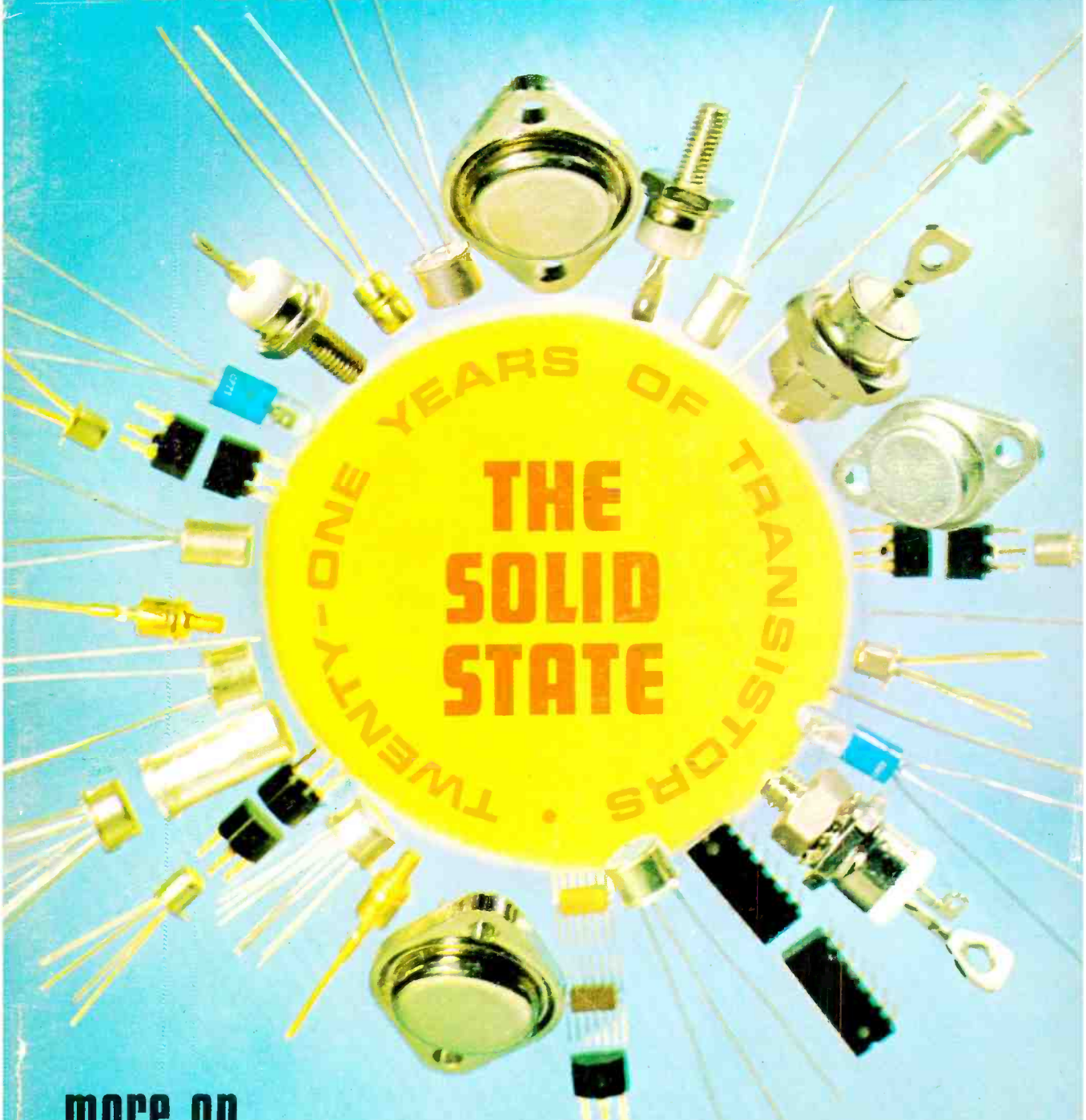


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This extremely high quality bookshelf speaker system by the world famous Foster Co. of Japan incorporates an acoustical suspension woofer and cone tweeter in a sealed infinite baffle enclosure with handsome oiled walnut finish. The performance of the Criterion is superior to many larger and far more expensive units and at Lasky's special purchase price is quite without equal. **SPECIFICATION:** Air suspension type 6 1/2 in. bass-midrange woofer with rolled cloth edge. 2 1/2 in. HF cone type tweeter. Frequency range 65-20,000 c/s. Maximum power handling 15W. 8Ω impedance. Cabinet constructed from 1/2 in. laminate with oiled walnut veneer finish; size 13 1/2 x 7 1/2 in. square. Dark green woven acoustic gauze. Phone input at rear. List Price £12.10.0 each.



Lasky's Price £8.8.0 or 2 for £16 Post 1-7/2-12/6

TEST EQUIPMENT

TTC Model C-1000

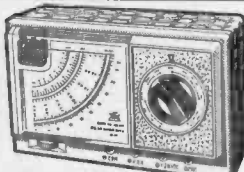
A really tiny 1,000 O.P.V. pocket multi-tester with "big" meter performance. Precision 2 jewel meter movement. Hand calibrated to ±3% accuracy on full scale of d.c. ranges, 4% on a.c. ranges. square meter. **SPECIFICATION:** a.c./V ranges: 0-10, 50, 250, 1,000V at 1K/O.P.V. a.c./V ranges: 0-10, 60, 250, 100V at 1K/O.P.V. D.C. current: 0-1-100mA. Resistance: 0-150K/ohms (3,000 ohms centre scale). Decibels: -10 to +22dB. Operated on one penlight cell. Two colour buff/green case—size only 3 1/2 x 2 1/2 x 1 1/2 in. Click stop range selection switch. Ohms zero adjustment. Complete with test leads, battery and instructions with circuit data.



