilly operates in the 2,000Mc/s frequency band with an output power of 10kW.

At Nutley, the STC multiplexing equipment, built at North Woolwich, London, combines twelve high quality telephone circuits, each containing frequencies in the band 300c/s to 3,400c/s, into a composite broadband signal of 60kc/s to 108kc/s for modulating the transmitter.



The ITT-Federal Laboratories' ground station at Nutley, New Jersey, U.S.A., showing the 40ft. diameter steerable parabolic reflector aerial system.

Revolutionary Telephone Exchange

ONE of the Post Office's latest telephone exchanges is claimed to be the most revolutionary in Europe. The exchange, which is installed at Highgate Wood, London, is constructed on a fully electronic system which will enable it to operate a million times faster than the ordinary electro-mechanical exchange. It will also be more efficient and cheaper to run, and once it has proved itself, the electronic system will be introduced throughout the country and thousands of exchanges will be affected.

R/T Equipment for Civil Defence

THE Home Office have awarded a contract to Pye Telecommunications Limited of Cambridge for 300 450Mc/s point-to-point radiotelephone equipments for use in Police, Fire and Civil Defence.

Radio links based on this equipment, which is of new design, will handle speech or speech-plus-telemetry and are expected to find wide application in home and overseas markets. The emphasis in design has been placed on extreme reliability and ease of maintenance, and extensive use of solid state devices has been made.

Anglo-American Communications Alliance

A TEN-YEAR agreement has recently been concluded between Pye Telecommunications Limited and the Aircraft Radio Corporation of Boonton, New Jersey, under which the Aircraft Radio Corporation will market Pye Communications' products throughout the United States. A wide range of communication products is to be marketed and great emphasis is being placed on Pye's new range of fully transistorised mobile radio telephone equipment. The Aircraft Radio Corporation is a subsidiary of the Cessna Aircraft Company.

Under the agreement, Pye has reciprocal rights to manufacture and sell ARC airborne products and the two companies will co-operate closely in design, manufacture and marketing of a wide range of communication products.

Radar for Burmese Aircraft

AN order for type E190 lightweight transistorised weather radar systems has been received by Ekco Electronics Ltd., and these are for installation in three Fokker Friendship aircraft being built for Union of Burma Airways. The equipment ordered includes the optional extra drift unit to provide measurement of drift angle using Doppler techniques.

These radar installations will assist safe, comfortable flying by providing accurate indication of turbulent cloud formations up to 150 miles in the path of the aircraft, enabling the pilot to take any necessary avoiding action.

New Assembly Methods

A NOVEL method of assembling a compact electronic unit has been devised at the National Engineering Laboratory, East Kilbride. Wander plugs are fitted to the sides of suitable lengths of plain Veroboard on which the components are mounted and wired. Each board has the same number of plugs, which are mounted in exactly the same positions on each. This allows one board to be mounted directly on to another by engaging one set of plugs into the corresponding ones on the other board.

This method of assembling provides easy access to each component and avoids the use of large numbers of plug and socket joints.

A TRANSISTORISED TREMOLO UNIT

BY P. L. TAYLOR

A TRANSISTORISED TREMOLO UNIT FOR ELECTRIC GUITARS

THE function of the tremolo unit when used in conjunction with an electronic musical instrument is to modulate the signal from the instrument with a low frequency of approximately 5-15c/s. This produces a plaintive effect reminiscent of the human voice which adds expression to the tone of the music.

The normal valve operated type of tremolo unit consists of a low frequency oscillator, the output of which is mixed with the signal from the instrument in a "gating" circuit. The unit is usually introduced between the instrument and power amplifier and operates at a low level of signal.

This type of unit has the disadvantages of relatively large size and of needing an isolated and very well smoothed power supply. The unit to be described measures $5\frac{3}{4}$in. x $2\frac{3}{4}$in. x 2in. (conveniently pocket sized) is driven from a 9V PP4 battery and uses three transistors.

The Circuit

Tr1 and Tr2 are coupled in a multivibrator circuit using 2μF capacitors, C1 and C2 to supply the low frequency signal. VR1 is the frequency control and VR2 controls the amplitude of signal fed to Tr3 and hence the depth of modulation.

The output of the multivibrator is a square wave having harmonics which extend into audio frequencies, and if the output were mixed directly with the signal, the harmonics of the square wave would come through the amplifier as an unpleasant train of clicks.

To remove these high frequencies the low pass filter R7, C3, R8, C4 is introduced to integrate the square wave and provide a smoothly varying voltage across C4.

This voltage provides the power supply for Tr3, a single transistor amplifier operated at very low collector current. Since the gain of the amplifier varies with the h.t. voltage, the low frequency ripple appearing on the h.t. supply to Tr3 will cause the amplitude of the output signal to fluctuate in the desired manner.

Since the collector current in Tr3 is low the noise introduced by the circuit is negligible, and the gain of the circuit is approximately unity,

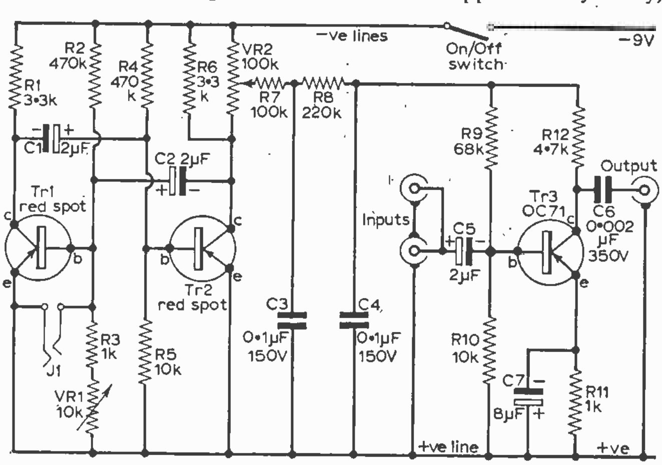


Fig. 1: The circuit of the unit.

allowing the unit to be inserted between instrument and amplifier without alteration of gain controls.

Construction

The unit is constructed in a small plastic case using normal sized potentiometers. The construction is uncritical and the circuit would lend itself to miniaturisation techniques.

The components are assembled on a small strip of tag-board as in the wiring diagram. The usual precautions should be observed when wiring tran-

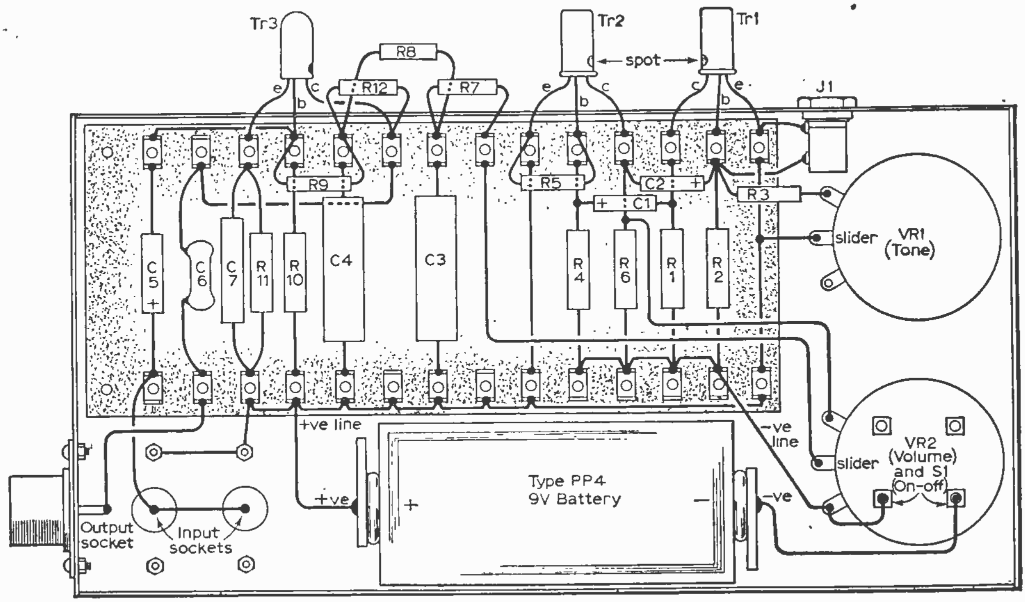


Fig. 2: The wiring diagram.

sistors and small electrolytics to avoid overheating the components.

Two coaxal sockets are provided for inputs. The sockets are not isolated from each other since electric guitar volume controls are usually connected " wrong way round " enabling direct mixing of the two circuits without interaction.

The inside of the plastic case should be covered with aluminium foil which is earthed to prevent pick-up. A layer of polythene sheet is used to insulate the underside of the tag-board from the screening.

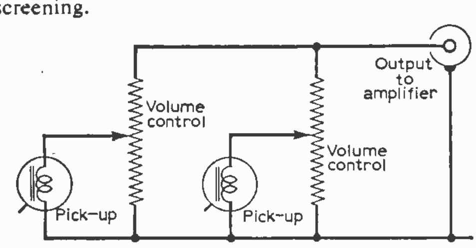
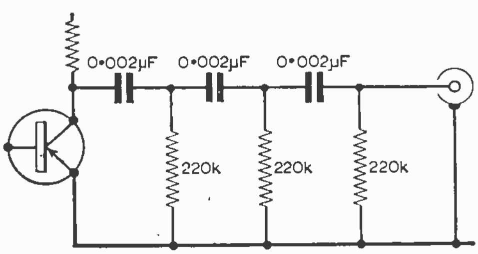


Fig. 3 (above): Electric guitar volume controls connected to permit direct mixing of signals from two pick-ups.

Fig. 4 (below): A high pass filter for use after the tremolo unit.



COMPONENTS LIST

Resistors:

R1	3·3kΩ	R7	100kΩ
R2	470kΩ	R8	220kΩ
R3	1kΩ	R9	68kΩ
R4	470kΩ	R10	10kΩ
R5	10kΩ	R11	1kΩ
R6	3·3kΩ		

(All resistors ¼W., 10%)

Capacitors:

C1	2µF, 12V	C5	2µF, 12V
C2	2µF, 12V	C6	0·002µF, 350V
C3	0·1µF, 150V	C7	8µF, 12V
C4	0·1µF, 150V		

Transistors:

Tr1 Red spot surplus type
Tr2 Red spot surplus type
Tr3 OC71

Potentiometers:

VR1 10kΩ VR2 100kΩ

Components C5, C6 and C7 are deliberately made small in order to introduce a measure of bass cut, but if the unit is to be used with an amplifier with strong bass response some trouble may be experienced with the low frequency signal coming through the amplifier as a " thumping " sound. This may be improved by the use of a high pass filter after the unit (Fig. 4).

If necessary the unit may be used with a foot switch plugged into the miniature jack, which is connected between the base of Tr1 and earth. This prevents the multivibrator from oscillating until the switch is opened. Thus the vibrato effect can be added at any time without using the hands.

The unit has given good service when used in conjunction with the author's electric guitar, and results obtained will justify the effort involved in its building. ■

short-wave CONVERTOR

By F. NEVILLE HART

THIS small transistor convertor can be connected "in front" of any medium-wave superhet to provide coverage of the short-wave bands. The coils used are for an immediate frequency of 1·6Mc/s and when the main receiver is tuned to this frequency, at the low end of the m.w. band, the combination forms a "double superhet". In other words, the mixer of the superhet receives the output from the convertor and heterodynes it to the normal i.f. of 465kc/s, or whatever it happens to be. It will be seen that due to the double conversion, selectivity is greatly improved.

Although the Denco coils specified are designed for a valve mixer circuit, slight modification in the form of an extra winding on each coil will permit these to be used in this transistor circuit. With care in adjusting, coverage can be obtained from 19 to 50m. The 16m band can also be received, but possibly with some sacrifice of strength on the 20m amateur band.

The coils are designed to plug into B9A (noval) valveholders, and other ranges can be tried if desired.

If other coil ranges are used, the pins for padders on the mixer coils fit into different numbers. This is because each range has a different padder value, so by this means the respective padder will be in circuit. In the circuit here described, however, only pin 4 is used.

The circuit is a normal autodyne transistor mixer Tr1, and the output from the collector is fed into the secondary winding of an ordinary medium-wave aerial coil acting here as an i.f. coil. This coil is inserted in an empty i.f. can for screening. The converter output is taken to the main receiver through a small capacitor C11 and the chassis is connected through C13 to the main chassis, effectively preventing pick-up of medium-wave stations.

Should a powerful m.w. station break through or make a carrier "squeak" the main tuning dial can be shifted slightly to a silent position. Little difference is caused by this to the tuning and, in fact, the main tuning dial can be used as a vernier control for more accurate tuning.

The convertor works satisfactorily with a supply of 4·5V and there is no point in using a higher voltage, as this will only increase background noise and transistor hiss.

Aerial Coil

A Denco range 4 (Blue) coil is used here. The existing connections are: primary winding (8) aerial, (9) earth; secondary winding (1) earth, (6) grid.

An extra winding is added for the base circuit of Tr1, in the following manner.

As two additional pins are required in the positions of 3 and 4, straighten out a wire paper clip, hold with a pair of pliers in a gas flame, and when the end is just red hot, push it carefully into the pins-end of the plastic former, having first marked the position.

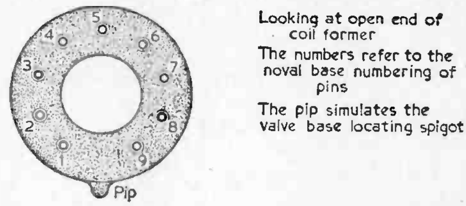


Fig. 1: The arrangement of pin numbers on the coils.

Do this with the coil former pin-side up on a piece of metal, so that when the hot wire goes through it does not penetrate too far and damage the existing coil. When the plastic cools, it will contract and the wire be firmly fixed in position. See that only sufficient wire is protruding on the upper side on which to solder the new coil.

Cut the wire to similar length of the existing pins. Solder and wind on one turn of 34s.w.g.

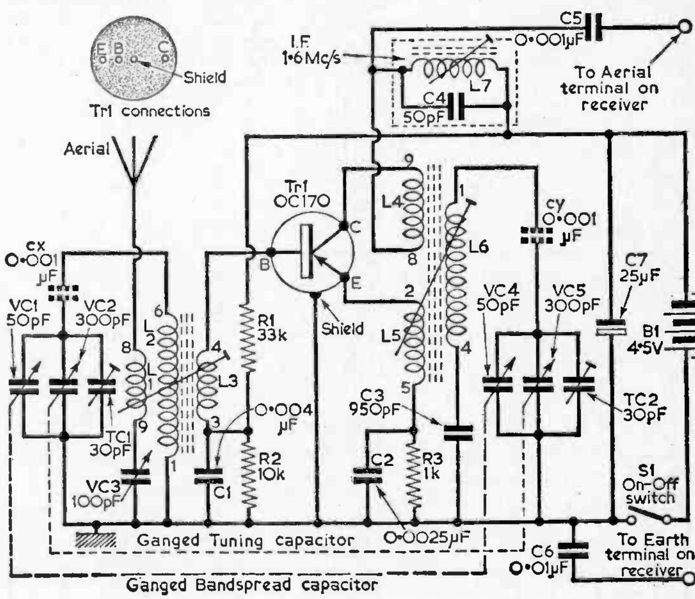


Fig. 2: The circuit of the convertor.

cotton covered enamelled wire over the main coil, near the bottom, and in a clockwise direction from pin 4 to pin 3 (looking at pins-end).

Mixer Coil

The Denco range 4 (White) is a superhet oscillator coil and the existing connections are: oscillator grid winding pins 1 and 4; coupling coil pins 8 and 9.

As with the aerial coil, two extra pins are added to this coil former: one in the position as 2, the other as pin 5. Solder on $2\frac{1}{2}$ turns of 34s.w.g. wire. Wind tightly on the outside (top) of the uppermost anode coil, clockwise from pin 5 to pin 2 (looking at former from pins-end). The $\frac{1}{2}$ turn is the distance between the two extra pins. Pin 2 is the emitter connection, and pin 5 that of the emitter resistor and capacitor.

The layout and wiring of the converter is simple and straightforward, though the usual care in "soldering in" the transistor is needed, using long nosed pliers as a heat-sink, with an elastic band over the handle to leave the hands free. The transistor should always be mounted last.

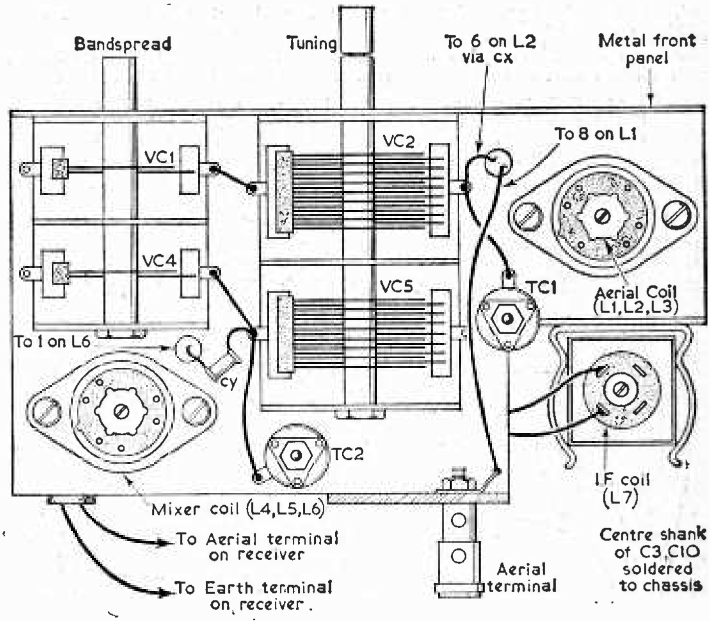


Fig. 4: The layout of the major components.

The series earth variable capacitor VC3 is not absolutely essential, but it helps to separate stations on the highest frequencies, and to reduce the volume of powerful ones. The prototype convertor was made on an old valve set chassis. Some constructors may prefer to mount the components on paxolin, but a metal front panel is essential to avoid hand capacity effects.

When used with a battery set, an earth connection to the convertor is an advantage, but this connection should be avoided with a mains set as there is a strong risk of damaging the transistor by a.c. flowing from the main receiver despite the series capacitors.

The battery holder is a piece of paxolin with two small angle brackets screwed on as contacts. When the battery is inserted it is kept in place with an elastic band. The negative (long brass contact) is bent right over against the side to avoid wrong connection. Consumption is under 2mA, so battery life is long.

A bandspread, two-gang capacitor is essential. Even with a slow-motion spindle or an epicyclic tuning gear on the main capacitor, tuning is too sharp to do without a bandspread con-

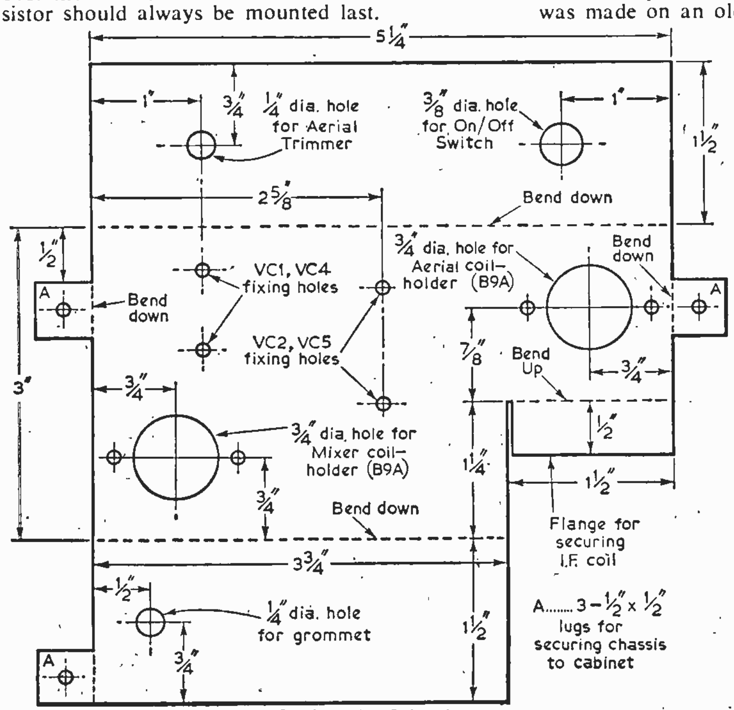


Fig. 3: Details of the chassis.

trol. If a 300pF ganged tuning capacitor is not handy, a 500pF gang may be used provided that a 1,000pF fixed capacitor is inserted in series with each section of the gang, as indicated with dotted lines on the circuit diagram.

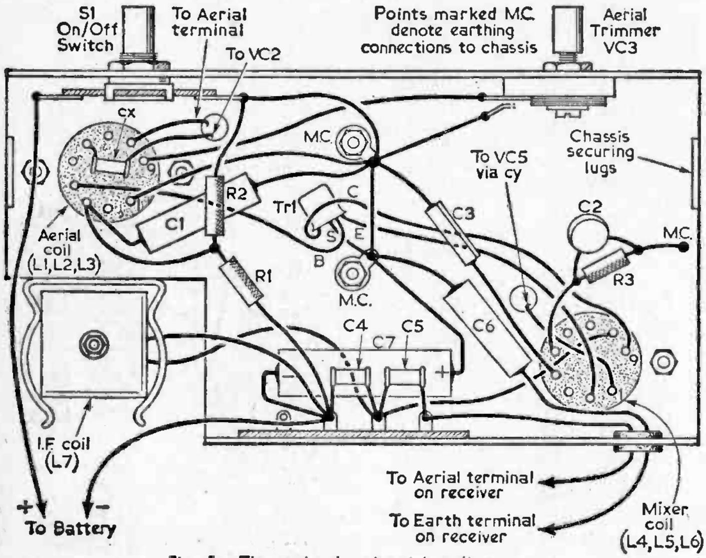


Fig. 5: The underchassis wiring diagram.

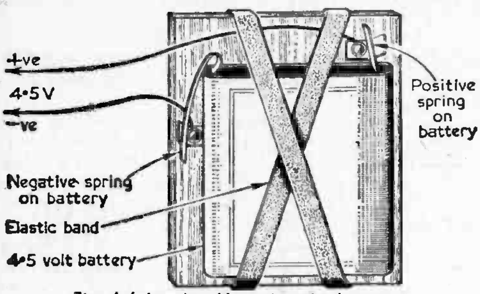
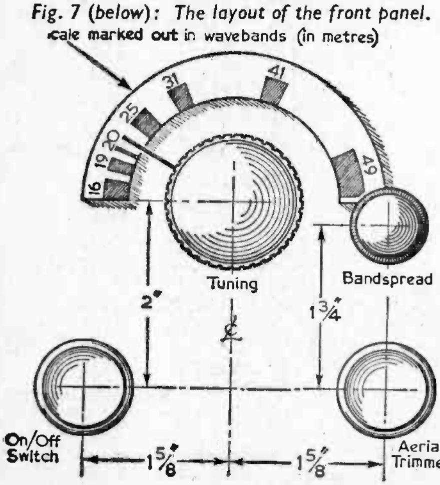


Fig. 6 (above): Mounting the battery.

Fig. 7 (below): The layout of the front panel.



To Operate

Set dial of main set to lowest wavelength (about 187·5m). Connect aerial to convertor and convertor output to aerial socket on main receiver. Tune in Radio Paris on 49m band or some other strong station. Adjust L7 for maximum output. This is not critical. The setting of the "slug" in the aerial coil is practically "all out" and that of the mixer about 6-8 turns "in". The mixer trimmer TC2 should be set about halfway in and the aerial trimmer TC1 somewhat further "out". Careful turn-by-turn adjustment of these is needed to keep the transistor in oscillation at the highest frequency end.

If the emitter coil L5 has been wound right, there should be oscillation and stations heard on most of the dial. With patient trimming the range of the convertor can be arranged to extend from 49m (maximum capacity) to 16m with the tuning capacity at minimum.

Should there be any tendency to overload the input of the main receiver, the value of C5 should be reduced to about 50pF. ■

COMPONENTS LIST

Resistors:

R1 33kΩ R2 10kΩ R3 1kΩ
All 20%, ¼W carbon.

Capacitors:

C1	4,000pF ceramic or mica
C2	2,500pF ceramic or mica
C3	950pF ceramic or mica (750 + 200pF)
C4	50pF ceramic or mica
C5	1,000pF ceramic or mica
C6	0·01μF paper or plastic foil
C7	25μF electrolytic 12V
VC1, VC4	50 + 50pF two-gang tuning capacitor
VC2, VC5	300 + 300pF two-gang tuning capacitor
TC1	30pF concentric type trimmer
TC2	30pF concentric type trimmer
VC3	100pF concentric type trimmer

Coils:

L1—3	Aerial coil. Denco range Blue (see 4 text)
L4—6	Mixer coil. Denco range 4 White (see text)
L7	I.F. coil. Weymouth or similar M.W. coil with screening can.

Miscellaneous:

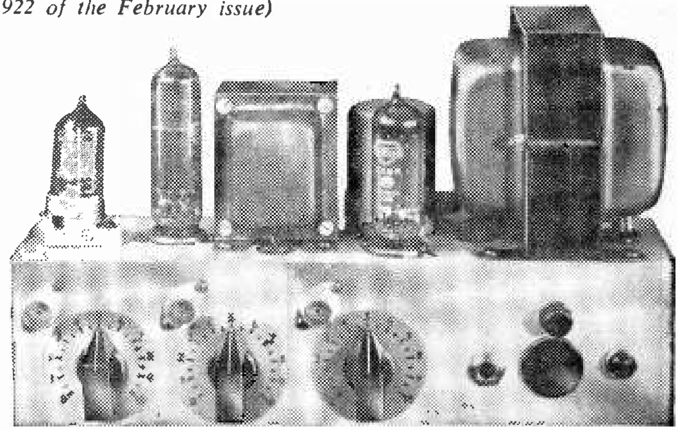
Tr1 OC170 B1 4·5V dry battery
S1 Single-pole, on/off switch
Two B9A valveholders (non-skirted). Aerial terminal. Slow-motion drive for VC2, VC5. Knobs. Tag strips, etc.

Home-movie amplifier

A GENERAL PURPOSE 4W AMPLIFIER WITH MIXING AND OTHER SPECIAL FACILITIES

(Continued from page 922 of the February issue)

By S. COLLINS



The finished amplifier

FOR constructors who like to complete the mechanical work before getting down to the actual wiring up the three variable controls can be fitted in the positions as shown, although it may be found easier to wire if the switched control is left until a little later in the proceedings. It is advisable before fitting the controls to cut the spindles down to ⅜in. long and also the graduated dials should be placed in position under the securing nuts.

It may be found necessary to make a different "flat" on the control spindles so that the pointer knobs accurately line up with the maximum and minimum positions on the dials.