Lasky's Price 39/6 Post 2/6

TTC Model C-1051

A completely new design 20,000 O.P.V. pocket multimeter with mirror scale and built in thermal protection circuit. Exceptionally large easy to read meter with D'Arsonval movement. Colour coded scales. Single positive click-in, recessed selection switch for all ranges. Ohms zero adjustment. Range spec. AC volts: 0-6-30-300-1200 V at 10K/ohms/V DC volts: 0-3-15-150-300-1-2KV at 10K/ohms/V. Resistance: 0-60K-6megs. DC current: 0-60μA-300mA. Decibels: -20dB to +17dB. Hand calibration gives extremely high standard of accuracy on all ranges. Uses one 1 1/2 V penlight battery. Strong impact resistant plastic cabinet—size only 4 1/2 x 3 1/2 x 1 1/2 in. Two colour buff/green finish. Complete with test leads and battery. Original list price £25.5

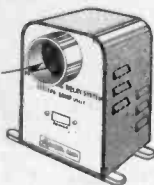


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PHOTO ELECTRIC RELAY



PHOTO MODEL Q4001 Photo Relay System—comprising "exciter" lamp and relay unit. Any interruption of the light beam instantly triggers the relay which in turn will operate light, alarm bell or buzzer, electronic counter, heavy duty relay or electric motor. Many useful applications in the home, office, shop, factory, etc. Operates on 240V. A.C.; exciter lamp 15V, 20W effective up to 15ft. in day-light or 50ft. at night. Very simple to install. In strong metal cases size (each) 8 1/2 x 4 1/2 x 3 1/2 in. Complete with mounting brackets wire and instructions.



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3in. Message tape, 300ft.	7 6	5 1/2 in. Triple play, 2400ft. Mylar	45 0
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5in. Double play, 1200ft. Mylar	15 0	7in. Long play, 1800ft. Mylar	19 6
5in. Long play, 900ft. Acetate	10 0	7in. Double play, 2400ft. Mylar	25 0
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5in. Triple play, 1800ft. Mylar	35 0	7in. Triple play, 3600ft. Mylar	50 0
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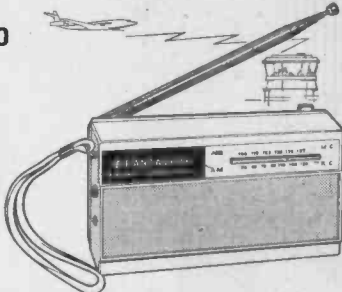
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The first pocket size Receiver of its type allowing you to "tune-in" anywhere to the entire air-to-ground, ground-to-air communications band covered by 108-137 Mc/s in addition to full AM medium wave band cover of 535-1605 Kc/s. An extremely sensitive 10 transistor and 2 diode, superhet circuit plus 1 variable capacitor and 1 thermistor. Intermediate frequencies: AM-455 Kc/s; VHF-10.7 Mc/s. Output power: 200mW. 2 1/2 in. Permanent Dynamic 8 ohm speaker, earphone also provided for "silent" listening. A built-in ferrite rod aerial is provided for AM reception and a fully directional telescopic antenna for VHF reception—the latter when collapsed neatly clips across the top of the set. Power is from 4-1.5V penlight cells and a jack socket for connection to a suitable AC converter is also provided. The Model TV-1008 is extremely well made and finished in grey plastic with metallic blue speaker grille, chrome telescopic antenna; attached wrist strap is also provided. Size 6 1/2 x 3 1/2 x 1 1/2 in. Complete with batteries, magnetic earphone, instructions and circuit data.



Lasky's Price £11.10.0 P. & P. 5/-

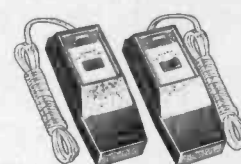
MIDLAND Model 10-502 VHF AIRCRAFT BAND CONVERTER

An entirely new item for the radio enthusiast bringing instant reception of the ground-to-air, air-to-ground waveband. For use with any standard AM or FM radio covering 535 to 1605 Kc/s, 88 to 108 Mc/s respectively—with no electrical conversion or connection required. The Model 10-502 (self powered by one 9V (PP3 type) battery) is merely placed close to the receiving set and then tuned over 110 to 135 Mc/s which covers the whole aircraft communications band. Volume and reception effectiveness is adjusted by moving both sets to the most favourable position and balancing the vol. controls of each accordingly. The Model 10-502 has a smartly designed black plastic cabinet with brushed metal front (inc. knobs), chrome telescopic antenna, size only 4 x 2 x 2 1/2 in. (inc. knobs). Complete with battery and full instructions.



Lasky's Price 79/6 Post 3/6

REMOTE CONTROL SWITCHING SYSTEM

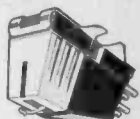


An extremely compact, simple to use and install remote switching system for use with a wide range of mains operated equipment. High freq. signal from the transmitter is relayed to the remote switching unit via the AC mains circuit into which the units are plugged—providing instant on/off—on/off control of appliance. Spec.: 3 transistor and 1 diode circuit. Frequency 190Kc/s (pre-set). Power 220/240V AC. 50/60c/s. Max. power of equip. to be switched—300W plastic cabinets size: 3 1/2 x 2 1/2 x 1 1/2 in., each with neon indicator lamp. Comp. with flex and instructions.