Before fitting the 12-way group board it should be carefully wired up at the back as shown in Fig. 3, using either 22s.w.g. p.v.c.-insulated wire or 22s.w.g. tinned copper wire and 1mm sleeving according to preference. It is suggested that to avoid the possibility of mistakes it is advisable to mark one end of the group board with a dab of paint, or to cut a small "V" slot as shown, and also to number the tags.

When wiring this group board please note that the wires should be passed through the eyelet hole and then soldered to the outer tag, thus leaving the inner one for mounting the various components. It is most important to check carefully the wiring of this part since once it is in position and the rest of the wiring completed it will be difficult to alter it without considerable dismantling.

Most of the components can also be fitted to the group board before it is mounted on to the chassis, but leave out C6, R2 and R3 until later as this will facilitate fixing.

To fit the group board first pass two ⅜in. 4B.A. screws through the chassis from the outside and place a thin paxolin backplate over them inside the chassis and secure it by means of 4B.A. nuts. The group board is now fitted and also secured by

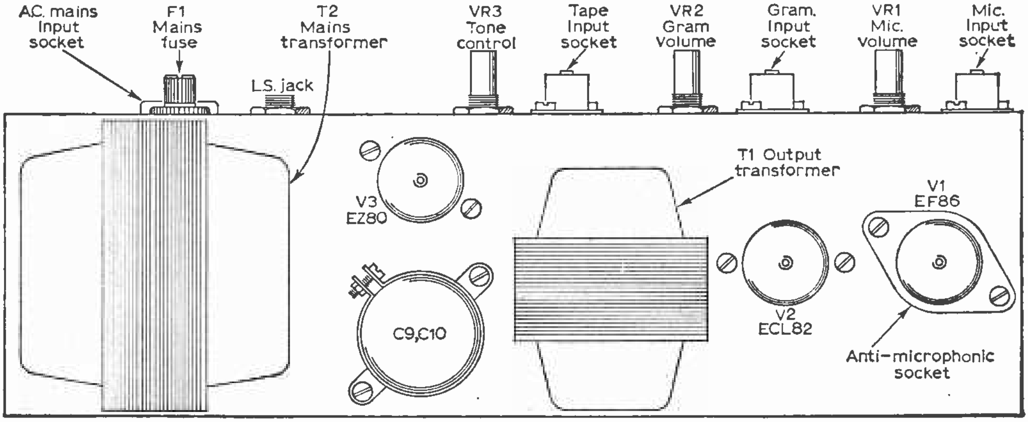


Fig. 7: An above-chassis view of the amplifier.

two 4B.A. nuts, making careful reference to the diagram to ensure it is the correct way round.

The remaining three components can now be soldered into position and a final check made to see that the polarity of the three electrolytics is correct.

The next step is to complete the heater wiring by taking the blue and orange heater wires from the mains transformer and, twisting them closely together, connect them to pins 4 and 5 of V3, keeping the wiring close to the chassis. As these are enamelled wires it is necessary to scrape the ends carefully before trying to solder them. Treat the pink and grey wires similarly and connect one to each tag on the pilot lampholder.

Next take two pieces of p.v.c.-insulated wire each about 8in. long and twist them closely together and wire from the pilot lampholder to pins 4 and 5 of V2, taking care to follow the route shown and keeping the wires close to the chassis. In the same way wire from pins 4 and 5 of V2 to pins 4 and 5 of V1.

It will be found convenient next to wire up the rest of the mains transformer and output transformer since this eliminates the rest of the loose wires. The h.t. leads (orange) should be twisted together and taken to pins 1 and 7 on the valveholder of V3 and the remainder of the wiring for these components is easily followed from the diagram. If not already in position make sure that rubber grommets are fitted into the holes in the chassis where the output transformer leads come through before these are finally soldered into position.

For good quality and efficiency the output transformer has a sectionalised secondary and this enables the output impedance to be readily adjusted for 3 to 15Ω. It is essential that the required links for either of these two outputs are inserted and the details are clearly given in Figs. 4 and 5.

Now complete the wiring of the h.t. circuit. Join pin 3 of V3 to the red tag of the reservoir capacitor and continue to one end of the 1·5kΩ smoothing resistor. Join the black tag of this capacitor to the centre earthed tag of the five-way strip and the other side of the capacitor can now be wired to the remaining end of the 1·5kΩ resistor and then continued on to the h.t. connection on the group board.

All the wiring should be kept as short and direct as possible with clean, neat, soldered joints. Either 22s.w.g. p.v.c.-covered tinned copper wire or plain tinned copper wire with 1mm sleeving can be used.

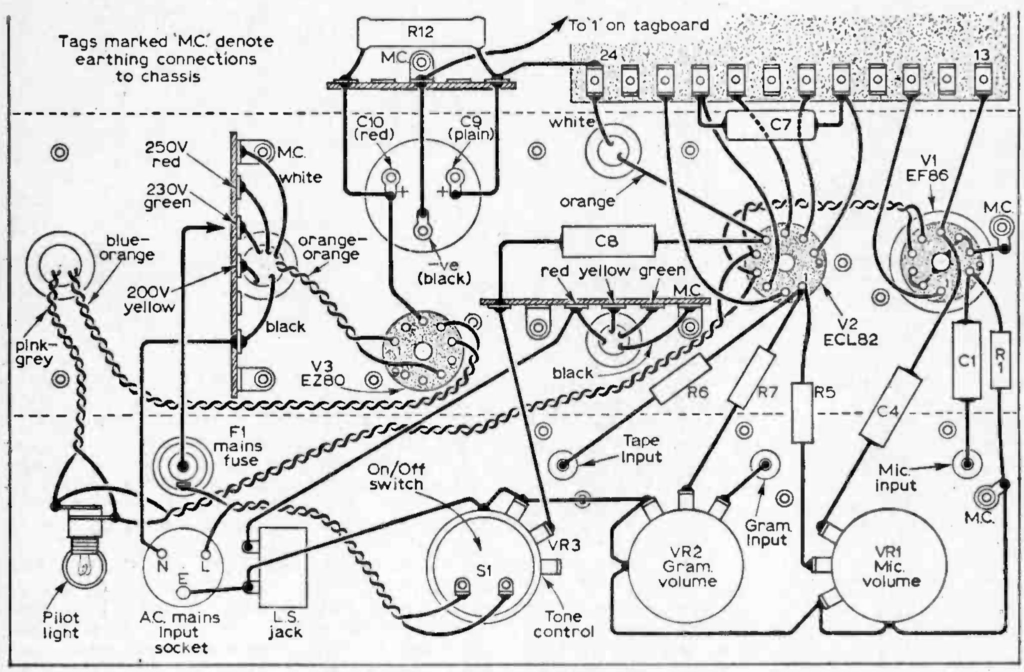


Fig. 8: The underchassis wiring diagram.

The mains input plug and fuse can now be wired up according to the diagram and this can be followed by the output jack, thus completing this end of the chassis. Some constructors may like to pencil or ink over each wire as it is completed on the wiring diagram so that it can be seen at a glance if any one is overlooked.

If the controls have not previously been fitted they should now be mounted, taking special note of the way the tags face, and the rest of the front panel wiring completed. An earth wire should be taken from each control, making sure it is soldered to the metal cover of each one as well and then to the earth tag at the microphone input socket.

To complete the wiring it will be found easiest to start at V1 and work round the pins in turn

(Continued on page 1003)

Protecting the p.a.

METHODS OF KEEPING THE ANODE CURRENT IN POWER AMPLIFIER STAGES OF TRANSMITTERS WITHIN SAFE LIMITS —— BY G3OGR

IN many transmitters the power amplifier stage can easily draw a destructive anode current, if adjustments or operating conditions are incorrect. This is particularly so with some of the modern, high efficiency valves, such as the 6146, when normally run at near maximum ratings. Means of keeping anode current within limits, when tuning up or adjusting aerial loading, thus serve to protect the p.a. stage, and are very helpful with home-designed equipment, or when using a transmitter for the first time. It may also be possible to work at reduced power, which is quite a useful feature.

The p.a. screen grid input and dissipation may be found from V×I in the usual way, where V is the screen grid voltage, and I the screen grid current: e.g., assume an 807 or 6146 valve draws 10mA at 150V; screen grid input=150×0·01=1·5W. Maximum dissipation is 3·5W for an 807, and 3W for a 6146.

Running the valve with excessive screen grid current or voltage can obviously cause the maximum rating to be exceeded. If component values are so arranged that the screen grid input is correct when the p.a. is fully loaded by the aerial, the dissipation may still be too high during tuning up periods, when the anode current is low. This is particularly likely when the screen grid supply is obtained from a low voltage power pack, so that the voltage remains constant, even when large currents are drawn. If the screen grid is supplied from the high voltage line, via a dropping resistor, an increase in screen grid current will cause a drop in screen grid voltage, thus keeping dissipation down. This method is usually adopted in phone transmitters using anode and screen grid modulation. A check on screen grid input, with the stage loaded to draw a range of anode currents, can be made. If there is any chance of the screen grid input being too high, with light loading (low anode current) then loading adjustments must be carried out rapidly.

The anode input is similarly V×I. For example, if the stage draws 100mA at 600V, this is 60W input. The r.f. output of the stage may be found from 12 × Z, where I can be measured with a thermocouple (r.f.) meter, and Z is a known impedance—usually made up from carbon resistors. Power lost as heat etc. in the stage is the difference between input and output: e.g., if the input is 60W and output 40W, 20W will be lost in the stage, and most of this will cause heating of the p.a. anode. Efficiency in the stage can be found by dividing output by input. In the example, as a percentage:

$$\frac{40\times100}{60}=66\%.$$

Maximum anode dissipation is 25W for an 807 and 20W for a 6146. When the p.a. anode circuit is tuned off resonance, the r.f. output of the stage is low, and the anode current high. If this persists for other than a very brief interval, the valve will be damaged. This can be avoided by correct tuning methods, and by reducing power during tuning up, if desired.

The p.a. circuit is always tuned to the point which causes the valve to draw least anode current. If this current is too low, loading is increased, anode tuning again being adjusted to resonance (lowest current). With the popular type of π-output circuit, loading is increased by adjusting the output capacitor (or aerial loading capacitor) to a lower value. Loading up thus commences with this capacitor fully closed. Anode current on resonance will then be low, and no harm arises provided screen grid dissipation is not exceeded, as mentioned.

With a new transmitter or home wound coils, an initial check to see that the anode circuit can be suitably tuned, and to find the capacitor setting for light loading, will help avoid possible damage. Tetrodes and pentodes are frequently used, without neutralising. If grid drive is applied, a slight

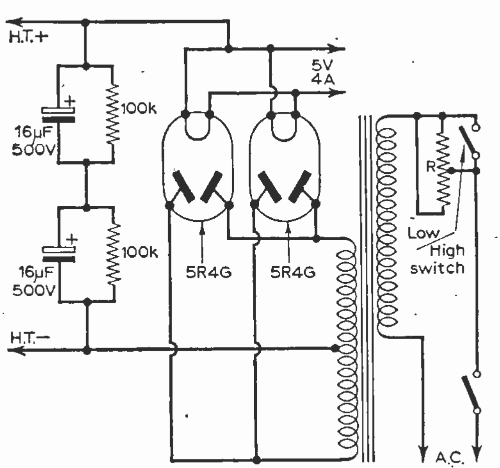


Fig. 1: Typical 600V 400mA power pack, with primary switch.

dip in grid current can be observed when the anode circuit is tuned to resonance. It is then safe to apply anode and screen grid voltages. The valve must never receive screen grid voltage alone.

Reduced Power

It is often convenient to tune up the p.a. at reduced voltage. If the high voltage supply is obtained from a transformer employed for this purpose only, the h.t. voltage can be reduced by reducing the primary voltage. A variac is ideal for this, though relatively expensive.

Another method of reducing the primary voltage is shown in Fig. 1. This is a typical 600V, 400mA power pack. A 0·3A mains dropper, as employed for a.c.-d.c. sets, was found suitable for R. One clip is used as a centre tap, and two outer clips are joined, to bring two halves of the resistor in parallel as shown. The switch is opened for low power working and closed for normal power. For smaller power packs R would need to be of higher value.

An advantage of this arrangement is that the modulating impedance of the stage can remain little changed with the lower input. The modulating impedance is anode voltage/current—e.g., for a pair of 807 or 6146 valves drawing 200mA at 600V it would be:

$$\frac{600}{0{\cdot}2}=3{,}000\Omega.$$

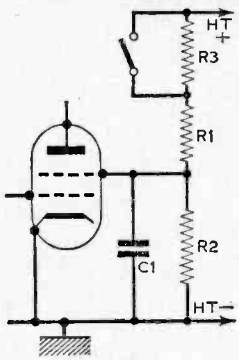


Fig. 2: A method of reducing s.g. voltage.

The stage input is $600\times0{\cdot}2=120$W. Assuming R causes anode voltage to drop to 400V and the stage is then loaded to 130mA, input is then $400\times0{\cdot}13=52$W and the modulating impedance is $400/0{\cdot}13=3{,}080\Omega$. It is thus possible to use the existing modulator, with a good impedance match, reducing gain to avoid over modulation.

It is convenient to load the stage to full input with the low/high switch closed, then open the switch and note the input. When tuning up subsequently, the stage can be loaded to the noted input with the switch open, and it may then be closed, for full input.

With the switch in the low position, the off-resonance current of the p.a. will be much reduced, so that the valve or valves are protected during tuning up and load adjustments.

With R added as in Fig. 1, the power pack voltage depends on the current drawn. That is, the supply no longer has good regulation. Despite this, the arrangement was found to work satisfactorily. If the transformer has heater windings, the resistor must be included in series with the h.t. circuit.

Another method of keeping down the off-tune current is shown in Fig. 2. R1 and R2 are the normal screen grid circuit resistors, and R3 is introduced when the switch is opened. Its value is found by trial. With a phone transmitter, the modulating impedance is increased. In the example given, the modulating impedance was 3,000Ω. If R3 gives half-power working, the modulating impedance is then $600/0{\cdot}1=6{,}000\Omega$ instead of 3,000Ω.

In many transmitters, bias for the p.a. is obtained by the voltage drop in a grid resistor, through which grid current flows. For example, a 6146 operated with a 20kΩ grid resistor, and 2·5mA grid current, will receive $R\times I$, or 50V bias. The method is simple and effective, but has the disadvantage that no bias is obtained if the grid drive ceases, due to any fault in the oscillator, multiplier or driver stages.

If ample h.t. voltage is available, protective bias may be obtained from a cathode resistor, R1 in Fig. 3. For satisfactory working on the h.f. bands, leads to C1 must be short. With a 6146, disc capacitors may be wired from the cathode tags of the valveholder, as shown.

Cathode bias is wasteful of h.t. voltage. It is convenient for a low power transmitter, but not for high power. On the l.f. bands, the lack of a very short, direct connection from cathode to chassis is also less important. A 10W top-band transmitter can readily employ cathode bias.

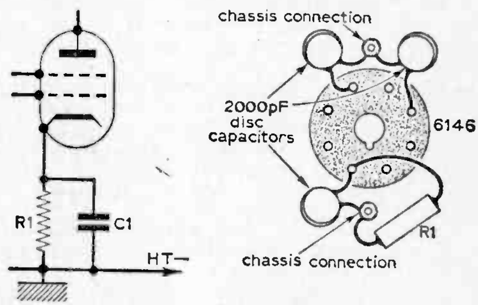
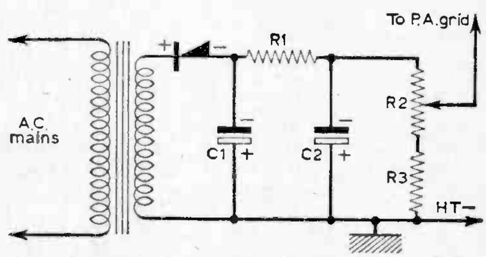


Fig. 3 (above): Protective cathode bias.

Fig. 4 (below): A pack for fixed bias.



For high power, fixed bias from a bias pack is satisfactory, and a circuit such as that in Fig. 4 can be used. R1 can be about 1kΩ to 5kΩ and R2 may be 5kΩ to 10kΩ or so, with R3 being around 5kΩ. A reasonably large bleeder current will result in a more stable supply, so resistor values should not be unnecessarily large. A total of 10kΩ will give a bleeder current of 8mA with a 80V supply. If the rectifier is reasonably large, a bleeder current of 20mA or 25mA may be adopted. R2 allows the p.a. grid voltage to be adjusted as needed. The same pack can supply bias to the modulator output stage. C1 and C2 can be about 150V working, and 50μF or larger.

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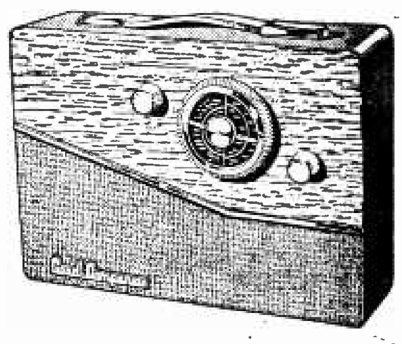

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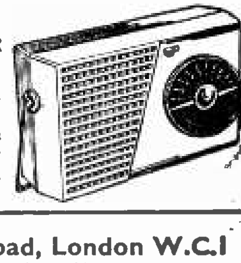

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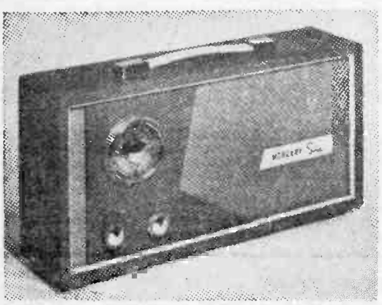

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Small transformers with an output of around 90V, as used for h.t. eliminators, will do well. The voltage should be a little higher than the maximum needed, as it can be easily reduced by means of R2 Capacitors need insulating from the chassis, as the bias supply is negative.

Screen Clamp Circuit

A screen grid clamp valve may be employed to protect the p.a. if grid drive fails, and also with buffer keying. A typical circuit is shown in Fig. 5. The clamp valve can be any audio output tetrode or pentode, such as the 6BW6, 6V6, 6L6, etc.

R1 and R2 are the usual screen grid potential divider. When drive is present, grid current in the 4·7kΩ grid resistor provides bias for the clamp valve, the 500kΩ potentiometer allowing adjustment of grid voltage. In these circumstances, the clamp valve passes very little current.

When grid drive ceases, either due to a fault, or because a buffer stage is keyed, grid current no longer flows through the 4·7kΩ resistor, and negative bias is no longer applied to the clamp valve control grid. The clamp valve thus passes a large anode current, causing considerable voltage drop in R1, so that the p.a. screen grid voltage falls. The 500kΩ potentiometer is adjusted so that the p.a. anode current is almost zero, when drive is removed. The circuit is automatic, and may be used with a c.w. transmitter, as mentioned, or with anode and screen grid modulation.

Heavy currents can be avoided by including suitable h.t. circuit fuses at a convenient point in the power pack. These fuses may be chosen so that they will blow if the current reaches a level likely to damage the p.a. valves. A 150mA fuse may be adopted for a single 6146, or a 300mA fuse for a pair of 6146's. Fuses afford no protection against excessive anode dissipation due to wrong tuning of the p.a. But they are useful as protection against any fault which would result in a very heavy anode current, which could otherwise persist until the valves or power pack were damaged.

It is quite usual to employ a single meter, for grid current, anode current, and possibly other

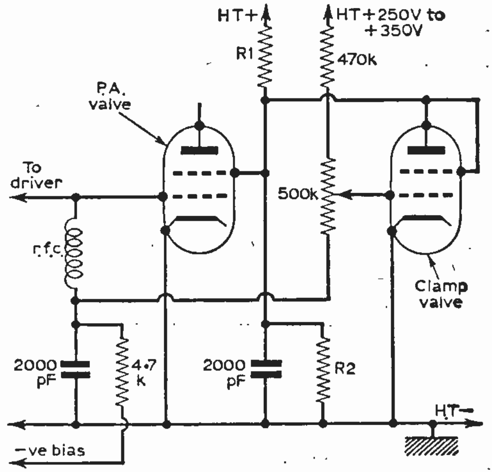


Fig. 5: A screen clamp valve circuit.

purposes, a switch selecting the appropriate circuits. If space permits, it is useful to have separate meters, so that grid and anode currents can be observed at once, or simultaneously. This is particularly important if any adjustment to anode tuning and loading considerably influences the grid current.

If little space is available, a miniature meter may be needed, and these are readily obtainable. Surplus meters are relatively inexpensive, but require more space. A meter which gives roughly a half-scale reading, with normal current, is convenient: e.g., a 10mA instrument for a pair of 807 or similar valves operated with 4mA to 6mA grid current, or a 250mA meter for anode currents around 100mA to 200mA, and so on. Sensitive meters may, of course, be shunted in the usual way, to increase the current range. A by-pass capacitor is included in parallel with each meter. ■

HOME-MOVIE AMPLIFIER

(Continued from page 998)

from No. 1 putting in the final small components. This stage has very high gain and particular care should be taken here with the wiring. The following points should be noted: the centre spigot of the valveholder must be earthed, the screening skirt of this valveholder must also be connected to earth, the wire from pin 8 to the earth tag should have a small single loop made in it to allow slight movement of the anti-microphonic valveholder.

Having completed the wiring to this stage, carefully check it against the diagram. It is also useful to compare it with the theoretical circuit.

Carry out the same procedure for the next stage, V2, noting that in this case the centre spigot is taken to one of the cathodes (pin 8). Do not overlook C7 0·05μF, which should be connected between tags Nos. 4 and 8 at the chassis end of the group board.

This almost completes the wiring. The earthing link from No. 1 tag of the group board to the centre earthing tag of the five-way strip should be inserted, making sure that it is well clear of the 1·5kΩ resistor which not only carries the h.t. positive but also gets quite hot in operation.

All that now remains is to insert the valves into their correct positions, screw in the 6·5V 0·3A pilot bulb, wire up the three-core mains lead, keeping the green lead for earth, and connect the loudspeaker into the jack socket.

The microphone circuit will give good results with any high impedance microphone, but it has been designed particularly for a normal crystal type. Care should be taken, particularly in small rooms, not to turn the microphone volume up too far as feedback will occur, causing a loud howl.

For cine work it will be found best to have the loudspeaker close to the screen, and facing the audience. The amplifier and microphone should be placed near to the projector, although if the projector is a noisy one the microphone should be screened from it. ■

TEST GEAR techniques

PART 2 - MORE ABOUT METERS

H. W. Hellyer

INDIVIDUAL volt and ampere meters are rarely found around the wireless workshop. They have their uses: mainly in specific applications, such as vehicle system testing, or in the industrial field as indicating devices, part of a static monitor. More widely employed, because of its versatility, is the multimeter, with a number of ranges for measuring volts, amperes and ohms. It may be a small pocket instrument, suitable for direct current readings only, the dozen or so ranges selected by plug-and-socket connections, or it may be a comprehensive "bench" type, with fifty or more ranges, a.c. and d.c., a wide scope of resistance checks and additional facilities such as high-voltage, capacity and "Q" measurement.

The Multimeter

Whatever the design of the multimeter, its accuracy and its dependability as a measuring instrument rely upon the quality of the basic movement, as described in Part One. Sensitivity of the meter determines its usefulness as an indicator of correct voltage, and limits the lowest scale. A typical multirange testmeter may have a sensitivity of 20,000Ω per volt on d.c., with a movement requiring only 50 micro-amperes for full scale deflection. (The same instrument would have a sensitivity of perhaps as little as 1,000Ω per volt on a.c.)

The principle of using a multirange meter on the highest voltage range, where a choice is available, to obtain the most favourable ohms per volt loading of the circuit (see Part One), is correct—but another factor should be considered. That is the accuracy of the meter.

For example, a meter with a stated accuracy of 2% could indicate between 98 and 102V when exactly 100V is applied to it, *on the 100V range.* In other words, this is a full-scale accuracy figure, and if half the voltage is applied, with the meter switched to the same range, a variation between 48 and 52V may be noted, which is a 4%, plus or minus, error. At the lower end of the scale, the error factor is even greater. Therefore, it is better to use a meter on the range that gives a deflection as near the upper end of the scale as possible.

From this, it can be seen that much depends on the circuit in which the meter is connected, and its sensitivity, in interpreting the error factor. In other words, one must grow used to one's meter and allow for the inevitable discrepancies.

A.C. Measurements

This is even more apparent when using a multimeter for a.c. tests in radio work. Here there are two more factors to consider. First, the shunting effect of the bridge rectifier and components reduces the meter sensitivity, and second, the frequency response of the instrument determines its accuracy of reading. The average multimeter is not intended to be used at much above 5kc/s for very accurate results, and is generally employed for measuring such things as heater voltage and current, at mains frequency, 50c/s. For higher frequency work, such as the measurement of stage gain in radio and audio frequency stages, an electronic meter is very much more accurate and trustworthy. This type of instrument will be discussed later.

Resistance Testing

An important function of the multimeter is the ohms range, or ranges. By fitting a battery in the meter, and arranging variable resistors to bring the meter movement to full-scale deflection when the circuit is completed, i.e. terminals short-circuited, zero ohms, then introducing the unknown resistance in place of the short-circuit, the reduced current can be indicated as a proportion of full-scale deflection, and read off directly from a scale —*which will now appear in reverse to the voltage and current scales.*

It will also appear non-linear, the divisions becoming progressively more cramped as maximum resistance, i.e. minimum current flow, is approached. The resistance will be zero at full-scale deflection, infinity at minimum deflection. The highest resistance reading that can usefully be indicated depends upon the sensitivity of the meter, and the battery voltage. But addition of an external battery extends the range of the instrument and alternative methods of connecting meter, battery and variable shunt can "open out" the lower range, enabling a reading of smaller resistance values.

This is seen more clearly in Fig. 4. Here there are three alternative ways of connecting a basic meter movement for resistance testing. At (a) we have the normal "series" arrangement, as and R2 are comparable, the value of R1 being such as to afford protection to the meter, preventing a current in excess of full-scale deflection flowing even when the battery is fully charged and previously described. If the values of resistors R1 R2 at minimum, then half-scale deflection, in ohms, will be R1+R2.

Where a meter is being adapted, it may be necessary to compute values of resistance for readings of current. This can be done if the full-scale deflection of the meter is known, and its internal resistance.

Calculating the Internal Resistance

To calculate internal resistance, Rm, connect the meter across a suitable supply, using it as a voltmeter, and note the reading. Then connect a known resistor in series and note the new reading. If this resistor is called R, and the first and second readings V1 and V2,

$$Rm = \frac{V2 \times R}{V1 - V2}$$

Then, referring again to Fig. 4, the value of an unknown resistor Rx across the test terminals can be calculated, using the following formula,

$$Rx = \frac{R\,(\text{total}) \times \text{f.s.d.} - R\,(\text{total})}{I}$$

where the total resistance is the sum of R1, R2, the internal resistance of the meter and the cell resistance. With a new cell, the last factor could be ignored for practical purposes. F.S.D. is the current required for full-scale deflection and I the new current reading obtained when the short-circuit across the test terminals is replaced by Rx.