Lasky's Price £7.19.6 Post 5/-

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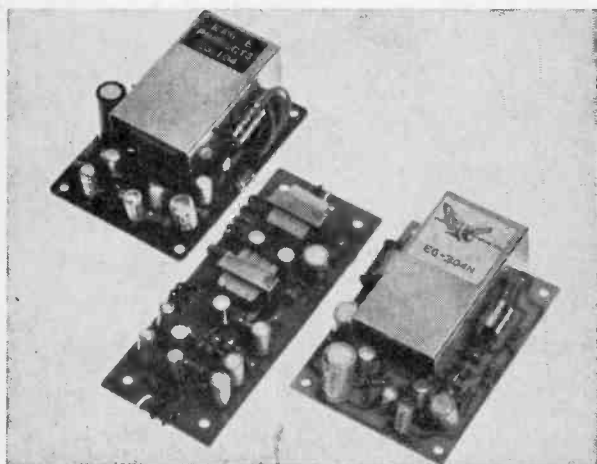
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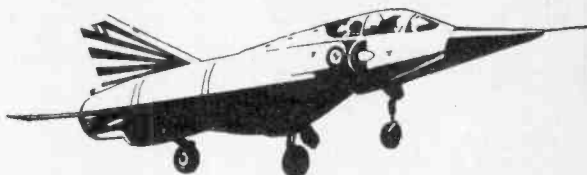


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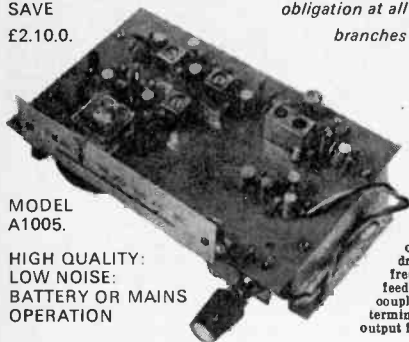
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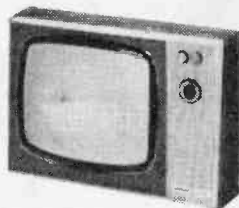
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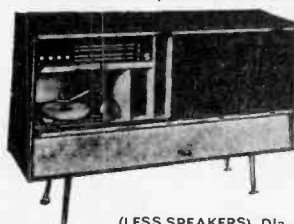
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Components for several receivers are available, including the following for the "Clubman".

T41/1E	1st I.F. Transformer	7/6
T41/2E	2nd I.F. Transformer	7/6
T41/3T	3rd I.F. Transformer	10/6
T41/3T	B.F.O. Coil	10/6

Details of these and our other components are given in an illustrated folder which will be supplied on request with 4d. postage please.

WEYRAD (ELECTRONICS) LIMITED

SCHOOL STREET, WEYMOUTH, DORSET

AERIAL WIRE: Coils of 25 yds., solid 2/8, plus 1/- P. & P.

TEST METERS: Still available ITI/2 20 K ohms per volt, at £3.6.8, plus 3/- P. & P. Also stocked Taylor AVO T.M.K.

TRANSFORMERS: Instrument, 250 volt primary 250 volt secondary 6:3 volt 19/6, plus 3/9 P. & P. Charger, 4 amp for 6 or 12 volt, £1.2.6, plus 3/9 P. & P. Mains 250:0:250 sec 6:3 volt 60mA. 18/9, plus 3/9 P. & P.

HIGH FREQUENCY HORNS: 1 1/2 to 4 1/2 volt, ideal for alarm circuits. 3/6, plus 1/- P. & P.

RELAYS: 12 volt suitable for car alarm, heavy duty contacts, £1.1.9, plus 1/6 P. & P. Small relays for electronic uses, 130 ohm coil, 4 change over contacts operate 6 to 18 volt. 19/6, plus 1/- P. & P. IV-6V Relay. 1 NOC, 30 OHM, 5/-, plus 1/6 P. & P.

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LOUDSPEAKERS: still available 8 ohm 2 1/2in. 7/6, plus 1/- P. & P.

VALVE HOLDERS: B7g, B8a, B8g octal 6d., plus 6d. postage.

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PHONO PLUGS: 5/- doz, plus 1/- P. & P.

WAVE CHANGE SWITCHES: 2 pole 6 way, 3/9, plus 1/- P. & P.

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Member of the Lander Group

NEW RANGE BBC 2 AERIALS

All U.H.F. aerials now fitted with tilting bracket and 4 element grid reflectors.
Loft Mounting Arrays, 7 element, 37/6. 11 element, 45/-, 14 element, 52/6. 18 element, 60/-.
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Complete assembly instructions with every unit. Low Loss Cable, 1/8 yd. U.H.F. Preamps from 75/-.
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BBC · ITV AERIALS



BBC (Band 1), Telescopic loft, 25/-, External S/D, 30/-, "H", £2.15.0.
ITV (Band 3), 3 element loft array, 30/-, 5 element, 40/-, 7 element, 50/-.
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Combined BBC/ITV, Loft 1+3, 40/-; 1+5, 50/-; 1+7, 60/-.
Wall mounting 1+3, 57/6; 1+5, 67/6; Chimney 1+3, 67/6; 1+5, 75/-.
VHF transistor preamps, 75/-.

COMBINED BBC1 - ITV - BBC2 AERIALS 1+3+9, 70/-, 1+5+9, 80/-, 1+5+14, 90/-, 1+7+14, 100/-.
Loft mounting only. Special leaflet available.
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External units available. Co-ax. cable 8d. yd. Co-ax. plugs, 1/4. Outlet boxes, 5/-, Diplexer Crossover Boxes, 13/6. C.W.O. or C.O.D.P. & P. 5/-.
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4-STATION INTERCOM



£7/15/0

Solve your communication problems with this 4-Station Transistor Intercom system (1 master and 3 Subs), in de-luxe plastic cabinets for desk or wall mounting. Call/talk/listen from Master to Subs and Subs to Master. Ideally suitable for Business, Surgery, Schools, Hospital, Office and Home. Operates on one 9V battery. On/off switch. Volume control. Complete with 3 connecting wires each 66ft. and other accessories. P. & P. 7/6.

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No batteries—no wires. Just plug in the mains for instant two-way, loud and clear communication. On/off switch and volume control. Price 12 gns. P. & P. 9/6 extra.

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Same as 4-Station Intercom for two-way instant communication. Ideal as Baby Alarm and Door Phone. Complete with 66ft. connecting wire. Battery 2/6. P. & P. 4/6.

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Why not boost business efficiency with this incredible De-luxe Telephone Amplifier. Take down long telephone messages or converse without holding the handset. A useful office aid. On/off switch. Volume Control. Battery 2/6 extra. P. & P. 3/6. Full price refunded if not satisfied in 7 days.

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HARVERSON'S EXCLUSIVE BARGAIN HI-FI GUITAR AMPLIFIERS



Refurbished units with a peak to peak output of approx. 20 watts. Brief spec: AC Mains 200/240v. EF86, ECC83, 2x ECL82 Bridge Rect. Two inputs via standard jack sockets for 1 or 2 guitars or mikes controlled by single volume control. Separate bass and treble controls. Tremolo with variable speed control and standard jack socket for remote control of tremolo on/off by foot switch. Standard jack socket for speaker output (3 or 15 ohm). Completely self-contained unit in attractive portable case finished in dark rexine with gold trim and folding handle. Size approx. 14 1/2 x 11 1/2 x 8 in. Also capable of really Hi-Fi reproduction when used with a gram deck or radio tuner. Each amplifier is carefully tested and checked by us before despatch, and due to the fact that the cabinets are slightly store soiled we are offering them at the unrepeatable price of £12.12.0. Carr. 10/- Standard Jack Plugs 2/8 each, if required. FOOT SWITCH for tremolo on/off control complete with lead and jack plug 2/76.

BRAND NEW 8 OHM LOUDSPEAKERS

5in. 14/-, 6in. 13/6, 8in. 27/-, 7 x 4in. 18/6, 10 x 6in. 27/6. E.M.I. 8 x 6in. with high flux magnet 21/-, E.M.I. 13 1/2 x 8in. with high flux ceramic magnet 42/- (15 ohm 45/-). E.M.I. 13 x 8in. with two built-in tweeters and crossover network. 3 or 15 ohms 4 gns. P. & P. 5in. 2/-, 6 1/2 x 8in. 2/6, 10 x 12in. 3/6 per speaker.