A more accurate arrangement is shown in Fig. 4(b). Here, the meter is connected as a voltmeter, with R2, the "Set Zero" control shunting the meter movement. R1 is again the limiting resistor. The formula for calculating Rx is:

$$Rx = \frac{\text{f.s.d.}}{(I - 1)} \times R1.$$

With this type of ohmmeter, greater accuracy is possible at the lower portion of the scale, which is also less cramped, but the sub-divisions are limited by the meter characteristics. Increasing the battery voltage allows an extension of the range and greater accuracy of higher resistance readings.

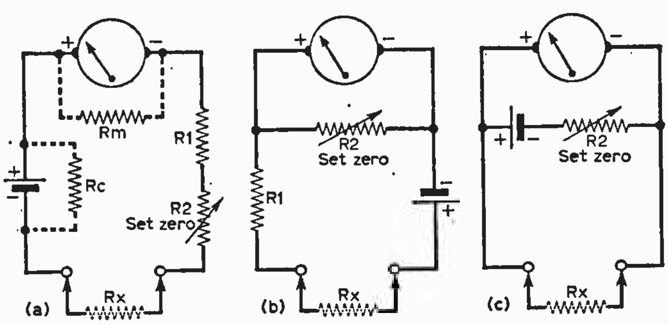


Fig. 4: Three ways of connecting a basic meter movement for resistance testing.

The Insulation Tester

To check lower values of resistance, a slightly different arrangement is needed, as shown at (c). This is the basic "insulation" tester. R2 and the battery are shunted across the meter, as is the test resistor, Rx. The set zero is adjusted with the terminals open-circuited, and readings increase from left to right. Greatest accuracy is obtained at the lower values. Connecting a test resistor across the terminals equal to the internal resistance of the meter, Rm, gives a half-scale deflection. From this we can see that the formula for interpolation (reading current as resistance directly), will be:

$$Rx = \frac{Rm \times I}{(\text{f.s.d.} - I)}$$

The normal arrangement for ohms measurement in the commercial multimeter is as shown in (b). When adding a battery for the extension of ohms ranges, it is merely necessary to connect it in series at the terminals, taking care to observe correct polarity.

Other methods of measuring resistance, such as the Wheatstone bridge, will be dealt with as different instruments are described.

Precautions

When making resistance tests in a receiver, ensure that power supplies are switched off and electrolytic capacitors are discharged before connecting the ohmmeter leads. It will be noted that the connection of an ohmmeter across an electrolytic capacitor will give a reading which "kicks" towards full-scale (low resistance) and slowly falls away. See Fig. 5(a). This is because the capacitor is partially charged by the ohmmeter battery, the charge leaking away through the discharge path of the meter resistance, its rate giving an indication of the "goodness" of the component. Larger capacities give a larger "kick" and a slower falling away.

This phenomenon is more noticeable on the higher resistance ranges, and provides a useful quick test for the engineer, but the presence of electrolytic capacitors in a circuit should not be overlooked as false readings can result.

Semiconductors

Similarly, a crystal diode in a series circuit will give a resistance reading that varies with the applied voltage. This is because the diode tends to pass current in the direction shown by the arrow in Fig. 5(b). Thus, a low resistance reading will be noted, whereas a high resistance will be indicated if the meter is connected with polarity as shown in (c).

Enlarging upon this theme, we can observe that transistors are also semiconductors and behave in similar manner to crystal diodes when the ohmmeter is connected to their leads. First, note that a meter with a battery voltage greater than 3V should not be used for making resistance checks around a transistor radio. But, if this stricture is noted, it is possible to make a rough test of a transistor while fault finding, as shown in Fig. 6.

Here, it will be noted that the polarity of the meter is indicated. This can be quickly verified by connecting the meter test leads across a semi-conductor diode and noting that a low reading is obtained when the meter lead carrying negative potential is connected to the cathode (red end).

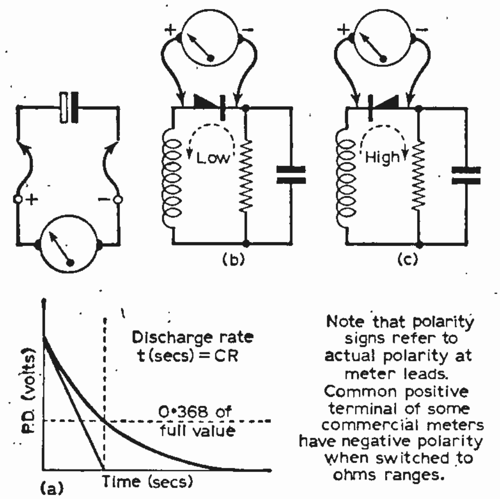


Fig. 5 (above): Connecting an ohmmeter across an electrolytic capacitor and a diode.

Fig. 6 (right): Making a quick transistor test.

These transistor tests are only a guide, with comparative readings taken by a 20,000Ω/V meter on the highest ohms range.

Choice of Instrument

The multimeter has a number of other uses. Mention will be made of these at the appropriate stage of our discussion. At this point it is only necessary to add that money spent on the purchase of a good quality instrument is never wasted.

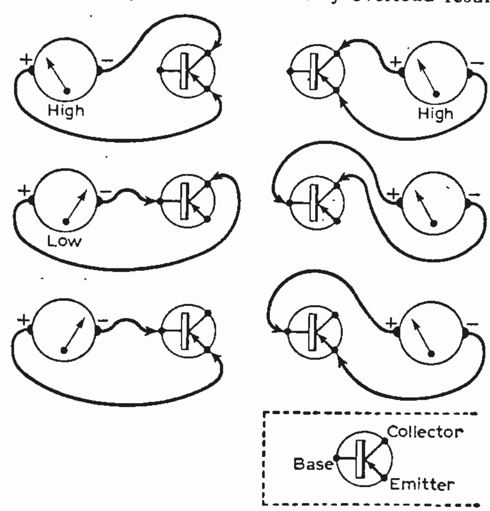
However, there are factors affecting one's choice, quite apart from quality. These are to some extent determined by the nature of the work being done. For example, a meter that is ideal on the bench may not be robust enough, or may have too (mechanically) sensitive a movement for work in the field. It is false economy to buy a meter with a number of facilities, then use it only for checking one's car battery. On the other hand, a good meter with fewer ranges can often be adapted quite cheaply and accurately for the occasional reading beyond its scale.

Remember that the a.c. ranges on a multimeter are less sensitive than the d.c., because of the shunting effect of the non-linear rectifier. Also, the frequency response on these ranges is not intended to cover audio or r.f. measurements accurately, for which special instruments are needed, as will be discussed later.

When using the meter for measuring unknown quantities, protect it by beginning at the highest range, then reduce until the pointer gives an indication within the normal scale limits. Avoid the damaging practice of causing the pointer to "slam" against its stops. Even with an overload of the mechanical type shown in Fig. 7, there is danger of bending the delicate pointer before the trip mechanism operates.

Overload Protection

The mechanism of Fig. 7 is that of the popular AVO meters, where a momentary overload results



in the spring tripping of the spindle S by the action of toggles T, push rod P, and jewel crank lever L and the reset arm R which engages a recess in the knob spindle. The spindle is attached to a former on which circuit contacts C are mounted. Remaking the circuit is simply done by pressing the re-set knob to engage the recess in the spindle with the sprung lever L.

Other forms of cut-out work on the electrical principle, with a rectifier of specially chosen characteristics shunting the meter and carrying excess current resulting from an overload. The difficulty here is that if the overload is prolonged, or too great, the shunts themselves are damaged and have to be replaced. This is a job for the specialist; fitting of an incorrect value will upset the meter characteristics. Even the fitting of the correct shunt normally requires that the meter shall be re-calibrated. The moral, obviously, is "Don't risk that overload".

Moving Iron Meters

All that has been said previously relates to the moving coil meter. It must not be thought, however, that the alternative type, the moving iron meter, has been completely superseded. It has its uses, and the very definite advantage is that it is suitable for a.c. measurements, as reversal of polarity does not prevent its functioning.

The meter movement has a fixed coil, through which the current to be measured flows. A soft-iron armature is mounted at the centre of this coil and interaction of the field of the coil and the magnetism induced in the armature cause deflection. This deflection is not linear, as with the moving coil type meter, the scale divisions widening as they approach full-scale deflection.

Although basically, this deflection non-linearity is proportional to the square of the current

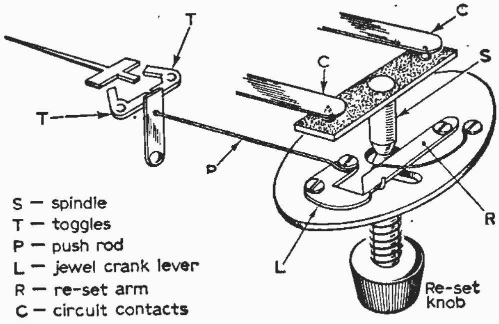


Fig. 7: A mechanical type of overload.

(Square-Law), variations in design enabling the armature to become magnetically saturated at low current values result in scales that, although cramped at the extreme left, are nearly linear over the rest of the scale.

Two types of moving iron instrument are used, the attraction and repulsion. The former is as described above, the two fields attracting. The latter has a fixed and a moving soft-iron piece, with the field from the coil inducing similar fluxes in each, causing repulsion and a swing of the lightly mounted moving armature.

Their special advantages are cheapness, robust construction and a.c. characteristics that are better than d.c. Disadvantages, as compared with the moving coil type, are, lower accuracy, higher required f.s.d. current, reactance error with frequency variation and susceptibility to external magnetic fields.

Electrostatic Voltmeter

Another "universal" instrument with a special application is the electrostatic voltmeter. This operates on an entirely different principle, independent of current. For this reason, it is employed where the loading on the circuit must be negligible—as, for example, measuring e.h.t. voltages of a television receiver, across the high impedance circuits commonly used in flyback systems.

The voltage is applied to two sets of plates, rather like the tuning capacitor of a radio receiver. One set of plates is fixed, the other is pivoted and the pointer is secured at the pivot. Fine hairsprings provide mechanical balancing, as with the instruments described previously, and the tension of these can be adjusted to zero the movement.

A voltage applied to the two plates in close proximity causes electrostatic attraction. and thus the moving plates tend to swing, the torque being proportional to the actuating voltage—but in practice, some initial torque is needed to overcome the mechanical suspension drag, and at the lower end of the scale the readings will be closer together.

One disadvantage is that low voltages cannot be measured by this method with any great accuracy. Another is that this is essentially a single-scale instrument. Any additional resistive multiplier defeats the no-loading characteristic, and adding a capacitative divider for a.c. measurement increases the loading, as the electrostatic voltmeter acts as a capacitance across an a.c. circuit. For the same reason, its frequency response is poor.

Bridge Rectifier

The foregoing notes have described meters that can be used to measure alternating currents and voltages, but with less sensitivity than is sometimes desirable.

The multimeter usually employs a bridge rectifier circuit for the conversion of the applied a.c. to a d.c. suitable to operate the meter movement. A typical circuit is shown in Fig. 8, with the four rectifier elements of the bridge called A, B, C and D. When a.c. is applied to the left-hand terminals, points X and Y of the circuit become alternatively positive and negative, and for periods of a half-cycle, current flows in one direction only.

Thus, when X is positive with respect to Y, current flow follows the dotted arrows, from Y, through C to the meter, and through A to the positive point X. Thus, the left-hand terminal of the meter is the negative pole. Now, when the a.c. reverses and X is negative with respect to Y, the current path is from X through D to the meter, through B to Y, so that the left-hand terminal of the meter is again negative. Thus, the meter measures a d.c. proportional to the applied a.c. The reason for the particular current paths is the non-linear characteristic of the semi-conductor rectifiers, which have a low "forward" resistance, allowing the easy passage of current and a high "back" resistance, impeding the current flow.

But it must be remembered that no semi-conductor is perfect, and a shunting effect on the meter is caused by leakage paths in an unwanted direction. Hence the loss in sensitivity when such an instrument is used on a.c. The frequency response is also affected by the rectifier.

Further, semi-conductors are prone to damage from overload, and suffer when sharply peaked transients are applied, such as may be caused by the making and breaking of a circuit. Switching both of the meter and the apparatus under test should be avoided when the meter is connected. This is important on both a.c. and d.c. Although all reputable makes of multimeter have protection devices, swamp resistors, surge limiters and overload shunts. it is impossible to protect the meter completely, and the careful user will be rewarded

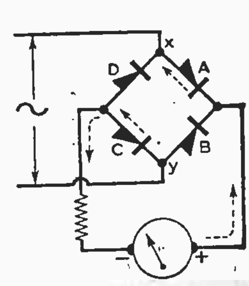


Fig. 8: A typical bridge rectifier circuit.

with a longer, more consistently accurate life of his instrument.

Thermo-couples

An instrument that is widely used for measuring a.c. over a wide range of frequencies is the thermo-couple meter. Several types are available on the surplus market and can find an application in experimental work.

The basic movement is a moving coil, often a millivoltmeter, responsive to as little as 300mA. This is used to measure the d.c. produced by the heating effect of an alternating current on the junction of two dissimilar metals. Iron and eureka are two of the metals widely used and several thermo-couples may be used in conjunction.

These instruments are accurate up to quite high frequencies and some which use antimony with platinum and copper with constantan have a relatively high thermo-electric power. As the e.m.f. at the junction is proportional to the heat and thus to I^2 the instrument is a square-law device. Thus the scale is cramped to the left, progressively widening toward the high-current readings. Pointer movement tends to be sluggish as compared with the meters previously discussed.

Hot-wire ammeter

This instrument is somewhat similar but employs the principle of metallic expansion under heat. It has a piece of fine, high-resistance wire through which the current passes and to which is attached a pulley via an isolating metal strip. As the current through the wire increases, expansion causes it to "sag", allowing the take-up wire to draw on the pulley and move the pointer. Movement is necessarily sluggish and mechanically the instrument is delicate besides being very susceptible to overloading. At higher frequencies skin effect introduces serious errors and further errors occur if the waveform being tested is not sinusoidal. This type of meter has largely been superseded by the thermo-couple except for some special laboratory applications.

The valve voltmeter

The use of a meter in a circuit makes some difference to the circuit characteristics whether voltage or current is being measured. One authority has stipulated that his ideal meter must have "infinite impedance on both a.c. and d.c., a frequency response extending up to 300Mc/s and a reasonable indication at about 10 microvolts".

This ideal may be asking too much but the modern valve voltmeter comes remarkably close to such perfection. An input impedance of 10 megohms or more is almost as good as an infinite impedance for practical purposes and is quite common. This is attained by feeding the voltage being tested into the grid circuit of a valve, which can be operated in such conditions as to present a high impedance and very little circuit loading as a result.

Some shunt capacitance is inevitable; the connecting leads themselves have a shunting effect. But a low-loss "probe" can be made which rectifies the a.c. voltage to be tested at the point of measurement, then applies the rectified voltage (now d.c.) to the instrument, several valve stages being used both to amplify this voltage and act as "buffer" stages to the meter. A carefully constructed probe can allow a.c. measurements up to 300Mc/s with very little loss, while a useful indication of about 100 microvolts is not uncommon even on standard instruments.

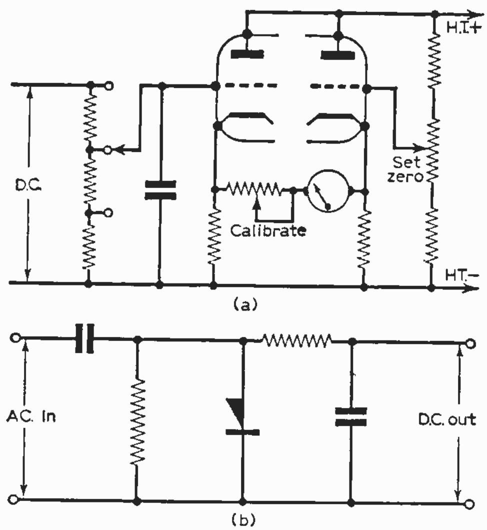


Fig. 9(a): The basic principle of the valve voltmeter; (b): a.c. probes.

The basic principle of the valve voltmeter can be seen from Fig. 9(a), which shows two halves of a double-triode valve in a balanced circuit. Actually they form a bridge across the h.t. supply with the meter reading a difference in cathode voltage. Thus when each triode passes the same current the cathodes are at the same potential and the meter reads zero. The bias of the second triode is altered by the set zero control and the bridge is balanced, but when a d.c. voltage is applied at the input terminals, effectively across the grid circuit of V1, the balance is upset, cathode voltages differ, and the meter indicates the change which is proportional to the input.

The valve voltmeter and its wide applications will be dealt with at greater length in the next part of the series.

A.C. probes, which differ in detail from that shown in Fig. 9(b), will also be discussed. Many probes now used are unsuitable for high-frequency work and it is necessary to go a little deeper into the effect upon components and circuitry of higher frequency, non-sinusoidal waveforms. It will be noted that the probes supplied with several of the better-class commercial valve voltmeters and electronic testmeters are considerably more complicated than that illustrated and also that the circuitry of the meter has been developed to a high degree of accuracy, stability and economy.

Power supply circuits are necessary for these meters and several refinements are employed to improve stability. It is hoped that a discussion of these points will be of assistance both to users of commercial equipment and to potential constructors.

(To be continued)

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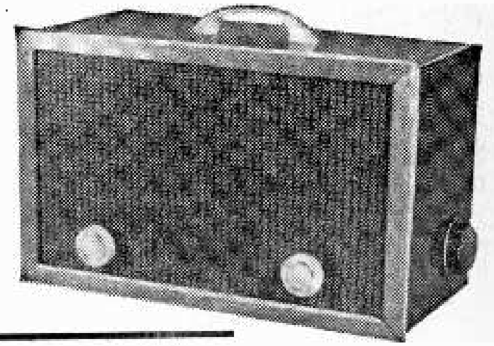

by V. E. Holley

THIS handy little receiver will give a good account of itself in the less favourable reception areas where simpler sets are inadequate. A directional aerial enhances the selectivity of the superhet circuit so that a good performance on the crowded medium waveband is obtained without excessive sideband cutting.

Mixer and I.F. Stages

Referring to Fig. 1, it will be seen that the signal from the ferrite rod aerial is applied via the switch S1, to the grid of a frequency changer valve, 12AH8, the capacitor C1 being included so that the lower ends of the aerial windings can be returned to earth and a.g.c. can be applied in the parallel mode to the grid.

Switches S2 and S3 select the oscillator coil appropriate to each waveband and signal and oscillator frequencies are combined in the valve to produce in the anode circuit the difference frequency of 465kc/s. The valve V2, which accepts and amplifies the signal at intermediate frequency, is a high slope variable-mu pentode, 6BA6, in a coventional circuit, the screen receiving its supply through the voltage dropping resistor R5, decoupled by capacitor C11.

This network also supplies the screen of V1 but as the valves work at different frequencies, there is no inter-action.

Detection and A.G.C.

It was intended to use a pair of germanium diodes here until it was noticed that a double diode valve and its base could be obtained ex-equipment at considerably less cost. The constructor who has diodes of the GEX34 type available, however, may substitute them directly for V3 in Fig. 1 without any alteration in the performance of the receiver. (The red ends of the diodes correspond to the cathodes of the 6AL5.)

A.G.C. voltage is derived from the primary of the second i.f. transformer. The voltage available

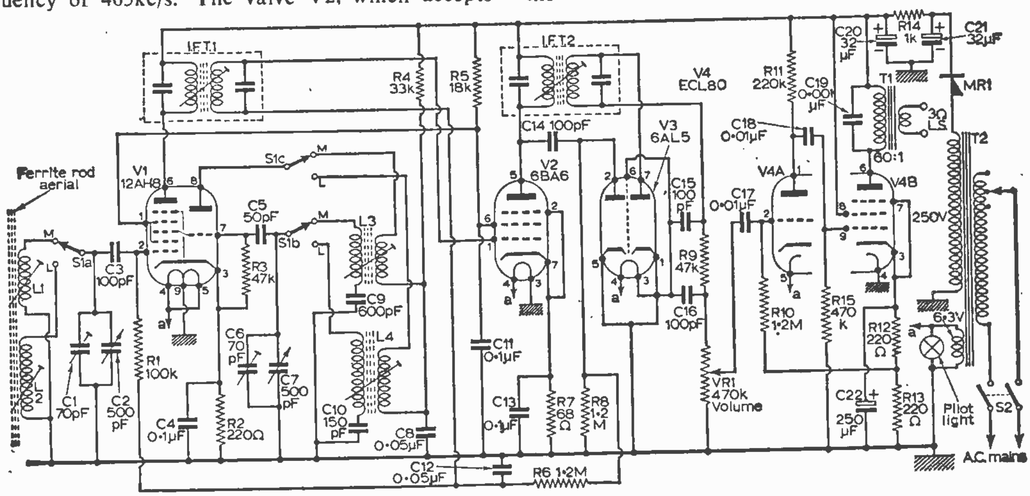

Fig. 1: The circuit.

at this point is considerably greater than that at the secondary, making the gain control that much more effective. The insulation of the capacitor C14 is important and a good quality mica component should be used.

Resistor R8 is the a.g.c. diode load and the filter R6, C12, removes the i.f. and audio components before the voltage is applied to the grids of the controlled valves. It will be noticed that the sensitivity to weak signals is limited by the absence of a delay voltage in the a.g.c. system, but a receiver of this sort would not normally be used for reception of weak and distant transmissions.

The second diode in V3 demodulates the signal for a.f. amplification, the filter network C15, R9, removing the now unwanted intermediate frequency before the signal is passed via the volume control, VR1, to the a.f. and output stages.

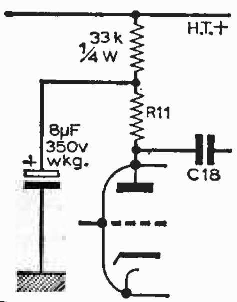

Fig. 2 (above): Additional smoothing to reduce residual hum.

A.F. Stages

Portability imposes its limitations and in order to keep the power-pack down to a reasonable size and weight, a.f. amplification and power output are obtained from a triode-pentode valve ECL80, which has only a modest current requirement.

The triode section is employed as a resistance coupled amplifier with an anode load of 220kΩ, while to provide the optimum bias, the grid resistor of 1·2MΩ is returned to a tapping on the cathode resistor instead of to earth as would be done if there were a separate triode cathode.

The pentode section provides a power output of about 1½W. The optimum load is 11,000Ω and for a 3Ω loudspeaker, the output transformer ratio should be about 60 to 1. Connected across the primary is a capacitor, C19, which corrects the response at the higher audio frequencies. The cathode network which is common to both sections of the valve, must be bypassed by a large capacitance and C22 should not be less than 250μF.

The overall gain of the two stages, though adequate, is not high and no trouble is likely to be experienced with hum. The residual hum level of the receiver is very low and can be reduced to inaudibility if desired by some additional smoothing in the anode circuit of V4A, as shown in Fig. 2.

Power Supply

An h.t. supply of about 45mA at 200V is required and the valve heaters and dial light need 1·5A at 6·3V. A double wound miniature mains transformer reduces mains borne interference to a minimum and makes the chassis safe to handle at all times.

It has a 250V half-wave secondary which feeds a contact cooled metal rectifier, MR1. Smoothing is provided by the resistor R14 and the two electrolytic capacitors, C20 and C21, which may of course, be one double component if desired.

Many miniature transformers do not have tapped primaries, so that the h.t. secondary voltage may vary somewhat with the mains voltage. The

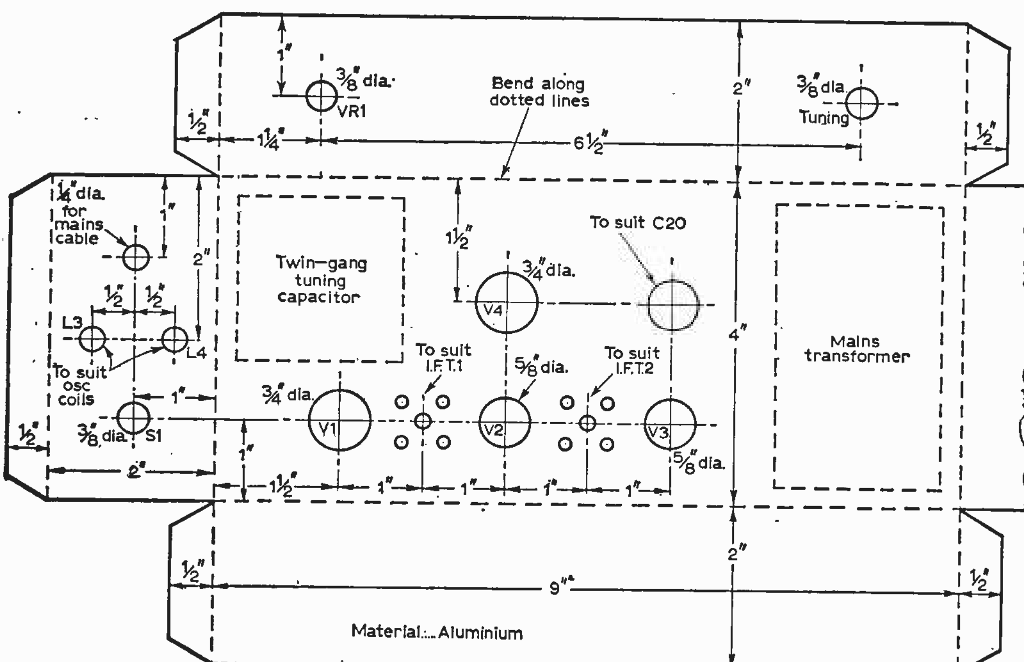

Fig. 3: The chassis drilling details.