BRAND NEW 12in. 15w. H/D Speakers, 3 or 15 ohms. Current production by well-known British maker. Now with Hifux ceramic ferrobar magnet assembly £5.10.0. P. & P. 5/-, Guitar models: 25w. £6.00 35w. £8.00. E.M.I. 3in. 4in. HEAVY DUTY TWEETERS. Powerful ceramic magnet. Available in 3 or 8 ohms 15/- each; 15 ohms 19/6 each. P. & P. 3/-.

12in. "RA" TWIN CONE LOUDSPEAKER, 10 watts peak handling, 3 or 15 ohm, 35/-, P. & P. 3/6.

35 OHM SPEAKERS

3 1/2in. 12/6, 7 x 4in. 21/-, P. & P. 2/- per speaker.

VYNAIR AND REXINE SPEAKERS AND CABINET FABRICS app. 54in. wide. Usually 35/- yd., our price 18/8 yd. length. P. & P. 2/6 (min. 1 yd.). S.A.E. for samples.

LATEST COLLARO MAGNAVOX 363 STEREO TAPE DECK. Three speeds 4 track, takes up to 7in. spools. Send S.A.E. for latest prices.

B.S.R. TD8, 4-TRACK STEREO TAPE DECK. Send S.A.E. for latest price.

QUALITY PORTABLE TAPE RECORDER CASE. Brand new. Beautifully made. Only 49/6. P. & P. 8/6. Dual Purpose Bulk Tape Eraser and Tape Head Demagnetiser 35/-, P. & P. 3/-.

ACOS CRYSTAL MIKES. High imp. for desk or hand use. High sensitivity. 18/6. P. & P. 1/6.

ACOS HIGH IMPEDANCE CRYSTAL STICK MIKES. Listed at 42/-. OUR PRICE 21/-. P. & P. 1/6.

SPECIAL OFFER! MOVING COIL STICK MIKE. Fitted on/off switch for remote control. High quality. High low impedance. (State imp. required). BARGAIN PRICE 30/-, P. & P. 2/6.

NEW S.T.C. TYPE 25 MINIATURE RELAYS— 12 volt. 4 s/p, c/o contacts. 1 amp rating. Coll resistance 155 ohms. Size approx. 1 1/2 x 1 1/2 in. high. 10/- each. P. & P. 6/6.

Also some similar to above but coll resistance 5,800 ohms 48 volt operation. 8/- each. P. & P. 1/6.

SPECIAL OFFER! PLESSEY TYPE 29 TWIN TUNING GANG. 400pF + 140pF. Fitted with trimmer and 5:1 integral slow motion. Suitable for nominal 470 kc/s I.F. Size approx. 2 1/2 x 1 1/2 in. Only 8/6. P. & P. 2/6.

MAINS TRANSFORMER. Primary 200-240V two separate 1/2 wave secondaries giving approx. 18V at 1 amp and 20V at 1 1/2 amp; sec. can be connected in series for 36V at 1 1/2 amp. Ideal for transistor power supplies. Drop through mounting. Stack size 2 1/2 x 3 1/2 x 1 1/2 in. 15/-, P. & P. 6/6.

MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240v. Sec. 9-0-9 at 500 mA. 11/-, P. & P. 2/6.

Pri. 200/240v. Sec. 12-0-12 at 1 amp. 14/6. P. & P. 2/6.

Pri. 200/240v. Sec. 10-0-10 at 2 amp. 27/6. P. & P. 3/6.

MATCHED PAIR OF 21 WATT TRANSISTOR DRIVER AND OUTPUT TRANSFORMERS. Stack size 1 1/2 x 1 1/2 x 1 1/2 in. Output trans. tapped for 3 ohm and 15 ohm output. 10/- pair plus 2/-, P. & P.

PARMEKO 7-10 watt OUTPUT TRANSFORMERS to match pair of ECL82's in push-pull. Sec. tapped 3-7.5, 7.5 and 15 ohm. Stack size 2 1/2 x 1 1/2 in. approx. ONLY 12/-, P. & P. 3/6.

7-10 watt OUTPUT TRANSFORMERS to match pair of ECL82's in push-pull to 3 ohm output. ONLY 11/-, P. & P. 2/6.

BRAND NEW MAINS TRANSFORMERS for Bridge Rectifier. Pri. 240v. AC Sec. 240v. at 50mA and 6-3v. at 1-5 amp. Stack size 2 1/2 x 1 1/2 in. 10/6. P. & P. 3/6.

(Special quotations for quantities).

HIGH GRADE COPPER LAMINATE BOARDS

8 x 6 x 1/4 in. FIVE for 10/-, P. & P. 2/-.

TRANSISTOR STEREO 8 + 8 MK II

Now using Silicon Transistors in first five stages on each channel resulting in even lower noise level with improved sensitivity. A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors giving 8 watts push pull output per channel (16W. mono). Integrated pre-amp. with Bass, Treble and Volume controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 3 to 15 ohms. Compact design. All parts supplied including drilled metal work. Cir-Kit board, attractive front panel, knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Freq. response -3dB. 20-20,000 c/s. Bass boost approx. 10+12dB. Treble cut approx. 10-15dB. Negative feedback 18dB over main amp. Power requirements 25V at 6 amp. **PRICES: AMPLIFIER KIT £10.10.0; POWER PACK KIT £3.0.0; TRANSISTOR £3.0.0.** All Post Free. Circuit diagram, construction details and parts list (free with kit) 1/6. (S.A.E.).



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E.M.I. 4-SPEED PLAYER

Heavy 8in. metal turntable.

Low flutter performance 200/

250 v. shaded motor (90 v.

tap). Complete with latest

type lightweight pick-up arm

and mono cartridge with 1/6

stylus for LP/78. LIMITED

NUMBER ONLY 69/-, P. & P. 6/6.

4-SPEED RECORD PLAYER BARGAINS

Mains models. All brand new in maker's packing. E.M.I. MODEL 999 Single Player with unit mounted pick-up arm and mono cartridge..... £5.5.0

B.S.R. UA25 with latest mono compatible cart.... £6.19.6

All plus Carriage and Packing 6/6.

LATEST GARRARD MODELS. All types available 1000

SP25, 3000, AT60 etc. Send S.A.E. for latest Bargain Prices!

PLINTH UNITS cut out for Garrard Models 1000, 1025,

2000, 3000, AT60, SP25. With rigid perspex cover.

OUR PRICE 5 gns. complete. P. & P. 8/6.

SONOTONE STAECH compatible Stereo Cartridge with

diamond stylus 50/-, P. & P. 2/-.

MONO T/O CARTRIDGE. Complete with LP & 78

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FEW ONLY! ACOS GP99/1. For EP and LP 10/-, P. & P. 2/-.

QUALITY RECORD PLAYER AMPLIFIER

A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7" w. x 3" d. x 6" h. Ready built and tested.

PRICE 75/-, P. & P. 6/6.

ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet below. PRICE 97/6. P. & P. 7/6.

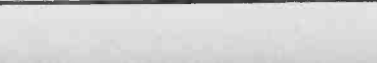
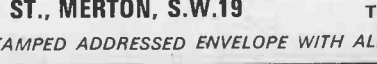
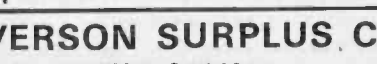
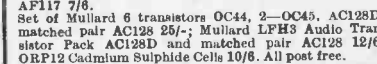
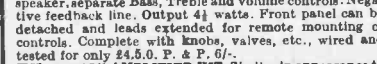
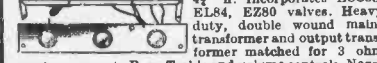
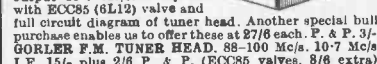
DELUXE QUALITY PORTABLE R/P CABINET Uncut motor board size 14 1/2 x 12in. clearance 2in. below, 6in. above. Will take above amplifier and any B.S.R. or GARRARD autochanger or Single Player Unit (except AT60 and SP25). Size 18 x 16 x 8in. PRICE £29.6. P. & P. 9/6.