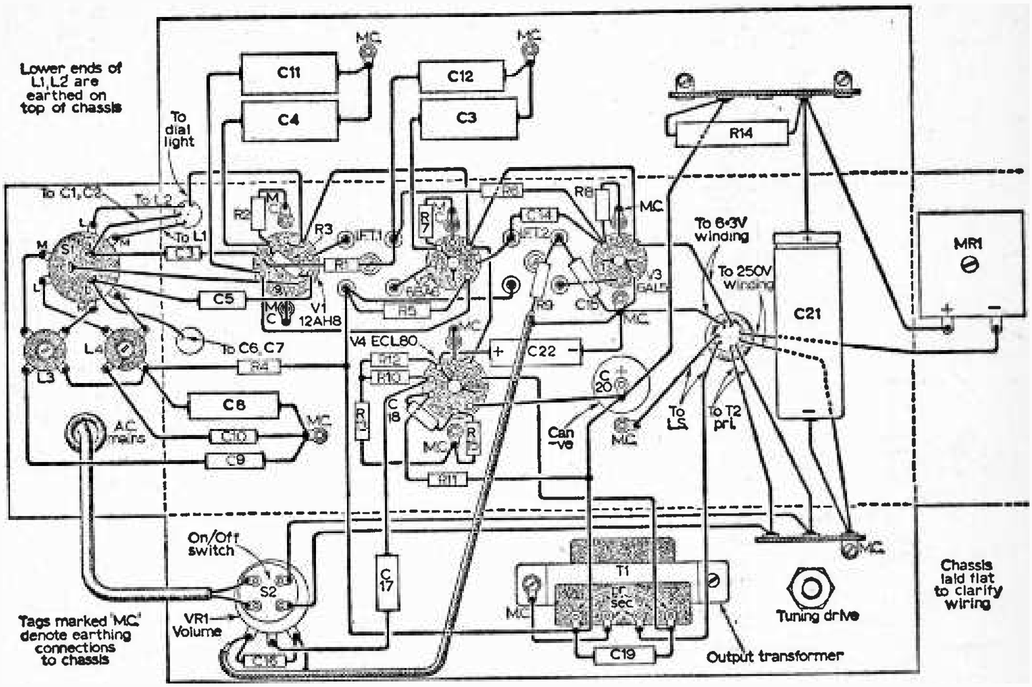

Fig. 4: The complete wiring diagram.

value of R14 may therefore need to be adjusted to produce the correct h.t. line voltage of 200 in the receiver. Mains switching is incorporated with VR1.

Components

To simplify alignment, fixed padding capacitances are used in the oscillator circuits, but this will be satisfactory only if the oscillator coils are designed for use with the particular ferrite rod aerial employed and the capacitances are those recommended by the manufacturer.

The values shown in Fig. 1 for C9 and C10 are typical but not universal. The mains transformer must be a miniature and the i.f. transformer should not be larger than 1in. square. All the other components can be standard and, as there is nothing critical about them, the constructor can use anything he has to hand which is electronically suitable and can be fitted in.

Construction

The receiver is constructed on a chassis of 18s.w.g. sheet aluminium, 9in. x 4in. x 2in., the details of which are given in Fig. 3.

A rough wooden box should then be made in which the chassis can be suspended upside down by its end flanges while the wiring is carried out. Tinned copper wire of 22s.w.g. is suitable for this, covered with sleeving in the case of connections more than 1in. or so in length.

Fig. 4 shows all the under chassis wiring with the connections opened out for clarity. The only really critical point is the lead to the grid of V2; if instability is experienced, it will almost certainly be due to pick up here and screening may be required even though the lead is short.

Aerial

The method of securing the aerial will vary somewhat according to the fittings if any, supplied with it. If there are none, a satisfactory arrangement is a bracket of 18s.w.g. aluminium to the measurements given in Fig. 5. Fit rubber grommets in the two ⅜in. holes and pass the aerial rod through them. This assembly can conveniently be supported, as in the illustration, at a height of about 4½in. above the chassis on a strip of 16 gauge aluminium 5in. x 1in., having ½in. turned at right angles at the bottom for bolting to the deck of the chassis.

Tuning Drive

The not inconsiderable expense of a tuning drive and scale is avoided by the arrangement shown in Fig. 6. The drive spindle is a discarded volume control with the body removed and carries a brass pulley from a well-known constructional toy drilled out and soldered to it.

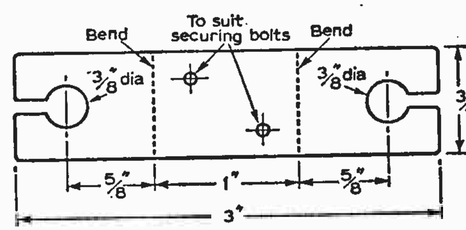

Fig. 5: Details of the aerial mounting bracket.

The drive cord is taken via two more pulleys (a) and (b) fitted to the chassis, to a 2¼in. drive drum on the tuning capacitor, engaging on the way with a cursor which is free to move along the length of an aluminium plate, 5in. x 1¼in., secured to the front chassis runner. The plate should be mounted on two 1in. long bolts and positioned by distance pieces or nuts far enough from the chassis runner to permit the drive cord to pass freely behind it. The exact position of pulley (b) in Fig. 6 is unimportant but (a) should be positioned so that the upper drive cord which engages the cursor is horizontal. The cursor is of 24s.w.g. tin plate.

Any arbitrary horizontal scale can be affixed to the aluminium plate or, alternatively, the plate can be painted matt black and the scale can be engraved on the perspex window in the front of the cabinet. This was done in the prototype, using a section of a scale on perspex found in a piece of ex-Government equipment.

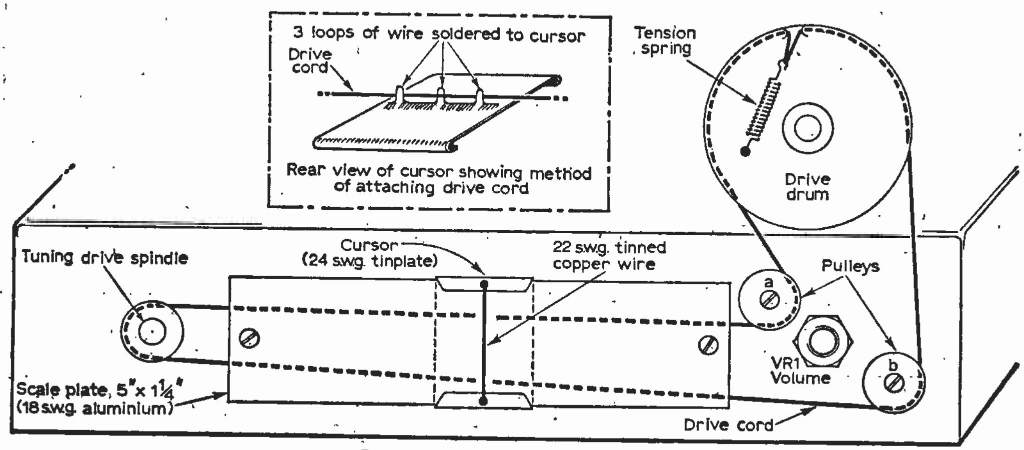

Fig. 6: The tuning drive assembly.

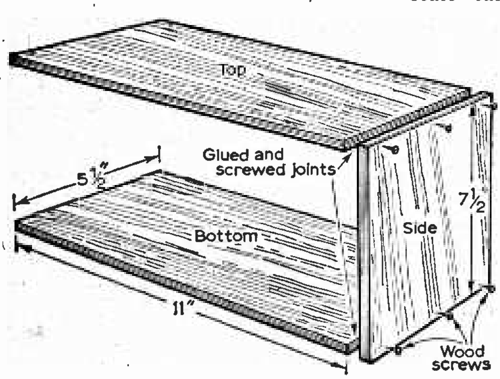

Fig. 7: The construction of the cabinet.

Testing

Before switching on, apply a meter on a high ohms range between C21 and chassis to see that there are no shorts in the h.t. wiring. Power can then be applied and the presence of voltages at the valve electrodes verified with the meter. Measure the h.t. rail voltage. It should be between 200 and 210V and if it is not, the value of R14 should be altered to bring it within this range.

I.F. Alignment

If pre-tuned transformers have not been used, it will be necessary first to align the i.f. amplifier with the aid of a signal generator. Inject a signal of 465kc/s at the grid of V1 and adjust the transformer cores for maximum response; the best indication of resonance is a high resistance d.c. voltmeter connected across VR1, positive to chassis, but if this is not available, a modulated signal can be used and the result observed with an output meter or judged by the sound output from the speaker. Keep the generator signal to the minimum necessary for adequate response.

R.F. Alignment

Start with the medium waveband. Normal coverage for a circuit of this sort with a 500pF tuning capacity, is from 1550kc/s to 515kc/s, and the first step is to obtain this. Set the medium wave aerial coil about ½in. from the end of the rod, open the gang capacitor fully and inject a 1,550kc/s signal by bringing the generator output lead into the vicinity of the aerial. Tune for maximum response with the trimmers C1 and C6.

Next, close the capacitor fully, inject at 515kc/s and adjust the core of L3 and the position of the aerial coil upon the rod for optimum response; secure the coil in position with a little beeswax. It now remains to track the oscillator. Using a signal of 1,450kc/s, manipulate the tuning capacitor and the trimmer C6 to find the combination of settings for maximum response; note the scale position carefully (point A). (If the scale is not fitted, mark the position of the cursor on the scale plate).

Inject now at 600kc/s and by manipulation of the tuning capacitor and the core of L3, again find the optimum combination and note the scale reading (point B). Repeat the adjustments at both

COMPONENTS LIST

Resistors:

R1	100kΩ	R9	47kΩ
R2	220Ω	R10	1·2MΩ
R3	47kΩ	R11	220kΩ
R4	33kΩ ½W	R12	220Ω
R5	18kΩ 1W	R13	220Ω
R6	1·2MΩ	R14	1kΩ 5W
R7	68Ω	R15	470kΩ
R8	1·2MΩ	VR1	470kΩ log.

(All ¼W except where otherwise specified)

Capacitors:

C1	70pF trimmer	C11	0·1μF
C2	500pF gang	C12	0·05μF
C3	100pF	C13	0·1μF
C4	0·1μF	C14	100pF (mica)
C5	50pF	C15	100pF
C6	70pF trimmer	C16	100pF
C7	500pF gang	C17	0·01μF
C8	0·05μF	C18	0·01μF
C9	600pF	C19	0·001μF
C10	150pF	C20	32μF electrolytic

C21 32μF electrolytic
C22 250μF electrolytic, 15V
(350V wkg. unless otherwise stated)

Valves:
V1 12AH8, B9A base.
V2 6BA6, B8G base
V3 6AL5, B7G base or two diodes GEX34 or similar
V4 ECL80, B9A base

Dial Light:
6·3V 0·3A

Rectifier:
250V, 50mA contact cooled

Transformers:
Mains 250V, ½-wave, 45mA, 6·3V, 1·5A.
Output Ratio 60 : 1 for 3Ω speaker.
I.F. 465Kc/s miniature (2 required).

Coils:
Ferrite rod aerial for long and medium wavebands with oscillator coils to suit.

points till no further improvement can be obtained, finishing off at point A.

Turn now to the long waveband. Close the gang capacitor fully, inject a signal of 175kc/s and adjust the core of L4 and the position of the aerial coil for maximum response. Tune in the Light programme on 200kc/s and check that the capacitor and the core of L4 are in optimum combination. Seal L2 in position with wax. Do not alter the settings of the trimmers C1 and C6.

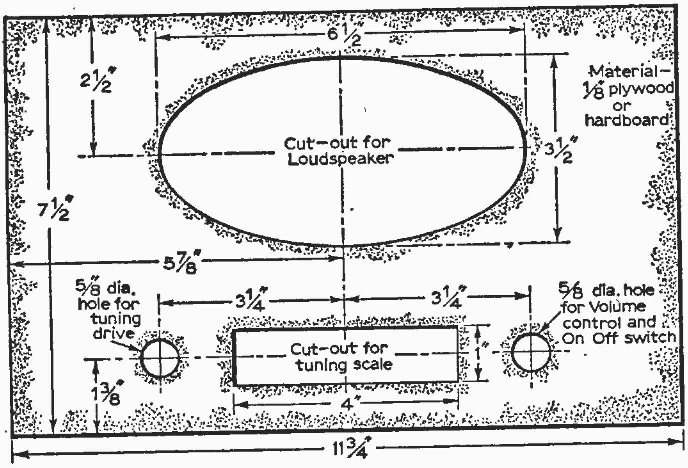

Fig. 8: Details of the front of the cabinet.

Alignment with no generator

This can be accomplished satisfactorily provided the i.f. transformers are pre-tuned. Commence with the medium wave signal and oscillator circuits as already described, using identifiable broadcast transmissions in place of the generator signals.

It will not be possible, of course, to check the coverage exactly but it is usually possible to find transmissions at or near the ends of the band from which a close approximation can be made. The frequencies of the transmissions selected for alignment points A and B are not unduly critical or difficult to find; Radio Luxembourg (1439kc/s) and the BBC Third programme (647kc/s) will be suitable in many areas.

On the long waveband, set L2 about ½in. from the end of the rod and manipulate the tuning capacitor and the core of L4 for optimum reception of the Light programme on 200kc/s. Adjust L2 for maximum and repeat once; fix L2 in position.

Cabinet

The cabinet shown in the illustration was made very simply from four pieces of ⅜in. plywood, plus a piece of ⅛in. hardboard for the front. No skilled joinery is needed, nor is there any painting, staining or french polishing to be done. Fig. 7 shows how the four pieces of ply are assembled.

Remember to cut a ⅝in. hole in the right-hand side for the wave change switch and a few holes in the bottom for ventilation.

The assembly should be given a rough sanding off, sufficient to remove any splinters, projections at the corners, etc. Nothing more than this is needed because the professional external appearance is achieved by covering the top and sides of the cabinet with laminated plastic as used on kitchen working surfaces, etc.

The top should be cut first, very slightly longer than the cabinet and ⅛in. wider than the depth, so that when fixed, there will be an overhang of ⅛in. at the rear, into which the back of the cabinet can be fitted. Fix it with the special impact adhesive sold for the purpose, taking care that the two

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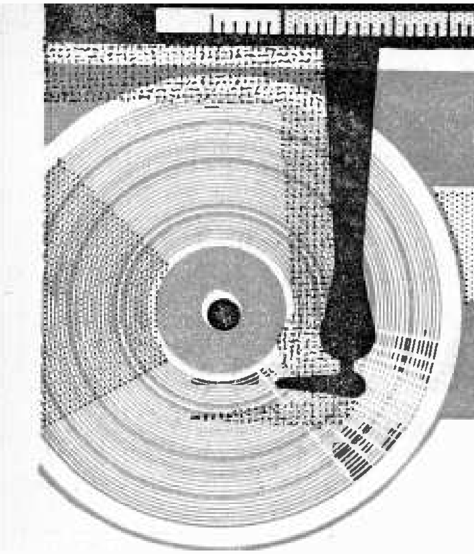


PARALLEL TRACKI UNIT

by E. H. GREEN

ALL disc records are produced by the cutting head moving across the record in a straight line passing just in front of the turntable spindle; this being for accuracy of movement and differential groove spacing. Most pick-ups move over an arc of a circle, this bringing in a tracking error which is to a certain extent counteracted by offsetting the head angle and making the needle swing slightly forward of the centre spindle, as shown in Fig. 1.

As the pick-up arm is increased in length the tracking error is reduced and an arm of infinite length, or parallel tracking, would produce no error.

Record Wear

There are two types of record wear, assuming the stylus is in good condition; (1) that due to the stylus downward pressure on the record and (2) that due to the stylus side load, moving the whole weight of the pick-up together with the bearing friction. The latter cause is sometimes in more expensive units, counteracted by offsetting the pick-up bearings, but there is still the inertia of the arm to overcome due to the acceleration of the arm inwards. The inertia loads of standard pick-ups, although small, are nevertheless quite real.

The value of the side force due to bearing friction is quoted as between 0·3 and 0·5 grammes in commercial pick-ups, which is more than the inertia loads, this being eliminated in the present design.

It is known that since the centre hole of a record is larger than the centre spindle of the turntable, in most cases a slight oscillatory motion of the stylus takes place. This motion must be transferred through the stylus to the arm and in doing so exerts a force on the record groove to counteract the inertia force of the pick-up arm. The weight of an average hi-fi tracking arm varies from about 5oz upwards to 1lb or more and, although the stylus pressure may be only five grammes, this whole weight must be moved bodily across the record together with the oscillatory motion. The main record wear is thus due to inertia forces and not the tracking weight.

Advantages of the Design

In the unit described here the tracking error has been eliminated and the record wear is about one-eighth of the normal value. The weight of the whole moving system is below 1½oz, including bearings, crystal cartridge and counterweight. Due to the method of construction it is impossible to measure any side load required to move the pick-up, thus the record wear is due solely to the tracking weight and the small inertia forces.

Due to the small inertia of the pick-up arm in the vertical direction the distortion due to the "pinch" effect is reduced. It is recognised that the pinch effect is a greater source of distortion than the tracking error.

The unit may be expected to give excellent

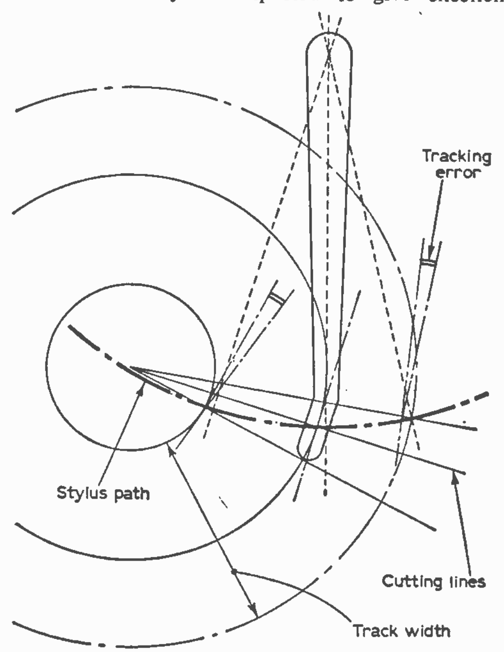
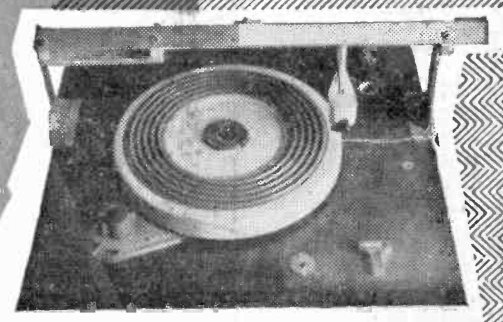


Fig. 1: Illustrating the tracking error to which the normal type of pick-up is subjected.

to minimise record wear



reproduction and reduced record "talk" from the needle, this latter being mainly due to the tracking error. However, a certain amount of adjustment is usually needed in setting up the equipment and eliminating any resonance in the moving part, particular attention being paid to the cartridge housing. An additional facility of the unit is that it enables the stylus to be put down anywhere on the record and removed without the risk of damage, as is easily done with conventional arms. It was found to perform very well with stereo cartridges and is useful for dubbing into a tape recorder, almost any passage being easily "logged" by the pick-up and scale.

The Basic Design

The cartridge is mounted on a small arm attached to a running angle and a larger V-bed is fixed across the turntable as shown in Fig. 2. Two small ball bearings are placed between the two units and the pick-up runs on these, being counterbalanced by a thin wire and a small weight.

The main framework consists of two vertical brackets fixed to the motor board carrying two square blocks which are attached to the main V-bed. One of the brackets has an elongated hole to allow for horizontal alignment, a detailed sketch being shown in Fig. 4.

All materials are light alloy and the V-bed may be made by either bending a strip or by using a piece of corner angle as used in furniture manufacture. If these are not available brass may be used, but steel or any ferrous metal is not recommended as it will induce hum into the pick-up leads.

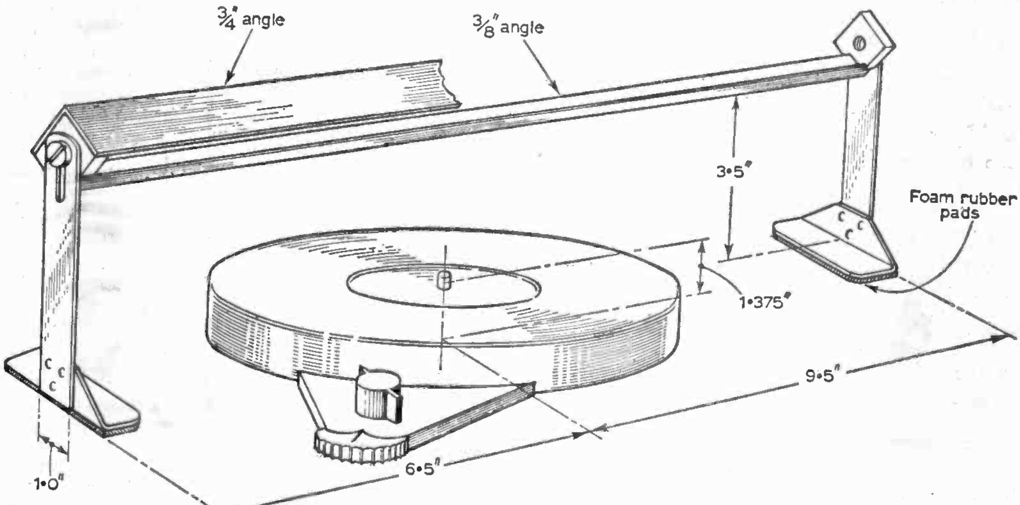
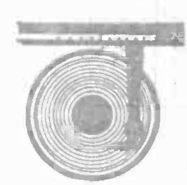


Fig. 2: The general construction of the cartridge running angle.

The ball bearings are ⅛in. car hub types and should have a very good surface finish.

The Pick-up Assembly

The pick-up assembly is shown in the dimensioned drawing in Fig. 3, all the pieces being 20s.w.g. alloy. Small triangular stops are glued in position as shown to limit the travel of the



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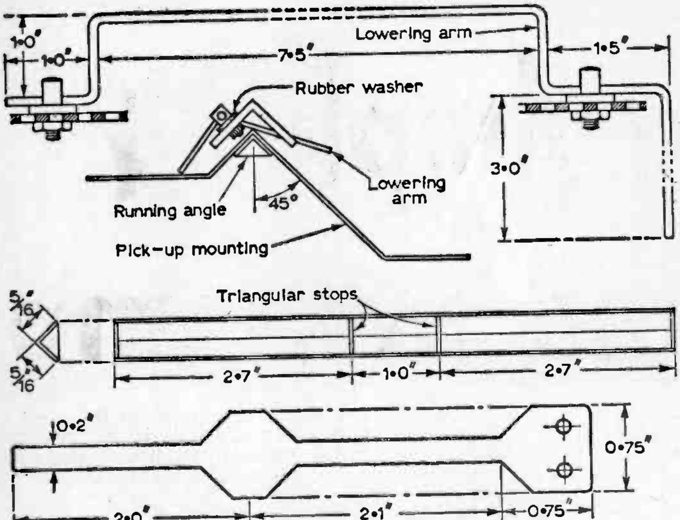

Fig. 3: Details of the lifting mechanism.

balls, the dimensions given being adequate to cover the standard 12in. l.p. with ⅛in. ball bearings. If the balls are of a different size the lengths can be calculated as follows: length of half-section = half travel length across record plus ball diameter. If the difference is too great the dimensions of the running angle and V-bed may need adjusting.

The bent arm is glued to the running angle as shown, the angles being only approximate. The glue used may be either clear Bostic or Araldite, care being taken to clean all the surfaces thoroughly if the latter is used.

The Lifting Mechanism

A bent piece of thick wire pivots on the top cover and bears on the rear of the pick-up assembly, the movement of the lever raising or lowering the pick-up. The wire, shown in Fig. 3 is long enough to allow the pick-up to be placed on the record in any position, a rubber washer supplying the friction to keep the wire in place.

The Cartridge Assembly and Mounting

The cartridge used in the original unit was the GC8, but the dimensions used will suit most turnover units. The lead-out wires are of 40s.w.g. enamelled or cotton covered wire and they are glued to the arm and led over the top of the running angle. Bostik or rubber solution being used for this purpose. After leaving the pick-up the wires are parted in a semicircle, as can be seen in the photographs, and pass through a small hole in the base-board. The wires should have sufficient length not to foul the movement of the pick-up along the bed for the width of the record.

The assembly is now placed in position on the base-board, small pieces of thin foam plastic being placed between the brackets and the board to spring the unit slightly. Place a record on the table and lower the pick-up on to it; ensure that the needle is running upright and not "digging in". The V-bed and running angle should be polished before assembly and occasionally during use as any roughness on these surfaces will impede the movement of the pick-up. Position the V-bed so the needle runs along a path exactly through the centre of the turntable spindle.

The Cartridge Housing

When the assembly has been finally positioned the cartridge is covered with a balsa wood and cardboard housing as shown in the photographs, the size being adequate to cover the turnover unit and is better to be larger than really necessary. The balance weight is mounted on a thin wire glued to the rear of the pick-up, the weight being a small collar and grub screw.

Final Adjustments and Testing

Before any record is played the balance weight is adjusted to give about five grammes or less as recommended by the pick-up cartridge manufacturer. It is possible to reduce the weight to zero, but a limit will be reached when the needle will jump out of the groove on loud passages as the reaction of the needle is not horizontal but has a vertical component which tends to push the needle out of the groove. On the front of the top cover is glued a scale marked in tenths of an inch and showing the let-down positions for 7, 10 and 12in. records, the marks corresponding to a line on the pick-up.

It is important to push the pick-up to the centre, beyond

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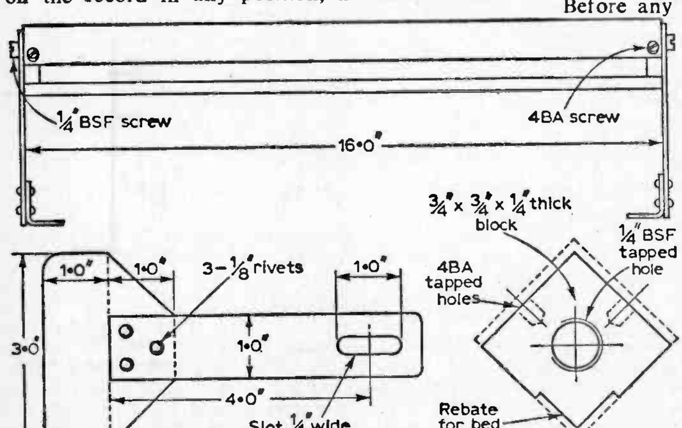


Fig. 4: Details of the running angle and its supports.

By A. Cole

Quality Amplifier and pre-amp

(Continued from page 911 of the February issue)

THE PRE-AMPLIFIER

THE pre-amplifier to be described is intended for those constructors who have built the main amplifier described in the two previous issues, but do not wish to build the tuner to be described in next month's issue, either because they already have another tuner they wish to use, or because they just desire a powerful gramophone-record or tapedeck amplifier system.

As was mentioned in the first article the sensitivity of the main amplifier is hardly sufficient for many high-fidelity pick-ups, so that for such a pre-amplifier is required, if one desires to maintain the high quality given by these types and not to revert to pick-ups of lower quality but higher output voltage.

The one-valve pre-amplifier here described is also usable for a large variety of general purposes requiring additional input amplification at audio frequencies, and on account of its simplicity and reasonably small size it may usually be mounted within the cabinet of equipment requiring it, and can be fed from the internal power-supplies of such equipment. A pre-amplifier of this type would also form a most useful "experimental brick" to have available in the workshop.

There is thus certainly every good reason for including this small article within this series. However, it is not intended to continue and conclude this text just with a description of the function of a single-valve audio-amplifier stage. This is so elementary, that very little would need to be said, and such theory has often enough appeared adequately-phrased for the beginner in other parts of this journal. It is, therefore, intended to devote the rest of this article to a clear discussion of some important points involved in the use of even such a simple circuit, which are probably by no means such common knowledge as the functioning of the pre-amplifier itself.

Hum Reduction

The heater supply for the pre-amplifier should come from a heater winding on the power supply which is not in any way connected to chassis, the commoning to chassis for one side being carried out *at the pre-amplifier,* as shown in the wiring diagram, Fig. 2. There is no danger to equipment if the heaters do not obey this specification, being already earthed at the main chassis since the supply is common to the valves there too, but hum levels are likely to be raised somewhat then. The h.t. negative should be earthed at all chassis involved, serving as the inter-chassis earthing.

Minimum hum is theoretically obtained if the screening of the cable from the preamplifier output (P2) to the main amplifier is earthed only to the main amplifier chassis, and if the screening of the input cable to the pre-amplifier is earthed to the pre-amplifier chassis at P1 and forms the only earth connection path for the input signal source. In the former case, for the output cable from pre-amplifier to main amplifier, there is in practice very little difference if the screening is earthed at both ends, which is probably more convenient in fitting the plugs. As far has hum alone is concerned, this is usually true also for the pre-amplifier input cable. But there is another most important consideration demanding that the cable

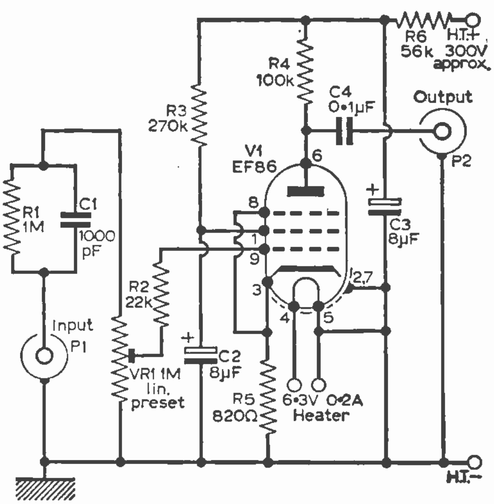


Fig. 6: The pre-amp circuit.

feeding the input signal to the pre-amplifier, **to P1,** should have its screening earthed to the pre-amplifier chassis at P1 and should carry earth connection to the signal source on its screening, the signal source receiving no other earth whatsoever.

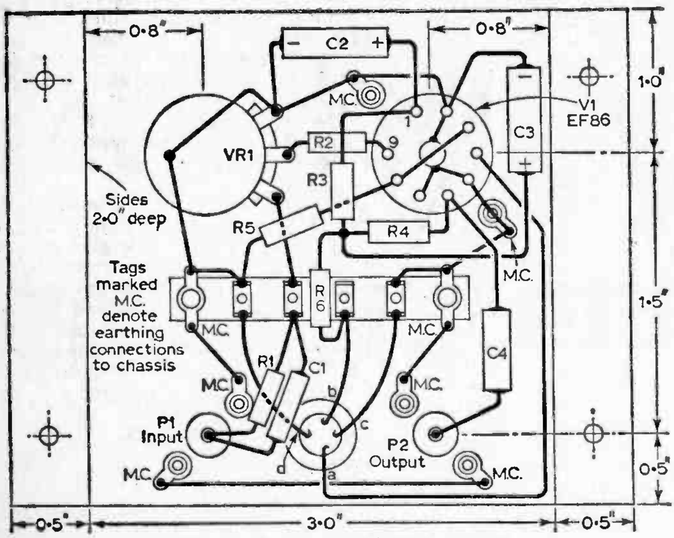


Fig. 7: The complete wiring diagram.

Positive Feedback Loops

Failure to observe this last condition runs the danger of causing the whole system to go into violent oscillation, because of positive feedback applied between the main amplifier output and the pre-amplifier input via crossed multiple earths. The frequency of this oscillation will normally be high, and is very often even supersonic, so that it is manifested merely as a reduction in tone quality and early failure of the output valves in the main amplifier, for reasons explained below, if one does not observe the output on an oscilloscope.

In less severe cases oscillation may not be permanently present, but may be triggered off by some transients of the signal proper, especially on bass-transients, then dying out after a few cycles. The actual feedback frequency is often not audible, but, because it over drives the amplifier, it cross modulates with bass and treble present in the signal proper being amplified, giving severely bad tone on transients.

If the input stage of a high-gain amplifier system receives any sort of casual, haphazard earthing, a part of its actual effective earth-path may turn out then to be common to the actual effective earth-path of the output load (loudspeakers) of the main amplifier. A voltage developed across this wire will be applied to the amplifier input and thus the conditions for instability are present.

The size of the unwanted feed-back-voltage will be directly proportional to the loudspeaker *current* and to the self-resistance of the common earthing section. If we have an output power of 20W peak feeding a 5Ω loudspeaker system, the loudspeaker current will be 2A. If the input sensitivity of the main amplifier plus pre-amplifier is 2MV for full power output, it only needs a thousandth of an ohm common earth-resistance in the loop to cause instability. A mere inch of connecting wire can have this resistance or more, so that instability is virtually unavoidable if the pre-amplifier input is given a multiple earth connection. The reason for the specified earthing method should now have been made quite clear.

Pre-amplifier Earthing

If the main amplifier is used alone, the required input for full output power is about 200mV, so that some two or three yards of common earthing are needed before a feedback voltage of this magnitude is set up.

If the full-power output of the amplifier were less, loudspeaker current maxima are less, so that for the same gain, larger earthing loops are tolerable before instability occurs. It is thus clear that the dangers of this form of instability are particularly great for high power output (push pull) amplifiers, as soon as these are brought to high gain by fixing up a pre-amplifier at the input. More cases of failure, or disappointment at results poorer than expected, in high power audio amplifiers may probably be attributed to this cause than to any other single cause except v.h.f. parasitics due to improperly designed grid circuits.

The only certain way of avoiding this trouble in a high power amplifier with pre-amplifier is to give the entire pre-amplifier input grid circuit only one single earthing point, located near the valveholder on the pre-amplifier chassis. The many earthing tags on the tiny chassis of the pre-amplifier (Fig. 7) are for better contact, and are to be considered as a single point at the frequencies concerned, though this would no longer be true at v.h.f., where true single contacts would be needed, and are familiar practice.

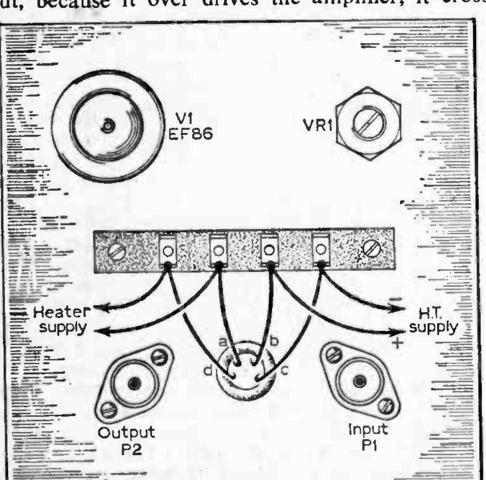


Fig. 8: The above-chassis layout of components.

Dangers of Over-Drive

An important point in the operation of

Class-A or Class-B push-pull audio amplifier using high power valves other than triodes is that strong over-drive, especially such as present if the amplifier is unstable and goes into oscillation, causes the severest strain on the output valves. This is because inductive transfers of surges, via the output transformer windings, can totally remove all anode *voltage* from each valve on a portion of each cycle. This results in powerful current-pulses on the screens, possibly far beyond the peak ratings of the valves. This is easily observed as a powerful glow in the over-driven valves, due to the screen-grids going bright red-hot. Readers who have observed this phenomenon may have been very puzzled, as a meter in the main h.t. supply shows a decrease of total current rather than an increase, but at any rate little significant change, in a class-A push-pull stage.

It is thus most necessary to avoid permanent supersonic instability, quite apart from the deterioration of tone thereby caused, for such instability causes a permanent condition of over-drive in the output stage, giving very much shortened valve life. Overdrive on a signal is also to be avoided.

Pre-set Volume Control

For this reason the volume control on the pre-amplifier is made a pre-set type. The proper and correct adjustment of this control is one giving *just* full-power output at the maximum setting of the main amplifier volume control, with the intended signal source (pick-up) feeding the pre-amplifier. This setting also minimises dangers of instability, because the total gain is thereby set at a level no more than absolutely necessary.

Output Cathode Resistor

The value of the cathode resistor, R25 in Fig. 6 (see January issue), for the main amplifier push-pull output stage has a strong influence on the amount of damage done by prolonged overdrive. If the small value of 90Ω is used, as specified, to keep the amplifier operating entirely in Class-A, and so give the very best tone quality, dangers of overdrive are unfortunately at their greatest. The completed amplifier, once a pre-amplifier is fitted and everything finalised in the manner it is intended to be used, should then be checked for supersonic instability with an oscilloscope connected to the output, for all possible settings of the controls. The correct setting of VR1 on the pre-amplifier, to make overdrove impossible with the intended signal source, is also then most important.

Dangers are reduced if R25 is raised to the value of 130Ω in Fig. 6 of the main amplifier, though strong overdrive still gives noticeable glow on the screens of the output valves. The actual usable output power is in fact increased by this change, but the quality very slightly reduced. It is probably advisable to use the higher value, 130Ω, for R25 in all cases where various undefined signal sources are to be used, making it impossible to set VR1 on the pre-amplifier to a position preventing overdrive on stronger sources, yet giving adequate output on the weaker ones.

Input Signal Equaliser

The network connected between P1 and the top of VR1 in the pre-amplifier should suit the type of pick-up or other signal source which it is intended to employ. The components C1, R1 here specified are to match the Collaro "Studio TX88" pick-up used in the prototype. Manufacturers' instructions should be followed for other pick-up types, and the value of VR1 may be changed if other values are specified. A linear potentiometer should be used for the preset volume control.

Other Valves

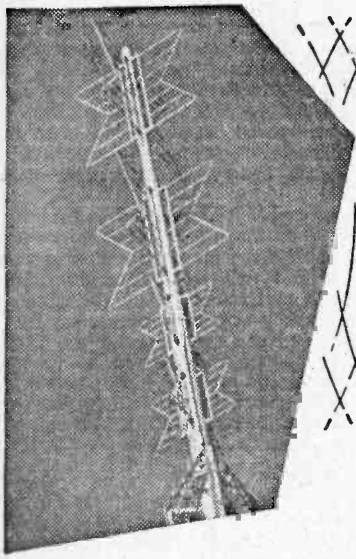
No other common valve is so well-suited for this pre-amplifier as the EF86, which is specially designed for this function. It has low microphony and special internal screening. If other types are desired, then the triode-section of double-diode-triode types used in normal superhets in the detector/a.v.c. first a.f. stage are the next mos advisable.

(To be continued)

The World's Largest Valve

What is thought to be the largest thermionic valve in the world will be used for research into the upper atmosphere—sponsored by the Minister of Aviation—at Great Baddow, near Chelmsford. It is 18ft long, over 7ft high, 6ft wide and weighs 4½ tons. The task of constructing the valve was that of the Admiralty's Microwave Electronics Division of the Services Electronic Research Laboratory at Harlow, Essex.

The valve is a travelling wave tube and will provide 100MW pulses of energy at a frequency of 420Mc/s. Power is obtained by interaction between a radio wave travelling along inside the valve and a beam of electrons travelling at about the same speed. By suitable design it can be arranged that the electrons give up about half of their energy to the radio wave, and thus a very high power can be obtained if a high energy electron beam is used. To obtain 100MW of radio power, a 250MW beam is necessary, in which the electrons are travelling at 4/5ths the speed of light. The electrons are accelerated to this velocity by means of a modulator which gives pulses of up to 500,000V at 500A



On Your Wavelength

By THERMION

I MUST commence this month's remarks by thanking all those readers who have sent me copies of the notes which I referred to in the last issue. They had apparently written for details and after making the necessary notes had sent them on thinking I would be interested.

It was very good of them and the thought is appreciated, but as will be seen from the page I had already had details of this particular device. My main interest in this connection is, of course, with the electronic type of device which utilises the more or less standard "Yes" "No" circuits, these being so arranged that they act as switches for the various channels, and so far all those which I have seen have been terribly expensive to make up.

It will be obvious that the first circuit may consist of two relays, transistors or valve circuits only, to provide one of two channels, but then to provide any degree of selection the next channel must consist of at least three circuits, and so on, doubling up in places to provide the necessary alternative routes. This naturally leads to multiple relays or transistors, etc. and the expense steps up alarmingly.

Old Components

As I have mentioned before, this interest in electronic devices of various types has led to the need to find various components which are not apparently now available, and I become more surprised every day at the number of various bits and pieces which at one time were commonplace but which now, due apparently to the increasing use of transistors and the consequent reduction in size of components, have apparently ceased to be made.

Two items which I recently wanted for a small unit were an ordinary audio transformer and some ½W carbon resistors. Many of the shops which I visited only stocked transistor type transformers, and I was informed at two or three shops that the larger "old-fashioned" component was no longer being made!

The same remarks apply to the carbon resistor. These now all seem to be the miniature ceramic-cased component and it is impossible to modify the value slightly as one could do with the older component, by filing away or scraping the component. Of course, r.c. coupling is now more or less universal in most valve equipment, as it is productive of much higher quality, but the old audio transformer used to be very useful in some circuits.

Those who can remember the early Ferranti components, with their sectionalised windings will probably hold that they gave as high quality as a modern r.c. circuit, without any of the latter's drawbacks, and I wonder if the Rev. Bonavia Hunt has changed his views on this particular item?

For many test set-ups, a 3d. carbon resistor which can be changed in its value is a much more interesting proposition than a 3s. 6d. variable component—and it takes up much less room. No, the modern experimenter seems to be at a much greater disadvantage than many of us "old stagers", who not only had to find out things for ourselves, but had the bits and pieces and the wherewithal with which to do it.

Two Hints

Now to end this month with two hints which may be found of use by some of those who find their main interest in "do it yourself experimenting". The first concerns the drilling of a chassis after a set has been made up and is working—perhaps for some form of modification.

A hole may be needed in the chassis, and there is a risk of the aluminium dust or drilling swarf getting into awkward or unwanted places in the set. The problem is how to keep it all together till the drilling is completed.

I get the necessary tools together and just before drilling the new hole, put a fairly large dab of Evostik or other rubber cement on both sides of the chassis, round the punch mark where the hole is to be drilled.

Immediately start the drilling, and as the cement is not too quick drying, all the chips and dust remain held fast by the cement.

When the hole is completed leave it for the cement to dry, and then carefully lift the edge of the "dab" with a penknife and peel it off, when it will bring away all the unwanted mess with it.

The other hint is to use a rubber grommet for holding resistors and small diameter capacitors when they may have to pass through a metal screen, and this will hold them firmly (if they are chosen of suitable size) enabling wiring to be carried out to them, removing their weight from the wiring with consequent reduction in the risk of broken connections, and if needed provide all-important screening in the wiring. Just small points but they can be very useful at times.

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TALKING POINTS ON CIRCUIT PRACTICE

No. 2—Calculating D.C. Values

IN the first article of this series, the general principles of D.C. Stabilisation of Transistors were explained. It is now proposed to explain how circuit values may be calculated.

In Fig. 1 is shown a transistor in grounded-emitter mode; Re is the emitter resistor, Rc the collector load and the Rb the base resistance (consisting in this circuit of R1 and R2 in parallel—as viewed by the base they are in parallel because if you short-circuit the supply battery for a moment it will be seen that they both go to the same point).

Suppose a sine wave applied across base and emitter at the points X-X. The negative half of the wave will move the base negatively across its standing bias and this will induce a rise in collector current by virtue of the properties of transistors.

The positive half of the wave will act similarly but will decrease the value of the collector current. (Note that polarities are reversed compared with valves.)

Thus a sine wave will appear in the collector circuit. It will, however, be of greater amplitude than the sine wave on the base. Amplification will have taken place. This is because the base admittance of the transistor is of only a few ohms resistance whereas the output resistance is several thousands of ohms: a small variation in base bias has influenced a large variation in collector current.

Transistor Gain

The amplification factor, which in transistor technique is referred to as the "gain" of the transistor, is the ratio of output current divided by input current and depends on the ratio of output resistance divided by input resistance—and it is given the symbol α. To make this clear: if a base input of 100mA induces a collector output current of 1000mA then the ratio is 1000/100=10, which is the α for that transistor.

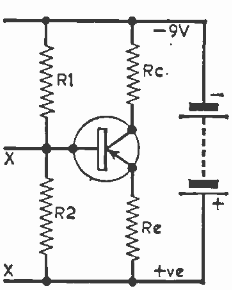

Fig. 1: A Transistor in grounded-emitter mode of operation.

Now let us suppose a case where the input sine wave is so greatly amplified that the negative half of the input wave causes a great increase in collector current that the load in the collector drops all the available voltage (only a meagre 9V anyhow) leaving the collector itself at no volts. Conversely, the positive half of the input wave reduces the collector current so much that none flows at all.

In the former case the transistor is termed "bottomed", in the latter it is "cut-off". In neither condition can it function properly. What occurs is that the incoming wave will move the collector current up to a point where it cuts off or bottoms as the case may be, beyond those points no further increase positively or negatively will be reproduced in the collector circuit, so that the wave in the collector circuit will appear as in Fig. 2 with the peaks of the waves "clipped".

Distortion will appear before the actual clipping point is reached, on the negative half cycle of the input wave, because of the "knee-volts" factor, see Fig. 3. Though from approximately 0·5 to 9V the characteristic is a straight line, below 0·5V on the collector it becomes hopelessly non-linear. As the increasing flow of current through the collector load on the negative half of the wave drops more and more volts, before the collector actually reaches zero volts it reaches the point where the non-linear characteristic sets in. The voltage should not in fact be allowed to drop even as far as the knee-volts point but on peak signals should be kept a tenth or so of a volt above it.

Either the incoming signal, therefore, must be kept *small* enough not to swing the output current so far that the consequent voltage drop across the collector load will drop the collector volts to the small value represented by the knee-volts point; or else the constants of the collector circuit must be adjusted to be sufficiently large (disregarding the load) that it can *take* the swing, without distorting or clipping.

In order to know what the current swing in the collector circuit is going to be for a given current swing of signal on the base, we have to know the amplification factor of the transistor α.

Unfortunately with transistors this is just what we don't know, because the gain of a transistor depends on the ratio of its input and output impedances and both these vary according to the amount of current passing through them, according to frequency and according to temperature. A transistor is "non-resistive"; it does NOT obey Ohm's Law. That is the first thing we have to realise.

If the "gain" varies, as it must if the resistances determining it vary, what value can we state for α?

There are, in fact, a lot of values for α in any one transistor, and they will be different again if you change the transistor.

Different Gain Symbols

This has necessitated a symbol for α which will state, within limits, under what conditions the value of it was measured. Thus, in order to show that α was measured in grounded emitter mode and not in grounded base mode for instance, we prime it with a dash α'. In order to show that it was measured at zero frequency (d.c.) we put a small nought below it: α'_0. And if it was measured at large current values and not small ones, we would put a bar over it: $\bar{\alpha}'_0$. To cover the differences between various individual transistors the makers themselves publish three different figures for α: the smallest you are likely to find, the average, and the highest. They also state the temperature conditions.

The fact that the base admittance resistance (the resistance in the base-emitter path) is not a constant value has another important effect, in an a.c. sense. It will distort the incoming signal if steps are not taken to prevent or minimise it, because it requires a constant resistance to give a faithful rendering in terms of voltage changes across it, and if the resistance itself is varying anything can happen, and usually does!

In order to minimise this, the resistance of the source which is driving the base should be very much higher than that of the base itself, so that the proportion of stable resistance to that of unstable, in effect, swamps out the unstable part.

A transistor is usually driven by the output circuit of a previous transistor and in this case satisfactory conditions are created because the output resistance of a transistor is high—several thousand ohms, as against the base resistance of the transistor it is driving, which is something like 50Ω or so only.

In fact, the output resistance of a transistor is effectively, in r.c. conditions, that of the collector load resistor because this is in parallel with the output resistance of the transistor itself, *as seen by the collector* (short circuit the supply battery again, to see this). But as the collector load resistance is usually several thousand ohms it is still sufficiently high to drive a following base with minimum distortion.

Thermal Stabilization

Now let us examine the effect of these facts.

The collector load resistance, as stated in the previous article, should drop half the supply volts in order to secure effective thermal stabilisation. But to calculate the ohms necessary to do this we must know the amount of current that will be flowing.

Most transistor circuits for small signal conditions adopt a nominal value of 1mA for the current in the collector circuit. It may be a little less in earlier stages in cascade, where the input signal is still small, and a shade higher in later stages where a bigger signal must be handled, but 1mA is the standard.

Given a collector current of 1mA we can evaluate the collector load as 4,500Ω; that is, the value necessary to drop 9 to 4·5V at 1mA. This however includes the emitter resistor if one is fitted, which will have to be subtracted to get the actual collector load value, since the emitter resistor is in the collector circuit also.

The larger the value of the emitter resistor the

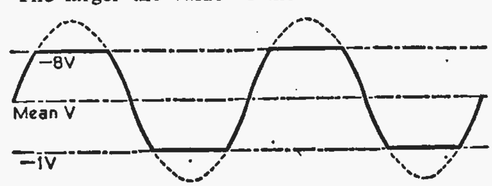

Fig. 2: A collector circuit waveform illustrating the clipping effect due to "bottoming" and to "cut-off"

better the stability, but we cannot let it drop too many volts when we only have 9V to start with. We found that if the emitter resistor drops from half to one volt we shall have reasonable working conditions. To drop 1V at 1mA requires 1,000Ω. This subtracted from the 4,500Ω leaves 3,500Ω for the collector load resistor itself.

We come now to the values of R1 and R2, the potential divider. As seen by the base, these resistors are in parallel (short-circuit the supply battery again and you see that both go to the same point).

The value of Rb, as we have seen, should for good stability be at least ten times that of Re—which is 1,000Ω. Rb must therefore be approximately 10,000Ω.

How to split up two resistors which are 10,000Ω in parallel sum, so that they will give us the 100μV, approximately, required on the base as bias?

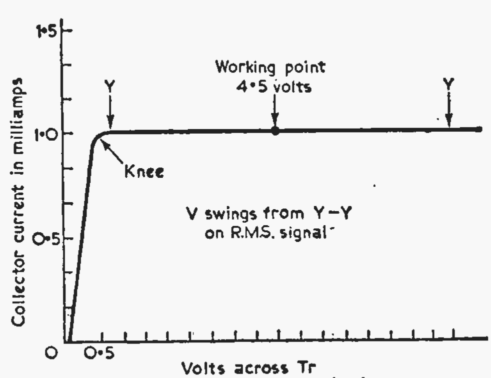

Fig. 3: Typical collector current v. collector volts characteristics.

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Here we must remark that in arriving at a figure of 10 x Re for Rb we were faced with several contradictory requirements for this potential divider. To begin with, it should be low in order to keep the base potentials as stable as possible (bleed as large as possible in relation to actual current taken by the base itself). But if it is too low it will take too much from the battery. It will also, being in shunt with the output resistance (as already explained) of the previous stage, effect the effective resistance of that in relation to the base it is driving, and in audio stages would shunt out the lower frequencies as well.

Ten times Re is therefore a compromise.

Calculation of Base Resistance

Now for the actual values of R1 and R2. The potentials which will exist at the junction, where the base is tapped on, will be determined by the various currents flowing in the chain. We have the base current itself, flowing through Re, thence through the internal resistance of the transistor to the base (the base leakage current plus the base current due to the base bias). Thus volts will be dropped over Re, and they will be dropped again over the internal resistance between emitter and base. The emitter will be negative to base, therefore, and the base itself slightly negative to emitter. But the drop over Re will be considerable because this has the collector current as well as the base current. So, with the emitter dropping 1V the base is going to be at 1V plus (negative).

The potentials developed in the potential divider will be due to the bleed current through the two resistors in series (as seen by the 9V line) plus the base current itself flowing through the two in parallel (as seen by the base).

The respective values of R1 and R2 can be worked out from the formula:

$$R1 = \frac{\text{Supply volts} \times \text{External Base Resistance (Rb)}}{\text{Volts base-to-earth (Vbb)}}$$

$$R2 = \frac{\text{Supply volts} \times \text{External Base Resistance (Rb)}}{\text{Supply volts} - \text{volts base-to-earth (Vbb)}}$$

The supply volts we know. The external base resistance Rb we have fixed at 10 × Re; namely 10,000Ω in this case. We have not evaluated Vbb. The potentials on the junction of the potential divider will be the product of the various currents flowing. The formula to evaluate Vbb, therefore, is:

$$Vbb = \left(Re + \frac{Rb}{\alpha'} \right) Ic + Vbe$$

Where Rb is the external base resistance; Ic the collector current; and Vbe the required voltage across base-emitter as stated in the published data (Fig. 4).

R1 will be somewhere around 66,000Ω in the example we have been working on, with R2 around 10,000Ω.

It would not be proper to conclude at this stage without remarking that many published circuits may appear to use values which differ considerably from those we have explained above.

We have proceeded hitherto on the assumption that the collector load resistance was going to drop precisely half the supply volts, therefore producing automatic thermal stability.

We have made no attempt to evaluate exactly what might happen in the circuit if all the values we had assumed for the transistor were in fact way out; if α for instance which we had taken as a stated value of 40 were in fact in this particular transistor 80; if the leakage current in the collector (which may be defined as the current which would exist through the transistor before any bias was applied at all; i.e. with the base open-circuited) given as a nominal 100mA were in fact nearer 200 (and under some circumstances it could even be milliamperes); and if the stated value of say 100μV for Vbe (volts base to emitter) were also way out.

Neither has there been any attempt to consider that all these values could change again if the temperature at which the transistor was operating increased—and change disastrously.

We are not going to evaluate them now, either; for the calculations involved would be beyond the scope of this article.

In the main, the effect of adverse changes in any of these factors would manifest itself in the form of an increase in collector current—which would in turn increase the temperature at which the transistor was working, if it increased the dissipation. So that the *maximum* collector current under these conditions could be a good deal more than the 1mA we started with.

What we *can* do, without working it out in detail, is make an automatic allowance for these possibilities—such as a change of transistors for instance—by *assuming* a value to which the collector current might rise owing to these variable

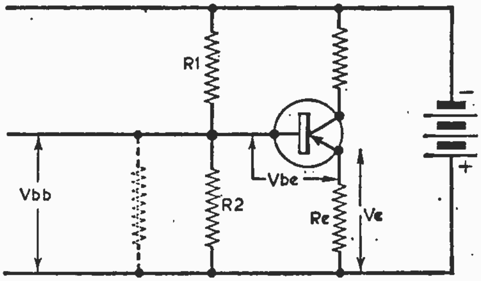


Fig. 4: The method of determining the values for R1 and R2 is explained in the text.

factors; and make correcting calculations accordingly.

Collector Load

Let us then assume a value for *maximum collector current*. with a nominal current of 1mA. Let us put I Max at 1·5mA, and re-calculate the value of our collector load resistance on that basis.

But we can make a corrected value for our supply volts, also. In fact, if the actual voltage on the collector is not to drop below the knee-voltage plus a couple of tenths more to keep the peak signal well clear of the knee-voltage, the last volt before zero volts is reached will never be used. In other words, the "minimum voltage" across collector-emitter will never be less than one volt; it will swing from 1V positive to 8V negative. We are assuming a large value for knee-volts and margin than is necessary; 0·5V would be enough in most cases. But we are dealing with principles rather than actual values, so 1V let it be.

Instead of 9V, therefore, we only have a supply voltage of 8V: that is, supply volts (battery volts) minus knee-volts plus peak-signal allowance.

To evaluate the collector load resistance, then, we now divide *true* supply volts by *maximum* current, i.e. 8V by 1·5mA. This will give us the corrected figure of 5,300Ω for the resistance in the collector circuit (Rc+Re). With 1,000Ω as before for Re, that leaves 4,300Ω for the actual collector load.

To evaluate whether the collector loads will drop half supply volts or more at nominal collector current: 5,300Ω at 1mA will drop 5·3V—which is more than half the supply, and we therefore have a good margin of safety.

The other calculation is for temperature. Transistors are rated for a maximum temperature and this must not be exceeded by more than a degree or two.

We need to know whether the actual temperature to which the transistor will rise at *maximum* current will exceed the maker's limits or not. The published data will give a figure for Maximum Ambient Temperature. We have already evaluated maximum current. Related to watts, the maker will also give us a diagram relating maximum permissible watts to ambient temperature.

The actual junction temperature to which the transistor will rise at maximum current is given by the following formula:

Tj=Max. Amb. Temp. + θ (max. current) (minimum voltage).

As an example: maximum ambient temperature may be given as 45° C (per mW). θ is a constant which is also stated in the published data for the transistor in question and we may take it as 0·4° C. Maximum current we have taken as 1·5mA, and minimum voltage as 1V.

Substituting:

$$45 + 0{\cdot}4(1{\cdot}5)\,(1) = 45{\cdot}60$$

which is inside a couple of degrees above 45, so we have a good margin of safety.

This is of necessity an imperfect analysis and we have taken liberties with the mathematics in the interests of simplicity. It far from exhausts the subject, referring as it does exclusively to transistors in the grounded-emitter mode, and in small-signal conditions, with r.c. couplings. Also, we have not considered the radio frequency aspects at all or those of large signal audio stages.

But if we have managed to add a little to anyone's understanding of these fascinating modern forms of the old Hertzite and Galeium crystals, and encouraged some who may have been hesitating, to tackle this new field of experiment, then go ahead! There are so many artifices one can produce—from automatic parking lights for your car which come on when darkness falls and go out again when day breaks, to transistorised burglar alarms around your strawberry beds! The whole subject of transistors is continually developing and is wide open to the experimenter and rich in excitement and reward.

MAINS SUPERHET RECEIVER

(Continued from page 1015)

surfaces come together in exactly the right position at the first attempt—they are extremely difficult to separate once contact is made.

Allow an hour or so for the adhesive to harden and then trim the ends of the laminate accurately with a file. The sides can then be cut, fixed and trimmed in similar fashion, again cutting very slightly longer than the height and ⅛in. wider than the depth.

Finishing

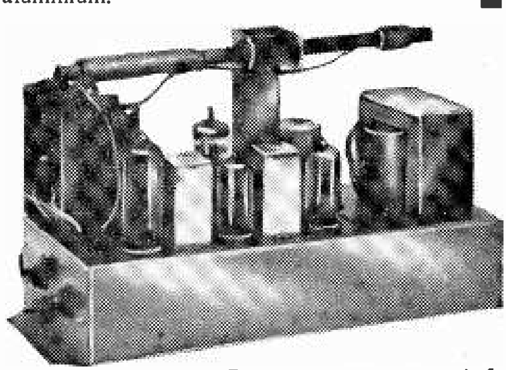
The next operation is to fit the loudspeaker and cover the whole of the cabinet front with loudspeaker fabric secured with adhesive; make sure that good positive attachment is obtained round the edges of the apertures. When the adhesive is dry, holes should be made for the control spindles and the fabric over the tuning scale aperture should be cut diagonally, folded back through the aperture and stuck to the rear of the hardboard.

If the perspex window is now cut accurately to size, it will be a tight push fit into the aperture. The front must now be treated with some kind of trim to hide the edges of the speaker fabric and hardboard.

Fitting the Receiver

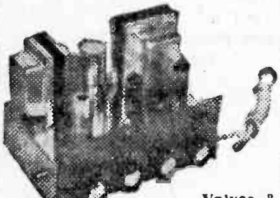
Reduce the length of the wave change spindle to ½in. and cut the other controls to the required length. Place the receiver in position and drill upwards through the bottom of the cabinet and through the chassis end flanges, two holes about ¼in. diameter at the mains transformer end and one at the other.

The chassis can then be secured by bolts or, if the holes in the wood are enlarged, by wood screws inserted from below, of such diameter that they will have a self tapping action as they enter the aluminium. ■



The prototype receiver ready for installation into its cabinet.

MULLARD 3-3 HI-FI AMPLIFIER



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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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Cabinet Price **£3.3.0** Carr. & Ins. 5/-.

Contemporary style, rexine covered cabinet in two tone maroon and cream. Size 18½ x 13½ x ht. 8½in., fitted with all accessories including baffle board and anodised metal fret. Space available for all modern amplifiers and autochangers, etc. Uncut record player mounting board 14 x 13in. supplied.

2-VALVE 2-WATT AMPLIFIER Twin stage ECL82 with vol. and neg. feedback Tone control. A.C. 200/250 v. with knobs. etc., ready wired to fit above cabinet, £2.17.6. P. & P. 1/6.
6in. Spkr. & Trans., 22/-. P. & P. 2/-. Complete Kit, including UA14 Unit as illustrated, £12.19.6. carr. 7/6.

JACK PLUGS. Standard 2¼" Igranic Type, 2/6. Screened Ditto, 3/3. Miniature 1¼", 2/3. Screened Ditto, 2/6.

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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 meg-ohms 20% ¼ and ½ W 3d., 1 W 5d. (Midget type modern rating) 1W 6d., 2W 9d. **Hi-Stab** 10% ½W 5d., 1W 7d. 5% ½W 9d., 1% ½W 1/6.

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DISTORTION

HOW IT IS CAUSED AND HOW IT IS CURED

by Gordon J. King

RADIO receivers and amplifiers are subject to two basic types of distortion. One is called "amplitude distortion" and the other "non-linearity distortion".

Amplitude Distortion

An amplifier is suffering from amplitude distortion when it fails to give equal amplification to all signals within its working frequency range. This is illustrated in Fig. 1, where the input signal is shown by the broken line and the output signal by the continuous line. In spite of the input signal amplitude being constant from about 20c/s to 10,000c/s, the output signal amplitude varies widely over the same range of frequencies, and is flat only from about 100c/s to 1,000c/s.

This shows that the amplifier is frequency selective in that it gives greater amplification to signals between 100 and 1,000c/s than it does to signals below 100c/s and above 1,000c/s.

Ideally, the a.f. stages in a radio receiver should amplify signals from about 30c/s to 15,000c/s evenly (Fig. 2). Good quality hi-fi amplifiers do far better than this and amplify evenly from about 15c/s to 50,000c/s. Although we can only hear frequencies up to about 15,000c/s—the exact frequency depending upon age—there are various acoustical reasons why an amplifier should respond

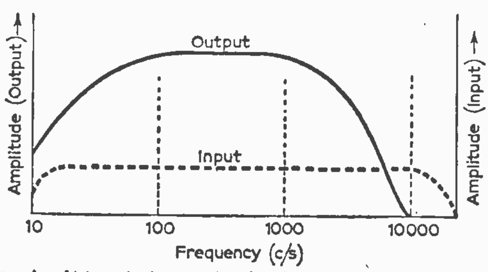

Fig. 1: Although the amplitude of an input signal (broken line) is constant over the a.f. spectrum, the amplitude of an output signal (continuous line) varies widely over the spectrum.

well above this frequency—but that is another story!

In domestic radio practice, reproduction sounds quite good provided there is no marked fall-off in amplification below about 8,000c/s and above 100c/s (Fig. 2). However, in reality, this is often far from the case. Loudspeakers and baffles on most popular receivers are usually incapable of giving an output at 100c/s, while adjacent station interference on the L.W. and M.W. bands makes it

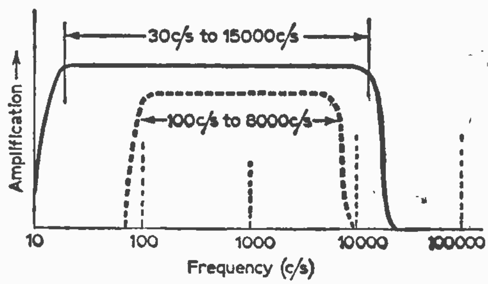

Fig. 2: An ideal amplifier provides even amplification from 30 to 15,000c/s (continuous line), while a practical amplifier may have a response as shown by the broken line.

impossible to keep a sufficiently wide i.f. passband to carry the sidebands of the higher audio modulation frequencies.

Thus, there is little incentive for the designer of a popular receiver to optimise the a.f. response. This does not apply, of course, to radiograms, where an extended amplitude frequency response is necessary for good quality reproduction of records.

Sideband Attenuation

When a carrier signal is modulated, two sideband signals are produced. These are called the upper and lower sidebands, and they are equal to the carrier frequency plus or minus the modulation frequency respectively. With a carrier frequency of, say, 470kc/s—which is the standard broadcast i.f.—modulated with a 10kc/s (10,000c/s) signal, the lower sideband is 460kc/s and the upper sideband 480kc/s. For these sidebands to be conveyed through the i.f. stages of the receiver without attenuation, the i.f. response must be sufficiently wide to accommodate them, as shown in Fig. 3.

Unfortunately, at medium broadcast frequencies such a response is entirely out of the question since adjacent stations are present within 10kc/s of the wanted station on certain parts of the band. The desirably wide i.f. response would thus accept not only the wanted station and all of its sidebands but also some of the sidebands of the unwanted adjacent station (Fig. 4). This would cause very bad interference—far more disconcerting than a restricted high frequency a.f. response.

It is necessary, therefore, to limit the i.f. response so that near adjacent stations and their sidebands are greatly attenuated (Fig. 5), but this practice, of course, attenuates the higher frequency sidebands of the wanted station.

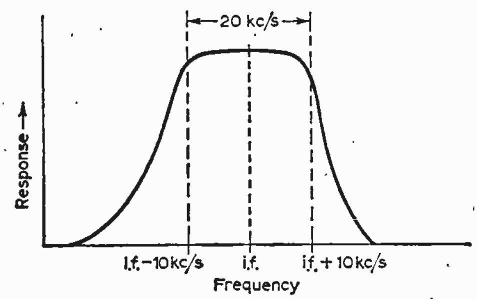

Fig. 3: To cater for modulation sidebands up to 10kc/s without attenuation, the i.f. response should be as shown.

The foregoing reveals, therefore, that considerable amplitude distortion just cannot be avoided on the L.W. and M.W. bands, even though the detected signals may be applied to a hi-fi audio amplifier.

Frequency Modulation

This is one of the reasons why frequency modulation on the v.h.f. bands was introduced by the BBC. Careful grouping of the v.h.f. stations makes it impossible for an adjacent station to fall within the i.f. passband of the required station, and as much more room is available in the v.h.f. regions, each f.m. channel can have approximately 200kc/s all to itself. This is adequate to handle the very highest f.m. sideband, which means that responses up to 15,000c/s are possible at f.m., provided they are present at the transmitter.

The majority of small a.m.-only sets do not give much output at audio frequencies above about 4,000 to 5,000c/s, but good quality f.m. sets may go as high as 10,000 to 15,000c/s. The falling high frequency a.f. response due to i.f. passband limiting on a.m. sets does not occur suddenly, but it tails off gradually. One can easily widen the i.f. passband, of course, by carefully realigning the i.f. transformers, preferably with an oscilloscope and wobbulator, but if this is done, the set will be useless on all but the very local station for reasons of adjacent channel interference described above.

Nevertheless, a top response up to about 4,000c/s is quite reasonable, and quite a few listeners feel that even this is too high, and cut it more by turning on the tone control! The tone control on the majority of popular sets is nothing more than a "top cut" control which attenuates the higher audio frequencies in the a.f. circuits. With maximum top cut, the response may not extend to more than about 3,000c/s. This is even practised by the "non-musical" on f.m. receivers, which are usually truly capable of giving a good top without adjacent channel interference and other distortions.

Non-Linear Distortion

This type of distortion can be much more disconcerting than frequency distortion, and it results due to some non-linearity in the amplifier valves, transformers and associated circuits. With an amplifier which is perfectly linear, any increase or decrease of input signal produces a corresponding increase or decrease of output signal over the voltage or power working limits of the equipment. This can be represented as a perfectly straight line on the transfer characteristic, as shown by the unbroken line in Fig. 6.

Unfortunately, however, no amplifier has such an ideal transfer characteristic, for due to the action of the valves and other components, the characteristic curves slightly, as shown rather exaggerated by the broken line in Fig. 6. This means, then, that the output signal does not follow perfectly faithfully any variation in the input signal. In practice, particularly in hi-fi amplifiers, the transfer characteristic is almost linear up to the overload point of the equipment and then it really starts to curve. This is one of the reasons why hi-fi amplifiers are relatively highly powered for within the normal domestic working power range of the equipment the linearity is very good indeed. With a lower powered amplifier, full domestic output may cause the signal to traverse the non-linear top part of the characteristic with consequent bad non-linearity distortion.

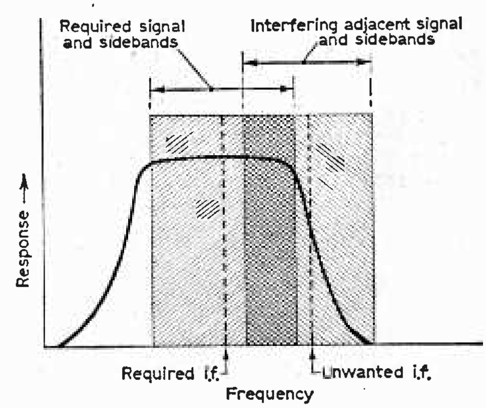

Fig. 4: A wide i.f. response cannot be used on medium broadcast frequencies owing to the breakthrough of an adjacent programme and its sidebands.

Non-linearity destroys the quality of reproduction mainly because it creates harmonics of the original signal. It thus introduces spurious tones

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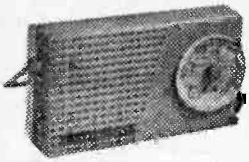

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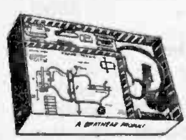

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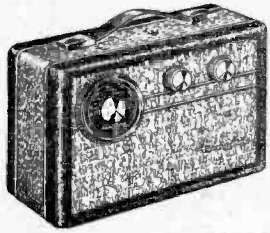

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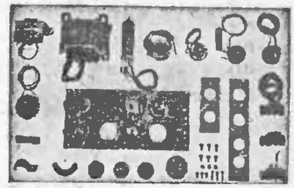

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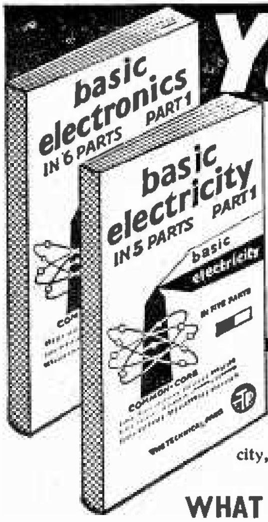

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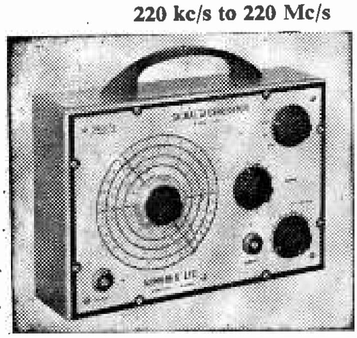

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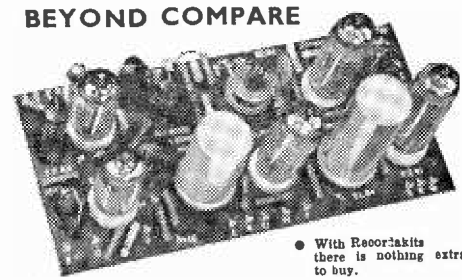

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which are not present in the original. Harmonic distortion is measured in terms of a percentage relative to the fundamental signal. This means that an amplifier which has, say, 10% harmonic distortion at 10W output creates 1W of spurious harmonic signal!

Total harmonic distortion is the square-root of the sum of all the various harmonics produced. A pentode output valve, for example, gives most third harmonic distortion (with other harmonics at smaller amplitude), while a triode valve gives most second harmonic distortion. With push-pull amplifiers, the second and even harmonics are largely precluded by cancellation in the balanced load of the output transformer, and the third and higher-order odd harmonics are most troublesome. These, however, can be very much reduced in amplitude by the careful application of negative feedback and by running the valves well within their power handling limits.

In the early days, triode valves were popular in the output stages of high quality amplifiers, because as these produce mainly second harmonic distortion, running them in push-pull gives almost complete second harmonic cancellation and good quality output without too much negative feedback.

The amount of non-linearity may not be constant over the entire frequency range of the amplifier. Indeed, towards the low frequency end it may rise considerably due to the speaker transformer being insufficiently large to act as an effective load. This is the direct result of small

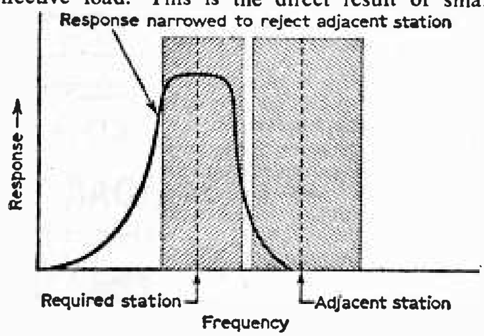


Fig. 5: To avoid adjacent station breakthrough the i.f. response is narrowed, but this also results in the attenuation of the higher sidebands of the wanted station.

primary inductance (and why output transformers in hi-fi amplifiers are remarkably large affairs), and if a set with a small output transformer is enhanced in bass response, very high order harmonics are produced.

Peaks in the response of loudspeakers, chokes and output transformers can also greatly aggravate harmonic distortion by causing the output to peak in the frequency range where the harmonics occur. This is rather like inadvertently tuning the amplifier so that the greatest output is obtained on the harmonics!

Other causes of Non-linearity Distortion

The main cause of this distortion is overload in a valve. This can happen due to the application of too great an input signal, low emission valve, incorrect biasing, incorrect anode, screen and heater voltages and poor design.

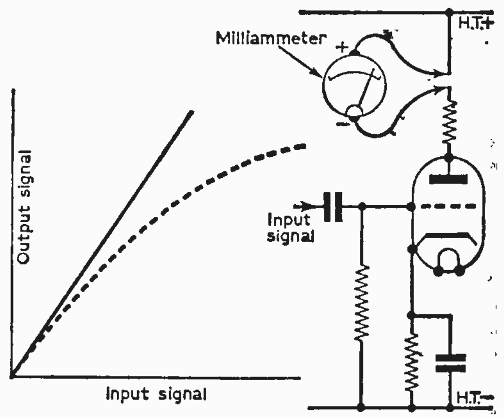


Fig. 6 (left): Transfer characteristic which shows perfect linearity (continuous line) and poor linearity (broken line). Fig. 7 (right): In stages with a high resistance in the grid circuit, non-linearity distortion can be gleaned by connecting a milliammeter in the anode circuit and observing the kicks on the needle with the stage carrying a signal.

A twin-beam oscilloscope is a useful device for investigating a.f. distortion in conjunction with an a.f. signal generator. One beam can be connected to the signal applied to the amplifier stage from the generator, while the other beam can be connected to the output of the amplifier. By adjusting the two Y-gain controls two traces of equal amplitude can be obtained on the screen representing the applied waveform and the output waveform. By careful use of the shift controls it is then possible to get one waveform to fall on top of the other, thereby giving visual indication of any difference between the two in terms of distortion on the output waveform.

The signal from the generator can then be increased, when the point of bad distortion will be evident by the output waveform differing considerably from that of the input signal. Another method of checking for distortion in Class A amplifiers is to introduce a milliammeter in the anode circuit of the valve (Fig. 7) and observe the needle with the stage carrying signal. Under true Class A conditions and zero distortion there will be no movement at all of the needle. Distortion, however, will show up as the needle kicking on loud signals.

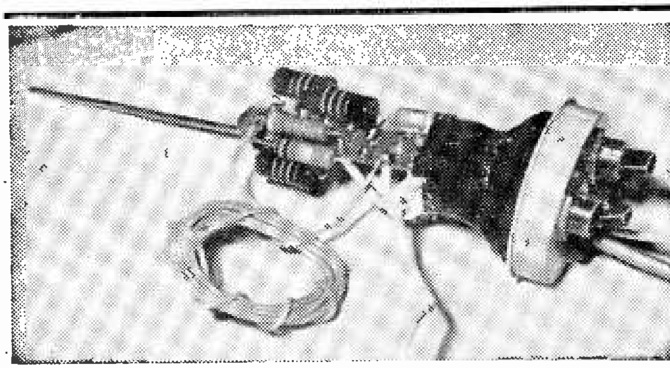
A downward kick (reducing current) usually means that the valve is passing grid current on the positive peaks of the signal. This could result from insufficient grid bias, low emission valve and incorrect grid components.

An upward kick, on the other hand, is symptomatic of anode-bend rectification on signal peaks, and is often caused by too much bias voltage (check the cathode resistor), a low emission valve, incorrect anode load resistance and low h.t. voltage.

Note that a disturbance to the biasing is frequently caused by a leak in the coupling capacitor at the grid from the anode of the previous stage.

Pentode valves may not give exactly the same effects, for here the screen grid conditions may also be rather critical. ■

THE AUDITRON



The Auditron probe

By M. L. Michaelis, M.A,

(*Continued from page 942 of the February issue*)

FOR the probe unit, a coaxial cable with a capacity not exceeding 1 or 2pF per inch, should be used for the Auditron signal input. With such a cable Cc+Ci (Cm)—see Fig. 13, last month—equals approximately 150pF.

If no probe were used, this full 150pF would load the signal source. Apart from serious waveform distortion gross detuning can result in many circuits as soon as the oscilloscope is connected in this way, and when testing oscillators, this capacitive load may even silence the oscillator completely. It is even possible to damage certain equipment if an oscilloscope is connected in this direct way.

Furthermore, the resistive loading, 135kΩ for the Auditron, is also rather low to impose directly in parallel with many test circuits. This could also silence oscillators due to damping, or grossly change the frequency of multivibrators or saw-tooth-oscillators under test.

It is necessary to reduce capacitive and resistive loading imposed on the signal source, in the face of the *inevitable* high value of Cm. This is done by placing a compensating circuit right at the head of the cable, immediately at the signal-source, and this constitutes the probe. Stray inductances and cable transit times have not been considered in the Auditron where about 300yd of cable would be tolerable before this consideration would come into play.

A simple compensated resistance capacitance bleeder is incorporated; this incurs only moderate loss of voltage which can be compensated by extra amplifier gain.

If we constructed such a resistive bleeder quite naively, it would take the form of a large series resistor Rb in series with the "prod" forming an extension of the core of the coaxial cable. Fig. 14 shows the effective equivalent circuit thereby developed out of Fig 13. Two new inevitable stray capacities have also thereby appeared, Cb, the stray capacity across Rb, and Ce, the direct stray capacity from the prod to earth. Ce is, of course, a direct loading which will be imposed on the signal-source, yet it can be kept very small by using a short straight wire for the prod, mounting Rb very close to it, and keeping the prod-wire adequately distant from the earthed casing of the probe. Thus, with a proper geometric design for the probe, Ce may be neglected.

Cb, however, is appreciable, and this cannot be avoided, in the Auditron probe in particular, because of the embodied switches and leads (see Fig. 16). We thus have, effectively, two bleeders in parallel, one a capacitive bleeder formed by Cb and Cm, and the other a resistive bleeder formed by the intended Rb and Ri.

These two bleeders form an a.c. bridge. If this bridge is not balanced, out-of-balance currents will flow in the diagonal CD, giving phase-shifts and amplitude variation with frequency for the signal reaching the amplifier.

The final step in construction of the probe is therefore to measure the magnitudes of the stray capacities concerned. and thus calculate the size of the capacitor required to be added to one or other of the strays, to bring the bridge to balance. The balance condition is. of course, that Cb times Rb should equal Cm times Ri.

The ratio of Rb to Ri is still free for choice, forming the final bleeder ratio. It should be given the smallest tolerable value (for maximum possible voltage-preservation) consistent with adequate reduction of loading (capacitive and resistive) on the signal source.

Yet in the Auditron the ratio is already fixed by virtue of the necessity for making the pre-calibrated valve voltmeter scale hold true. Certainly, the design there used, and details given in the section dealing with the signal amplifier, already dimensioned these matters such that the ratio of Rb and Ri will come out at the optimum, lying between 10 and 15, so the constructor need not be bothered with this consideration any more.

However, slight variations in the meter specified, or making the damping-shunt R48, will finally lead to slight differences in the final value to be selected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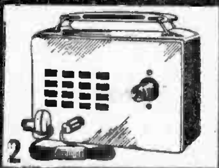
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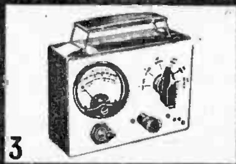
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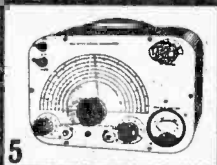
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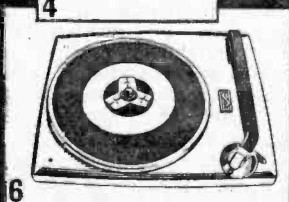
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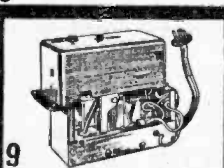
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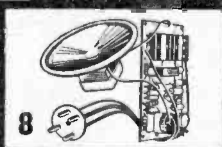
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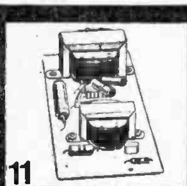
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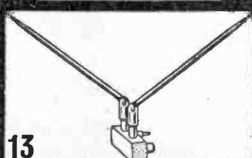
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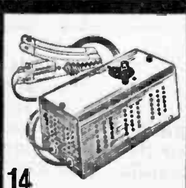
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for Rb, and this is automatically taken care of if the following procedure is observed.

Take an insulated lead from the signal-amplifier input plug, P1, of the finished and operating Auditron, and connect this, in series with a 1MΩ fixed resistor and a 1MΩ linear variable resistor, to an h.t. voltage of known value.

Adjust the variable resistor (see Fig. 15) until the built-in meter reads the known correct value. Measure the resistance of the variable resistor after disconnection, for the setting thus arrived at. This gives the required resistance value which, increased by 1MΩ, gives the correct value for Rb. In the prototype, three 560Ω ±5% resistors in series gave the correct value for Rb; individual Auditron's may well give slightly different values, but if departure is too severe, R53, R48 and the meter sensitivity should be checked in the signal amplifier, as well as the voltage across D10 and D11.

It is advisable to split the determined value for Rb into three equal, or nearly equal, resistors in series, to give better stability in the face of the high input voltages to the probe acceptable (about 1kV p.p. maximum). Take great care to insulate everything in the probe.

Figs. 16 and 17 give all the necessary information for construction of the probe. It is, of course, necessary to determine the required values for Rt and Rv, and instal these components as well as finalising everything except Ct before making stray-capacity measurements for determining Ct.

The choice of Rv is best made, after installation of the determined value for Rb by wiring a 100k potentiometer in place of Rv. This is then adjusted when applying the probe to a test voltage of about 50V d.c., until one-tenth of the v.t.v.m. reading is equal to the test voltage as observed on the multimeter (V closed). A value of about 47kΩ will be found satisfactory; the actual value to be used is the measured potentiometer resistance for the correct setting found.

Switch V is intended to give a tenfold increase of sensitivity compared to "normal" use of the probe. This facility is primarily intended for use with the v.t.v.m. function.

The Auditron may also be used for "scope" purposes with V closed, with the same tenfold sensitivity, provided excessive signal amplitudes are not applied. About 100V peak-to-peak will overload the Auditron in this setting. Because the probe is not balanced in this state, and signal source loading is high, care must be exercised, and reasonably accurate reproduction of waveforms can only be expected if no frequencies in excess of about 10kc/s are contained. Thus switch V also serves the purpose of narrow-bandwidth high-gain/high-bandwidth low-gain changeover. With V closed, the a.c. sensitivity is about 50mV r.m.s. for full-screen deflection on the c.r.t.

The switch C is the one already mentioned in the text on the Bridge Circuits, used when measuring large capacities by the charge-time method. The value should be selected for giving correct readings with the there-described method, using a large capacitor of known value, and will be found to lie somewhere between 2 and 3MΩ. The exact value should be made up of two resistors as nearly equal as possible, to distribute the voltage strain. This was not required for Rv, because this is for a low-voltage range.

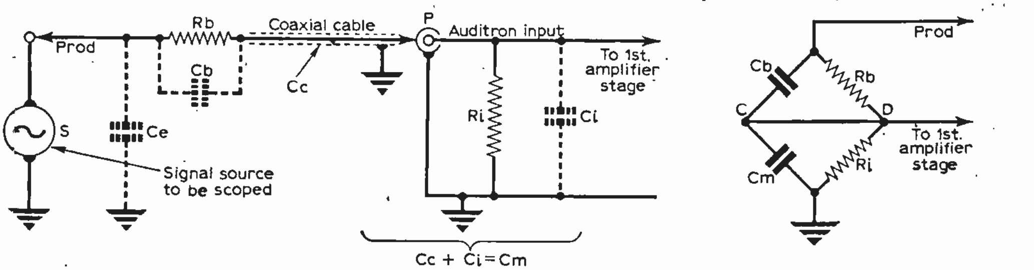

Fig. 14: An equivalent circuit showing the stray capacities operative in the design of a bridge-bleeder probe.

Do not otherwise use more resistors in series or parallel to obtain the required values but try and obtain or select single resistors with the desired values. This is in the interests of minimising stray capacities, which are seen to play a vital role in probe-design. Normal 1W types should be used throughout.

Demodulating R.F. Signals

To enable r.f. signals to be detected, a small sub-

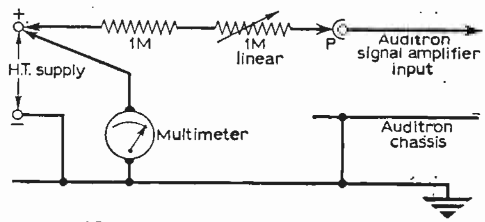

Fig. 15: Determining the correct value of Rb.

probe can be constructed for fitting as a thimble over the prod of the main probe. This small unit contains a 1,000pF capacitor in series with a 4·7Ω resistor; across the resistor is a semiconductor diode. This circuit is connected between the main probe input and earth.

The Auditron probe may be used with this additional probe for tracing signals through the r.f. and i.f. stages of a receiver. The peak carrier amplitude will be shown on the Auditron v.t.v.m., whether or not modulation is present, and the latter, if present, can be scoped and listened to on the "tracer" facilities.

Excellent Linearity of Auditron

The Auditron amplifier itself will *not* demodulate in contrast to many other amplifiers of poor quality. This is because of its extreme linearity,

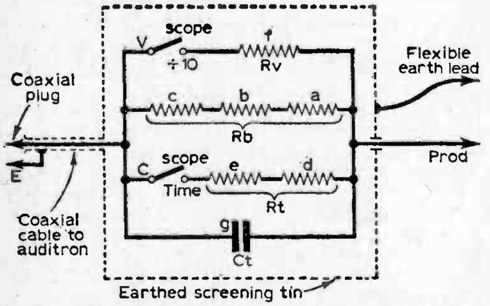

Fig. 16: The circuit of the probe. No list of components is given, as they must all be selected critically according to the details given in the text. Switches V and C are normally set at "scope", i.e. "off", and the probe is balanced for this condition.

especially at the critical input stage, on account of the high quality cathode follower input stage.

Only those r.f. signals of sufficient amplitude to overload the input stage (about 20V r.m.s. at the first grid) will be rectified, unless the frequency is so high that the cathode follower cannot function properly, when somewhat lower amplitudes will commence to be rectified.

To prove the excellent linearity of the Auditron signal amplifier, a job of work recently done with it may be described briefly. Two signal generators had been built, with nominal ranges 40 to 60kc/s, to a customer specification for a specialised purpose. These were required to operate with a standard tuned circuit (supplied) of 50kc/s resonant frequency as external load.

It was required to calibrate the tuning dials of these signal generators. A simple method was devised, operating both generators simultaneously, and joining the outputs via two equal resistors in series, from the junction of which the Auditron amplifier was fed. One generator having been brought to resonance with the standard tuned circuit, the other was brought to zero-beat, i.e. constant-amplitude on the c.r.t display on the Auditron.

It was then progessively detuned, the amount of detuning being given by the audio frequency of the observed amplitude-variation envelope. This frequency could be measured on the Auditron in the normal way, and progressed from zero to about 10kc/s as the signal generators were respectively tuned through either way. Now, although this amplitude fluctuation at audio-frequency was observed at full-scale deflection, *nothing was heard* in the tracer-loudspeaker, proving that no true beat frequency as such was being produced.

As will be familiar from the basic theory of frequency-changers, rectification or multiplication of two frequencies is needed to produce the beat-frequency as such, i.e., non-linearity in some circuit element dealing with a mixture of two initial frequencies. This test is *extremely* sensitive for testing for non-linearity, and the Auditron signal amplifier in the prototype passed it well.

The mixture of two nearly equal supersonic frequencies from the signal generators corresponded to the sidebands of a (suppressed-carrier) signal modulated at an audio frequency equal to half the separation. But this audio frequency is not present as such until it is demodulated out, i.e. rectified, and the Auditron amplifier is too distortion-free to perform this function, even though the waves and modulation envelope were being observed at full-screen amplitude on the c.r.t. This is as good a credential as any for the quality of the Auditron within the limits of operation for which it is intended.

Testing Frequency-response

Many specialised uses are possible for the Auditron, apart from the more obvious normal uses. A number of these make use of the timebase-waveform output provided, which is most useful, quite apart from wobbulator-use.

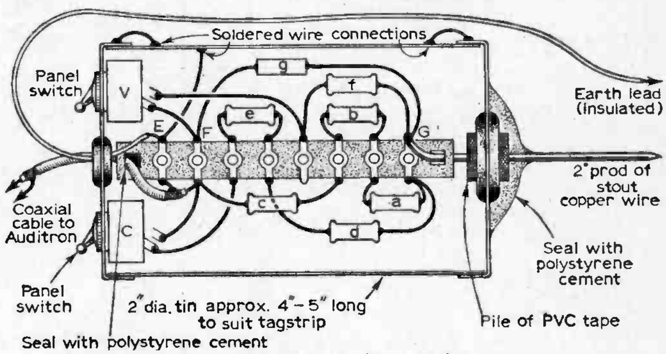

Fig. 17: The wiring of the Auditron probe.

This timebase-waveform is, first of all, a very useful general-purpose audio test signal, to provide an input of adjustable frequency for simple tests. For such, largely audible, tests, the waveform is not important, the sawtooth being as good as a sinewave—in fact probably better, on account of its better audibility, especially at low frequencies, compared to the sinewave.

Furthermore, it is an ideal signal for feeding into a circuit, and tracing with an oscilloscope through the stages of the circuit, particularly when it is, as here, simultaneously the timebase of the display-scope. Working at high signal-level in the circuit, and at a frequency where all important harmonics of the sawtooth lie within the linear frequency-range of the test circuit, the display on the c.r.t. is necessarily a direct picture of the characteristic curve of the test circuit, in the conventional form of drawing this in the form of an input/output graph. Non-linearity, blocking, over-drive, bottoming, etc. can thus be observed directly and visually. Remembering that the v.t.v.m. shows the d.c. level represented by the timebase zero-line set with the Y-shift, and that the Y-deflection can be quantitatively set with the Zener-calibrator, the display of the characteristic curves is also quantitive, i.e. it can be immediately read off, at what dynamic voltage any effects noticed take place. ■

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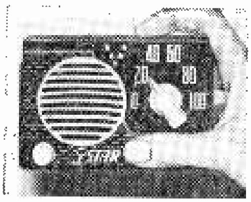
THE NEW "VOLKSRADIO" ONLY 14/11

TAKE-OVER BID MAKES THIS FANTASTIC OFFER POSSIBLE—the beautifully compact "5-STAR VOLKSRADIO" measuring 4¾ x 2¾ x 1¼in. Perfect personal earphone reception—in the Bedroom, Office, Garden—over all medium waves (incl. Luxembourg). Under 1d. hour running cost. ANYONE can assemble it in one or two hours using our simple A.B.C. plan. Complete set of parts ONLY 14/11, plus 2/6 P.& P. C.O.D. extra. (Parts can be bought separately.) Money Back Guarantee.



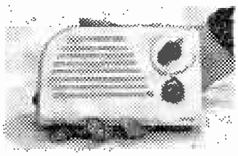
NO EARTH OR AERIAL REQUIRED

Revolutionary INTERNAL FERRITE AERIAL Makes this sensational pocket-size radio the best money-saving bargain of all time. Powerful, superb tone and clarity, ensures perfect reception for all your favourite programmes Completely portable, only 5¼ x 3 x 1¾in. Two-tone case. Anyone can assemble with our simple PRINTED CIRCUIT PLAN. Send 37/6, plus 2/6 P. & P. (C.O.D. 2/- extra. Satisfaction guaranteed. (All parts available separately).

"OUR NEW 4-STAGE MINUETTE"

39/6

Build this newly-designed **"MINUETTE" 4-STAGE** transistor set in very strong ready drilled **ULTRA-MODERN CASE**, size only 6 x 3½ x 1in. Uses three transistors and diode and **SELF-CONTAINED LOUDSPEAKER.** Very sensitive, ideal for office, bedroom, holidays, etc. Months and months of listening off a 1/2d. battery. Can be built **FOR ONLY 39/6,** including **PROPER CASE,** miniature speaker, etc. **SIMPLE AS A.B.C. PICTORIAL STEP-BY-STEP PLANS** etc., plus post and packing 1/6 (C.O.D. 2/- extra). Parts sold separately, priced parts list 1/-.



FREE HIGH SENSITIVITY HIDE-AWAY EAR-PIECE GIVEN WITH EACH SET.

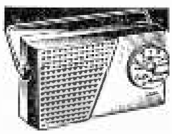
THE MINUTE TRANSISTOR RADIO

MIAMI ONLY 32/6

Unbelievably small—Outrageously cheap. You will be amazed at the fine quality of tone and volume of this great little radio. Only a fantastic 3¼ x 2¾ x 1¼in. the **MIAMI** will bring you great entertainment for months on an 1/2d. battery. Simple assembly plan with each set. **ONLY 32/6. YES 32/6!**

Plus 2/6 P. & P. (C.O.D. 2/- extra). Satisfaction Guaranteed. Demonstrations given daily. Parts available separately if required.

THE NEW "COSTA BRAVA" 49/6



NO EARTH or AERIAL REQUIRED ALL TRANSISTOR RADIO

Revolutionary **INTERNAL FERRITE AERIAL** and moving coil speaker makes this sensational pocket-size radio the best money-saving bargain of all time. Powerful, superb tone and charity, ensures perfect reception for all your favourite programmes. Completely portable, only 5¼ x 3 x 1¾ in. Two-tone case. Anyone can assemble with our simple **PRINTED CIRCUIT PLAN.** Send 49/6, plus 2/6 P. & P. (C.O.D. 2/- extra). Satisfaction Guaranteed. (All parts available separately).
FREE HIGH SENSITIVITY HIDE-AWAY EAR-PIECE GIVEN WITH EACH SET.

THE NEW "LISBON" TRANSISTOR SET

19/6

This is a pocket 2-stage transistor set not much larger than a matchbox. Excellent clear reception covering all medium waves, works for months off a tiny 1½ or 3 volt battery costing only 8d. Easy to build and an excellent introduction to transistor circuitry. Everything can be supplied down to the last nut and bolt incl. **SIMPLE PICTORIAL STEP-BY-STEP PLANS FOR ONLY 19/6,** plus, post and packing 1/6. (C.O.D. 2/- extra). Parts sold separately, priced parts list 1/-.

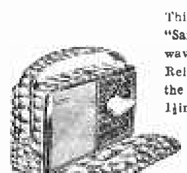
BIG PROFITS FOR YOU IF YOU BUY NOW! Made to retail at 7 gns. you can now buy this famous Twin-gong Alarm for only 37/6—but only if you act now . . . stocks are strictly limited. Easily installed and operated. Switches on or off at any time Fantastic FINAL reduction to clear (minimum order of 3) Carr. Free. **37/6** Free literature sent with each alarm.

Bulk purchase of bankrupt stock ensures this fabulous money-making offer.

AUTOMATIC CIGARETTE LIGHTER

instantly provides ready lit cigarette without the driver taking his eyes from the road. Heavily chromium plated case holds 10. Easily and simply fitted to any car's dashboard. Works off 6 or 12 volts. Retail Price 44/9. Special Clearance offer only sold in minimum lots of 6. Carriage free, **12/6** each.

THE NEW "SAN REMO" 6 STAR 32/6



This All Transistor Speaker Radio—The "San Remo" 6 Star covers all medium waves including "Home," "Light," etc. Reliable and lightweight—Slips easily into the Pocket or Handbag—size only 4½ x 2¾ x 1¼in.! Works for Months on 1/2d. Battery! Ideal for holidays, Camping, Bedroom, etc. Anyone can assemble it in an hour or two with our simple-as-ABC PLAN! Complete set of parts including miniature speaker—everything—only 32/6, plus 2/6 P. & P. (C.O.D. 2/- extra.) Parts can be bought separately.

Cheques accepted. Cash on delivery 2/- extra. Please print name and address in block letters. Suppliers to Schools, Universities, Government and Research Establishments. Complete range of components and values stocked. Regret no C.O.D. abroad. DEMONSTRATIONS DAILY AT WORKS.

CONCORD ELECTRONICS

(DEPT. 14/12) 210 CHURCH ROAD, HOVE, SUSSEX

Trade News

NEW MULTIMETER

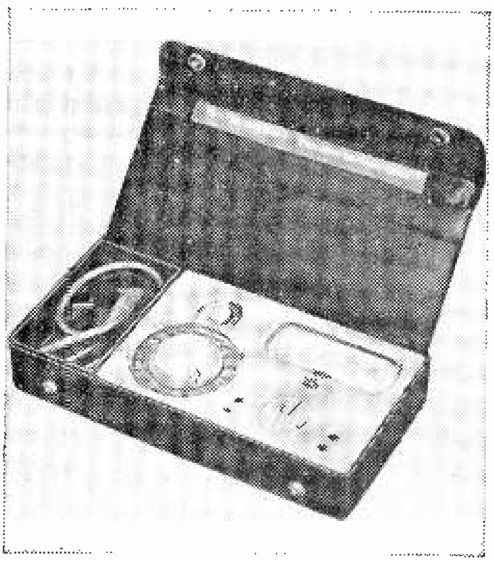
A RECENT addition to Avo Limited's range of electrical test equipment is the AVO Multiminor mark 4. This instrument supersedes all previous models in this series, and incorporates as standard, accuracy to B.S.89/54 and a new design of scale plate.

Each range of the instrument is selected by a single switch and the same two sockets are used for all tests.

The 19 ranges cover d.c. voltage from 100mV to 1,000V, with the sensitivity on these ranges being 10,000Ω/V; a.c. voltage from 10V to 1,000V, the sensitivity at 1,000Ω/V; d.c. current from 100μA to 1A and resistance from 0 to 20,000Ω and from 0 to 2MΩ using the internal battery.

These ranges can be extended by external accessories if required—a 2,500 d.c. multiplier and 5, 10 and 25A d.c. shunts are available. The instrument is supplied complete in a carrying case with leads, prods and clips.

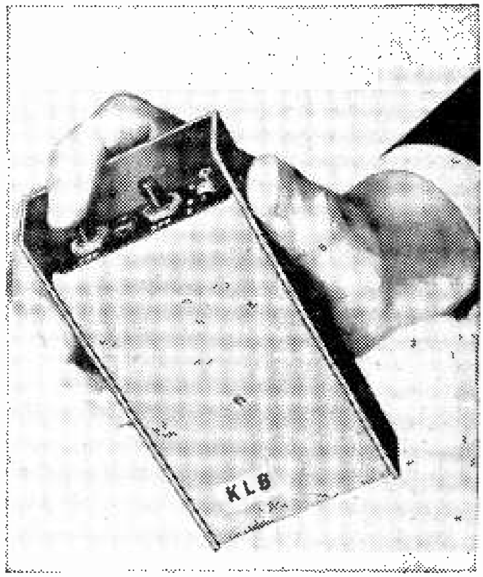
The Multiminor mark 4 is made by *Avo Limited, Avocet House, 92/96 Vauxhall Bridge Road, London S.W.1.*



The latest multimeter from Avo's.

REDUCED VALVE PRICES

THE recent cuts in Purchase Tax on radio and television sets is also applied to radio valves, and Mullard Limited have recently announced reductions in the retail prices of their valves. For example, the EF86 now costs 15s. 9d. which before the cuts in Tax cost 17s. 6d., and the PY80, which previously cost 9s. 9d., now costs 8s. 9d.



A transistor check instrument made by K.L.B. Electric Ltd.

TRANSISTOR CHECK

AN inexpensive transistor tester, known as the "Transistor Check", has recently been introduced by K.L.B. Electric Limited. This simple instrument is not a comprehensive analyser but has been designed for use by service engineers and maintenance technicians to locate a transistor failure in equipment that has developed a fault.

The instrument is pocket sized and the controls are protected against accidental battery drain by being recessed into the case.

A.C. gain is measured, and indication of a good transistor is shown on a miniature cold-cathode tube. Both p-n-p and n-p-n transistors can be accommodated; wire ended types can be inserted directly into the sockets whilst special plugs are provided with the instrument to allow extension leads to be used for in-circuit checks in some cases.

The price of this new piece of equipment is £4 12s. 6d. and manufacturers are *K.L.B. Electric Limited, Holloway Engineering Works, Parkhurst Road, London N.7.*

Club News

REPORTS OF CURRENT ACTIVITIES

COVENTRY AMATEUR RADIO SOCIETY

Hon. Sec.: Alan J. Wilkes, G3PQQ, 141 Overslade Crescent, Coundon, Coventry, Warwickshire.

The aim of the Society in 1963 is to be even more active than last year, and much of this activity should materialise in the use of the newly acquired 150W transmitter for the Club station.

January 7th was devoted to a committee meeting. At the film show given on January 21st, the three films shown were "The Manufacture of Radio Valves", "Mirror in the Sky" and "The Principles of Transistors". On the 28th of the same month a lecture was given on 70 cm.

EXETER AMATEUR RADIO SOCIETY

Hon. Sec.: Stuart Line, 46 Roseland Crescent, Heavitree, Exeter, Devonshire.

This Society meets on the first Tuesday of each month, and in January the Annual General Meeting was held.

LICHFIELD AMATEUR RADIO SOCIETY

Hon. Sec.: V. Hickman, G3LXR, 143 Main Street, Stonnall, near Walsall, Staffordshire.

The Society's Annual Dinner and Dance which was held on January 11th, provided members with an enjoyable start to the New Year.

MITCHAM AND DISTRICT RADIO SOCIETY

Hon. Sec.: B. Blandford, 1 Biggin Avenue, Mitcham, Surrey.

At the first meeting in January—Friday the 4th—Robin Sykes (G3NFV) gave a talk on the "Ham Hop Club".

On January 18th members gathered to discuss arrangements for National Field Day. This was the second N.F.D. meeting, and topics on the agenda included reports on an alternative site and also the possibility of the Society operating only one station this year.

Future Event:
February 15th—Annual General Meeting.

NORTHERN HEIGHTS AMATEUR RADIO SOCIETY

Hon. Sec.: A. Robinson, G3MDW, Candy Cabin, Ogden, Halifax, Yorks.

On January 30th, Mrs. Shaw (G30MM) gave a very interesting talk and exhibition on the subject of "Radio on Stamps".

Future Event:
February 13th—Ragchew.

PURLEY AND DISTRICT RADIO CLUB

Hon. Sec.: E. R. Honeywood, G3GKF, 105 Whytecliffe Road, Purley, Surrey.

At the meeting on January 4th, members had the chance to have their queries and problems solved at a lecture on constructional hints.

RODING BOYS' SOCIETY (RADIO SECTION)

R. Marchant, 154 Essex Road, Leyton, London, E.10

This Society was formerly the Junior Section of the Wanstead and Woodford Radio Society, but now exists as an independent group. Regular activities include films, constructional projects and lectures on various topics. Work for the R.A.E. and morse proceeds as the demand arises.

Recently six members passed the R.A.E. out of the eight who sat it. Enquiries from any young people in the Roding Valley area who are interested will be welcomed.

"GO NORTH, YOUNG HAM"

THE population drift from North to South continues, following industry and work in the unarrested influx into and around the metropolis, ever increasing the hold London has not only on the country's economy, but also on its arts and sciences, its fashions and habits. No one can remain free from the influence of the big city, where all forms of entertainments and pastimes centre. The music and drama lover homes on to the West End like a pigeon to its pigeonry; the soccer fan must inevitably find that Wembley is his goal; and *no one* seems exempt from the grip of London.

Yet it is our experience that at least the North of England remains the active nucleus of the world of amateur radio, when all other interests centre on the South-East.

It is difficult to imagine the reason for this situation, but the Club reports that we receive show clearly that as far as amateur radio enthusiasts are concerned, England is top-heavy. These reports also suggest that the Northern club member is far more conscientious when it comes to attending club-nights, as quite a few of the Southern clubs' newsletters seem to make a regular feature of scolding members for not turning out for the last meeting and pleading with them to come to the next. This, of course, is a generalisation, there being many South of England clubs with regular support from all their members, but this overall impression is one gained by reading the hundreds of reports, from clubs all over the country, which yearly reach the PRACTICAL WIRELESS offices, and is therefore one very hard to dispute.

Yorkshire seems particularly well represented, with clubs in most of the major towns. Societies in Scotland also seem to be flourishing, and in the Midlands, Derby sets a very good example of efficiency in club organisation.

And so " go North, young ham " seems the best advice we can give to any frustrated radio enthusiast who is finding insufficient vitality in his Southern club; and, who knows, he might one day be regarded as a pioneer of a general reversion to the North.

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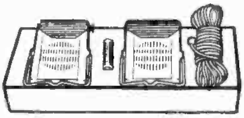
TWO SENSATIONAL TRANSISTORISED INTERCOMS

HANDY INTERPHONE

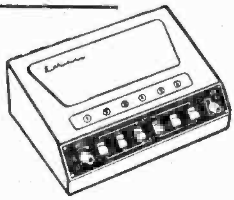


For Home, Workshop, Office, two-way calling. Consumes current only when talking or calling. Housed in attractive plastic cabinets with chrome stands. Completely portable. Master and sub-station. Replacement battery only 2/6.

MAILPLAN PRICE **89/6** Incl. PP3 battery, and 25 yds. lead with plugs. P. & P. 3/-.

(Today's value 8 gns.)

7 Station De Luxe Transistorised Intercom



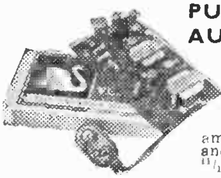
The very latest in Office and Factory communication. Calling is audio and visual. Battery operated but consumes current only when calling or talking. Neat compact attractive units, up to 6 extensions supplied separately. Battery life 300 hours.

Master **14 GNS.** Post free.
Extension 2 gns. Post free.

HALF THE PRICE OF OTHER MAKES

Construct your own Record Player, Intercom, Tape Recorder, etc., with the

PK.543 SUBMINIATURE 4-TRANSISTOR PUSH-PULL AUDIO AMPLIFIER 52/6



An assembled and wired miniature amplifier incorporating output transformer, and 4 transistors, class B. 200 m. watts. All connections for battery, speaker and volume control. The quality is amazing. Complete with instructions and circuit P217A. Size 3 x 1$^{9}/_{16}$ x $^{11}/_{16}$in.

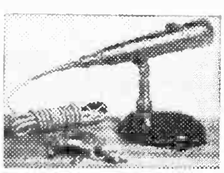
8 ohm speaker to suit above, 2½". Flux density, 7,800 gauss. Power. 200 mW. **16/6** P. & P. 1/-

M178 CRYSTAL LAPEL MIKE 17/6

100-9,000 cps. 1¼in. diam., 5ft. lead. P. & P. 1/-.

SLIM CRYSTAL 3-way MICROPHONE

- ★ Hand held.
- ★ Stand mounted. or
- ★ Suspended by lavalier cord.

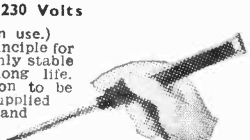


MODEL 100C 39/6 Post Free

Check the spec. and judge for yourself. Response 60-10,000 cps. Built-in ON-OFF Switch. Output Level —52 dB. Omni-directional. Termination above 500 K ohms. Satin Chrome Finish. Accessory Table Top Stand, 8/6.

PORTABLE SOLDERING IRON Model SPI

30 Watt 230 Volts



(Size 10½in. 6½in. when not in use.) Designed on an entirely new principle for light-weight applications. Highly stable heat characteristics ensure long life. Removable handle permits iron to be carried safely even while hot. Supplied complete with Vinyl bag, lead and plug. Spares available. Element 4/6. P. & P. 6d.

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DM.II MICROPHONE with Base. A flexible, newly designed, dynamic microphone integrated with a matching desk stand. Professional quality, ideal for tape recording, public address, broadcasting and communications. Ruggedly constructed, removable base for desk or hand use. 360° swivel ball joint allows tilting in any direction. 9" high, body dia. 2" tapering to ¾". Base 5" dia. Magnificently finished in mist blue with chrome trimming. Complete with shielded cable stand. **Fully guaranteed.**

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Checks Alpha gain (Current gain—AC)
Checks Beta gain (Current gain under DC conditions).
Measures Leakage currents between Collector/Base and Collector/Emitter at any voltage between zero and 25 V.
Specially designed for all receivers using PNP Transistors.
Size 5¼ x 3 x 2¾in.

NOW you can carry out fast testing of transistors and miniature transistor receivers without removing transistors from circuit. Self-contained signal tracing oscillator, self-contained variable power supply.

Miniature Clear Plastic Panel Meters

FOR YOUR HOME BUILT TEST EQUIPMENT

DC MICROAMMETERS	Model MR.25 0 to 50 µA	..	39/6
	Model MR.250 0 to 500 µA	..	32/6
DC MILLIAMMETER	Model MR.21 0 to 1 mA	..	27/6

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

"S" METER MODEL SR.2P. Standard "Ham" Signal strength indicator. Calibrated in "S" units from 0-9 with scale terminating in +10 to +30 dB calibrations. Additional full scale calibrations of 0-5+0-10 in linear scale divisions, 35/-.

VU METER MODEL VR. 1P. Calibrated and damped in accordance with standard VU Meter Practice. Upper scale reads —20 to +3VU. Lower scale 0-100% modulation. Uses precision carbon film multiplier resistor and full wave rectifiers. 42/6.

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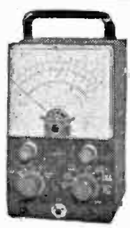
Tests TV Windings for shorting turns by unique pulse method. This compact instrument can save you pounds. It detects a single shorting turn in a line output transformer, deflector coil or other Windings. The pulses provided by the instrument detect intermittent faults. In position one, the continuity of the Windings is checked; in position two, high impedance coils, and in position three, low impedance coils. Once you have used the Skantest you will regard it as a must in TV Servicing.

Exclusive Mailplan Offer 99/6 P. & P. 2/9

MULLARD TAPE RECORDER AMPLIFIER

Printed circuit board and set of 27 capacitors ranging from 50 + 50 µF at 350 v. to 47 pF. **28/-** plus 1/6 P.P.



MODEL V-7A/F VALVE VOLTMETER

Equal to many higher priced instruments. Gold-plated printed-circuit. High input impedance (11 meg-ohms). The V-7A measures A.C. volts (0-1.5, 5, 15, 50, 150, 500, 1,500) R.M.S. and A.C. volts (0-4, 14, 40, 140, 400, 1,400 and 4,000) pk.-to-pk. D.C. volts (0-1.5, 5, 15, 50, 150, 500, 1,500) Ohms (with 10 ohms centre) X1, X10, X100, X1000, X10K, X100K, and X1 megohm.

£19.18.6 Complete with 32-page handbook.

MODEL V-7A (in kit form). **£13.18.6**

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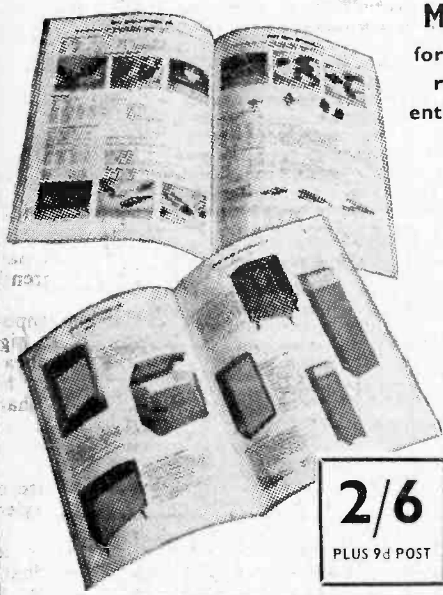

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TYPE 46 WALKIE-TALKIES. Best buy in TX/RX units in years. Complete with all accessories at give-away price. 3-channel crystal controlled TX and R/X. Supplied complete with one pair of crystals, coil box, rod aerials, leads and plugs, valves, balanced armature head set with throat-mike. Coverage: 3.6 to 4.3 Mc/s or 6.7 to 7.6 Mc/s by means of plug-in coil pack. (State which frequency preferred when ordering.) Requires only 150 v., 15 v., and 3 v. dry batteries. Range over 10 miles under good conditions. Full instructions supplied. As new. We offer this fine unit as listed above with all accessories, at 42/6 per unit or £4 for two. Postage and packing 6/6. Set of batteries 24/- per set.

SPECIAL OFFER TYPE 46 WALKIE-TALKIES

As described above with valves, crystals and coil box but having had the original send/receive switch removed. *Without other accessories.* This set is supplied with a substitute switch and full wiring details at 18/6 each or 35/- per pair. P. & P. 5/6.

BRAND NEW TAPE RECORDING HEADS. For single, centre track recording. With leads and 4-pin plug, 12/6. Postage 1/6.

DIODES. OA81, 2/9 ea., OC71, OC72 substitutes, 3/6 ea.

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Sangamo Weston, brand new (not boxed), 0–750 micro amps flush, round, 3½in. dia. 49/6
Sangamo Weston, brand new (not boxed), 0–1 micro amps flush, round 3½in. dia. 47/6
0–5 micro amps M.C. projecting 6in. dia. steel case .... 39/6 each
0–15 micro amps M.C. projecting 6in. dia. steel case .... 39/6 each
0–50 micro amps M.C. projecting 6in. dia. steel case .... 27/6 each
0–100 micro amps M.C. projecting 6in. dia. steel case .... 27/6 each
P. & P. 2/- per instrument.

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Self starting, non reversing synchronous motor operating on 200/250 v. A.C. continuous rating 20 amps. at 250 v. Special insulated switching device switching on and off in 24-hour cycle automatically, also incorporates manual switching should normal sequence need to be interrupted. Takes extra pair switch arms to give 2 "ons" and 2 "offs". Perspex cover. Ideal for all domestic and electronic circuits. Price 79/6. Extra arms 2/6 per pair.

SILICON RECTIFIERS. Miniature power diodes at the right price. Leading makes. 400 P.I.V. at 650 mA, 6/- each. 500 P.I.V. at 200 mA, 3/6 each. 800 P.I.V. at 550 mA, 7/6 each. 1,000 P.I.V. at 500 mA, 8/6 each.

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LARGE RANGE OF 10X, 10XJ, FT243, FT241 CRYSTALS ALWAYS IN STOCK.

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BC610 TUNING UNITS

Choice of 5–6.35 or 6.35–8 Mc/s. These compact units (9 x 4 x 2in.) were used as plug-in tuning boxes with the BC610 TX. Containing miniature variable condensers of 140 pFd, 100 pFd and a standard size 50 pFd. A 0–100 graduated knob dial 1½in. dia. D.P.D.T. toggle switch and several others components. Price 6/6 ea. P.P. 3/-.

HELIPOTS. Brand new and boxed, 2,000 ohms. 10 turns, ±0.1% linearity. 18/6 ea. P. & P. 1/6.

50 VOLT 10 AMPS OUTPUT TRANSFORMERS. 230 v. primary. Conservatively rated. Brand new in maker's cartons. 55/- each. Carriage 7/6.

TERMS OF BUSINESS

CASH WITH ORDER. Handling charge of 1/6 on all orders under 20/- where P.P. is not otherwise stated.

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.

THE CHANGING WORLD OF WIRELESS

SIR,—When I look at the original *Newnes Wireless Constructors' Encyclopaedia*, a copy of which I still have, I can't help but wonder at the great steps which have been made in wireless since those early days. I can remember the first radio valve, the first bright emitter and the first screen grid valve.

What marvels have now become commonplace things, which not so long ago were mere pipe dreams! We indeed should be thankful to all those "backroom boys" who did so much to make our lives the more enjoyable. And who knows what is to come in the future with satellite communications and colour television already here?

My regards to the staff of P.W. who have given many of us radio amateurs such interesting articles, blueprints, etc., and thank you for making my life, at least, more enjoyable.—H. T. ROLLER (London S.W.6.) (Member of the Radio Amateur Invalid and Bedfast Club).

LOCAL COMMERCIAL RADIO

SIR,—Having read with interest recent letters in P.W. concerning local radio stations, I find myself agreeing with the sympathies expressed by your correspondent, Mr. P. Robinson, in the November 1962 issue.

Commercial stations, running at low power, and situated in the major towns, would, I feel, make a welcome change to the programmes put out by the BBC.

The opinion of Mr. Dent (January issue) that these stations would be cluttering up the wavebands is nonsense, as two or three low power stations, if displaced widely apart and equipped with beam antenna, could easily operate on the same channel.—W. B. MOON (Hull, Yorkshire).

HI-FI FANATICS

SIR,—Mr. D. R. Davenport's criticism of his friend's hi-fi system (December issue) surprised me. Fingermarks on record grooves attract dust, and if a record is played without first having such dust removed, a great deal of surface noise will be apparent. Extra wear and tear on both the stylus and the record will also result.

As to fiddling about with the controls for about twenty minutes, I find this difficult to believe. However, Mr. Davenport's friend may purposely have taken his time, solely to impress him, apparently without success.

As a closing word, I suggest that Mr. Davenport listens to one of his own records over a high quality system. The surface noise will be unbearable, and it will, I hope, make him reconsider his "cheap record player".—E. W. SKEEN (Johannesburg, South Africa).

SIR,—If Mr. Davenport and Mr. Nicholls are of the opinion that hi-fi enthusiasts are self-styled, then I am afraid they are sadly mistaken.

Mr. Nicholls considers that such terms as "frequency response" and "negative feedback tone circuits" are merely tagged on to articles to impress the buyer, and so it seems to me that he cannot read P.W. very carefully.

Also if Mr. Davenport has never heard the terrible effects caused by fingers carelessly rubbed across the groove of a record, then I suggest that his friend had better demonstrate this to him (with one of Mr. Davenport's own records!).—A. FERGUSON (Eastbourne, Sussex).

SIR,—May I be allowed to support Mr. D. R. Davenport in his criticism of hi-fi enthusiasts? I agree that it is a bore and a trial to be victimised by the enthusiasm of others.

With regard to the letters of Messrs. J. D. Maitland and D. L. Miller, surely, if one has to have the skill of a jeweller or of a dental technician to handle modern gramophone records correctly, it is high time to find and apply a better system of sound recording?—W. F. FANSHAWE (Chesham, Buckinghamshire).

LANGUAGE BARRIER

SIR,—As a newcomer to short wave listening, I find it very annoying when I tune into a foreign amateur station only to find that I cannot understand the language of the operator. This language barrier problem could very easily be solved by the use of Esperanto. So why not make it the accepted language for radio amateurs the world over? If any help is needed, there is an Esperanto Society of Great Britain to assist those interested, as I am sure many amateurs would be.—A. JAMESON (Wigan, Lancashire).

COMPONENTS WANTED

SIR,—I wonder if any of your readers could assist me in getting hold of an item of equipment not obtainable in this locality.

It is the coil pack and switch assembly of the R208 reception set (10-60Mc/s). The existing component in my set has been damaged beyond repair, and therefore if any reader knows of a source of supply for this part, I would be very much obliged if they would get in touch with me.—W. C. STEPHENSON (10 Plungington Road, Preston, Lancashire).

SERVICE SHEET WANTED

SIR,—Apart from constructing radios in my spare time, I am also the Troop Leader of our local Boy Scout troop. We obtain most of our funds from hiring out our hall for dances, etc. and in connection with this we have a rather elderly m.w. receiver/p.a. amplifier, the Ambassador type PA.145.

For a long time, we have had trouble with microphony and intermittent distortion, but this has become so bad lately that the equipment is almost unusable. I have tried without success to obtain a service sheet and I would therefore be very grateful if one of your readers could give me the valve line-up or preferably loan or sell me the circuit diagram or service sheet.—J. B. McGINN (13 Hunters Chase, South Godstone, Surrey).

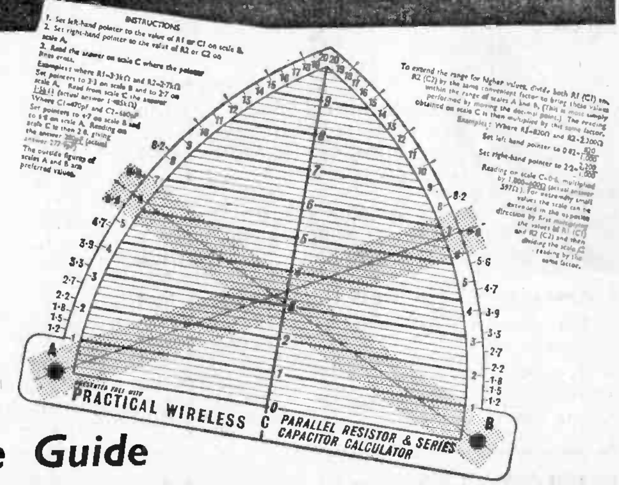
PARALLEL TRACKING UNIT

(Continued from page 1018)

the run-out groove, and then out again to the 7, 10 or 12in. mark before placing the pick-up on the run-in groove. The unit is pushed with the first finger behind the cartridge, during this time the pick-up sliding on the lowering arm back portion, and by depressing the lowering arm the needle will be brought down on to the record. At the completion of the record the arm is raised and the pick-up pushed away from the centre, allowing the record to be removed.

If on certain passages the unit resonates, either a slightly greater tracking weight is needed or the cartridge housing needs stiffening up by adding extra struts of balsa wood. An error of only $\frac{1}{8}$in. in the needle run each side of the centre spindle will increase the distortion considerably. Further distortion will arise if the needle does not run exactly upright in the groove and a careful sight along the record at right-angles to the needle path will show any error. The table and V-bed must be horizontal when the unit is working, a small spirit level being useful for this purpose. The V-bed may be adjusted by means of the elongated hole in the left-hand bracket.

These adjustments may take several hours, but the time will be well spent in ensuring optimum results from the equipment.



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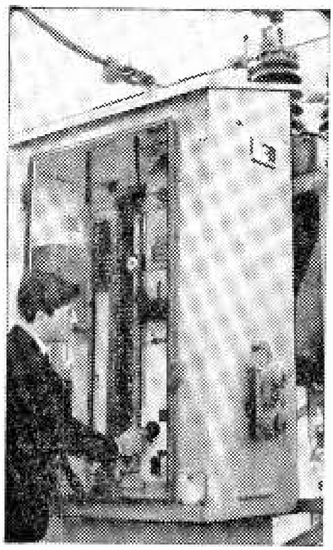

Q. What is Electricity Supply?

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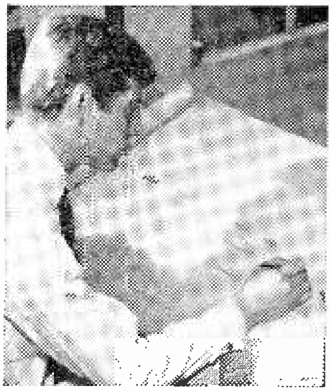
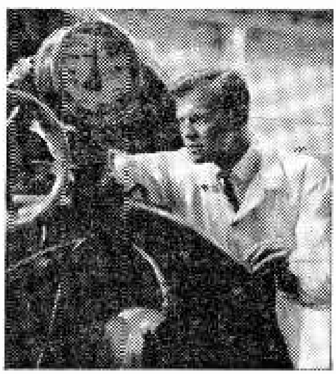


Q. What qualifications must I have?

A. School-leavers need either a good Ordinary level G.C.E. including Maths, English, and a Science subject; or two Advanced level passes in Maths and Physics. Graduates need a British degree in electrical or mechanical engineering. Or you need an engineering diploma. You can apply in your last year at school or college — preferably in the January-March period before you take your final exams.



Q. What sort of training do I get?

A. For school-leavers, there's a 5-year apprenticeship. It consists of planned practical experience in the various departments, accompanied, for 'O' level entrants, by day release to a technical college and, for 'A' level recruits, by a 'sandwich' course, both leading to engineering qualifications.

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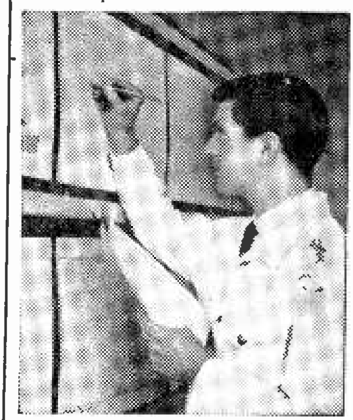

Q. Where do I go from here?

A. It's impossible to tell you here all about an industry that has to *double* its output every ten years. But jobs include everything from running a Power Station to bringing power to a new estate. For full details, write (giving age and exams you've passed) to: The Education and Training Officer, The Electricity Council, 155 Winsley Street, London, W.1.

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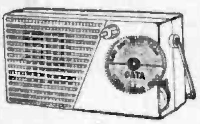

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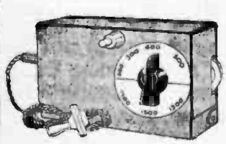

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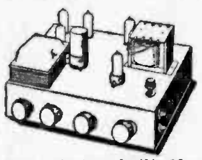

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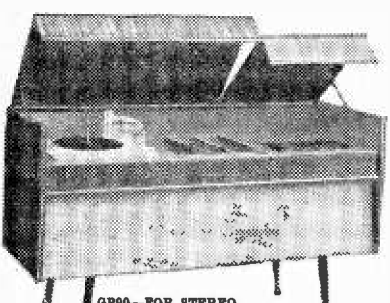

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(Classified Advts. cont. on page 1063)

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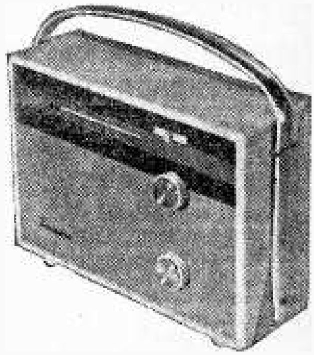

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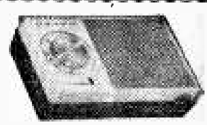

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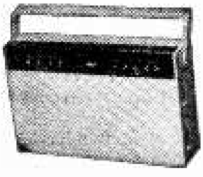

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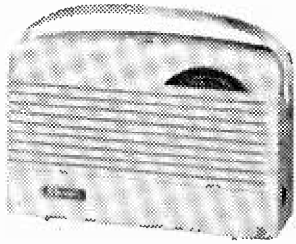

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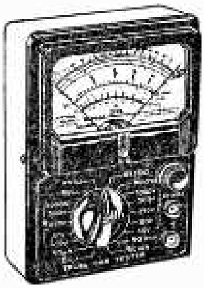

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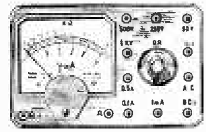

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Size 5 x 3½ x 1¼in. with batteries, test leads and instructions.

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11. Pocket Radio Booster Unit, for any radio. Improves output and quality. 30/-. P.P. 1/-.
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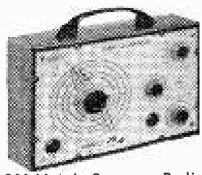
TRANSISTOR PORTABLE SIGNAL GENERATOR



PRICE
£7.10.0
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A 1st class Signal Generator covering 220 Kc/s to 200 Mc/s in 8 ranges. Radio broadcasts and I.F., Amateur, VHF, Shipping, TV, etc. R.F., I.F., A.F., modulated R.F. outputs. Easy to read and use with full details. Within 2% accuracy. Size 6⅝ x 4⅝ x 2in.

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50 Microamp 2in. square MC, 35/-.
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2½-0-2½mA, 2½in. flush. D.C. ... 12/6

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We stock the largest range of transistors, valves and quartz crystals and components for the home constructor. Fully detailed and illustrated Catalogue 1/- plus 6d. post.

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14. Crystal Contact Microphone for guitars, etc., 12/6.
15. Personal Earphones: 600 ohm 10/6, 1,000 ohm 12/6, Crystal 8/6, 8/10 ohm 9/6. Fitted leads, jack plugs and sockets.
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Open Monday to Sat: 9-6, Thurs. 1 o'clock

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Practical Wireless BLUEPRINT SERVICE

ALL of these blueprints are drawn full-size and although the issues containing descriptions of these sets are now out of print, constructional details are available free with each blueprint except for those marked thus (*).

Send (preferably) a postal order to cover the cost of the Blueprint (stamps over 6d. unacceptable) to PRACTICAL WIRELESS, Blueprint Dept., George Newnes, Ltd., Tower House, Southampton Street, London W.C.2.

DOUBLE-SIDED BLUEPRINTS

Each blueprint in this series contains details of two separate instruments or items of equipment.

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SOME EARLIER DESIGNS

THE following blueprints include some pre-war designs and are kept in circulation for those constructors who wish to make use of old components which they may have in their spares box. *The majority of the components for these receivers are no longer stocked by retailers.*

Experimenter's Short Wave	PW30a	2/6
Midget Short Wave Two	PW38a	2/6
Simple S.W. One-valver	PW88	2/6
Pyramid One-valver	PW93	2/6
BBC Special One-valver	AW387	2/6
A One-valver for America	AW429	2/6
Short-Wave World Beater	AW436	3/6
Standard Four Valve S.W.	WM383	3/6
Enthusiast's Power Amplifier ...	WM387	3/6
Standard Four Valve	WM391	3/6
Listener's 5-Watt Amplifier	WM392	3/6

QUERY COUPON

This coupon is available until 7th March, 1963, and must accompany all queries in accordance with the notice on our "Letters to the Editor" page.

PRACTICAL WIRELESS, MARCH, 1963

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"CAPRI" POCKET-6

6-TRANSISTOR SUPERHET

Size only 4½ x 2¾ x 1¼in.

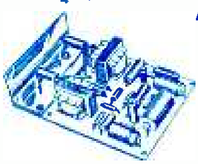
REALLY POCKET SIZE !

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

TOTAL COST **£5.19.6** P.P. 2/-

● **Slip it into your Pocket** ●

¾ WATT 4 TRANSISTOR AMPLIFIER



● Improved Version

1½ watt peak output.

± 3dB 70c/s to 12 kc/s.

Output to 3 ohm speaker

9 volt operated.

Details on request.

Built and Tested	Kit of Parts
59/6 OR	**52/6**
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● 6-7½ volt Garrard turntable with crystal pick-up. Plays 45 r.p.m. Ideal for above amplifier. 55/- P.P. 1/6.

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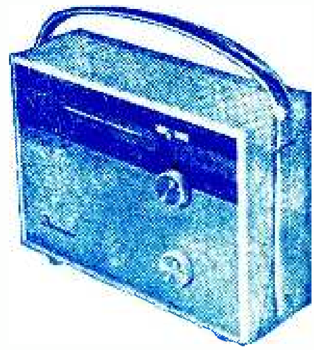
● COMPONENT SPECIALISTS

"CONTESSA" III

★ **COMBINED PORTABLE AND CAR RADIO** ★

AMAZING SENSITIVITY AND SELECTIVITY ON MEDIUM AND LONG WAVEBANDS



★ The easiest Superhet Radio to build on the market. Features clearly marked printed circuit and packaged components with full illustrated building instructions. Full tuning of medium and long wave bands with unbeatable sensitivity and selectivity. Excellent tone and volume with over 600MW push-pull output.

★ Clearly marked horizontal station dial with slow motion tuning. Two colour Blue or Beige cabinets with Gold handles, grilles and fittings. Size 10¾ x 7¾ x 3⅝in., include car aerial socket, recording sockets.

★ 6-Mullard Transistors and 2-Diodes.
Guaranteed the Best Obtainable

● **Attractive Appearance—Reliable Design—Quality Performance** ●

NEW TOTAL COST **£9.19.6** P.P. 3/6

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PERSONAL POCKET RADIO
3-TRANSISTORS 2-DIODES

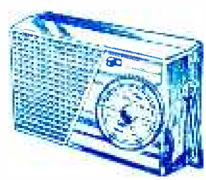
Size only 3 x 2 x ¾in.

A new printed circuit 5-stage personal pocket radio fully tunable on medium waves and top band, including Radio Luxembourg. A tiny but powerful radio designed to fit into your jacket top pocket. No external aerial or earth. Full station separation with amazing sensitivity and volume. Fully illustrated instructions free on request with clearly marked pre-tinned printed circuit and 1st grade components make this radio Easy to Build and use. Fitted volume control and calibrated dial. All parts sold separately. After sales service and guarantee.

TOTAL COST **59/6** P.P. 1/6

"QUINTET" Mk. II

POCKET RADIO



● 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.
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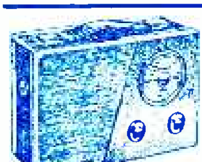
'TRANSFIVE' PORTABLE RADIO



Total Cost of all Parts
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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 6¼ x 3¼in.

★ Plans Free on Request ★

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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.**

59/6 P.P. 1/6

P.W.-6 SUPERHET £7.19.6. P.P. 2/-.
P.W. "MERCURY" £9.10.0. P.P. 2/6.
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