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Beautifully designed and precision engineered by Dorman & Wadsworth Ltd. Supplied ready fitted with twin 0005

tuning condensers for AM connection. Preset FM section covers 86-102 Mc/s. I.F. output 10-7 Mc/s. Complete with ECC85 (6L12) valve and full circuit diagram of tuner head. Another special bulk purchase enables us to offer these at 97/6 each. P. & P. 3/6.

BORDER F.M. TUNER HEAD. 88-100 Mc/s. 10-7 Mc/s. I.F. 15/- plus 2/6 P. & P. (ECC85 valves, 8/6 extra)



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Completely self

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unit etc. Works perfectly with our special offer High

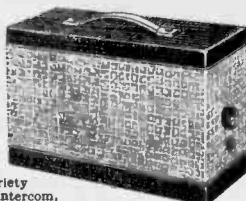
Impedance Dynamic Microphone (30/-). Output 1000mw.

Uses standard 9 volt battery. Smart two tone carrying

case size 12 x 4 x 9in. fitted standard input jack socket,

volume controls, 7 x 4in. speaker. Completely built and

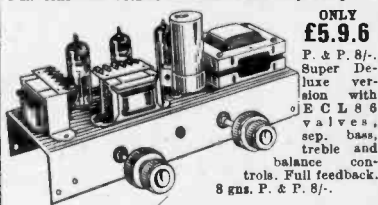
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Only 79/6 P. & P. 5/6

STEREO AMPLIFIER

Incorporating 2 ECL86s and 1 EZ80, heavy duty, double wound mains transformer. Output 4 watts per channel. Full tone and volume controls. Absolutely complete.



HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT Type TA1

- Peak output in excess of 1 1/2 watts.
- All standard British components.
- Built on printed circuit panel size 6 x 3in.
- Generous size Driver and Output Transformers.
- Output transformer tapped for 3 ohm and 15 ohm speakers.
- Transistors (GTT14 or 21 Mullard AC128D and matched pair of AC128 o/p). 9 volt operation.
- Everything supplied, wire, battery clips, solder, etc.
- Comprehensive easy to follow instructions and circuit diagram 2/6 (Free with Kit). All parts sold separately.

SPECIAL PRICE 45/-, P. & P. 3/6. Also ready built and tested, 52/6. P. & P. 3/6.

HARVERSON'S SUPER MONO AMPLIFIER

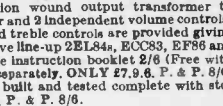
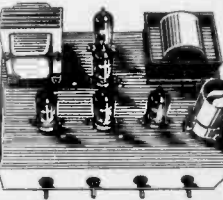
A super quality gram amplifier using a double wound mains transformer, EZ80 rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3.5 watts. Volume and tone controls. Chassis size only 7" wide x 3" deep x 6" high overall. AC Mains 200/240v. Supplied absolutely Brand new, completely wired and tested, with valves and good quality output transformer. LIMITED NUMBER ONLY.

OUR ROCK BOTTOM BARGAIN PRICE 49/6 P. & P. 6/-

10/14 WATT HI-FI

AMPLIFIER KIT

A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15 ohm speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2E184s, ECC83, EF86 and E280 rectifier. Simple instruction booklet 2/6 (Free with parts). All parts sold separately. ONLY 27.9.6. P. & P. 8/6. (No available ready built and tested complete with std. input sockets, £9.5.0. P. & P. 8/6.)



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Tube Station

HARVERSON SURPLUS CO. LTD.

170 HIGH ST., MERTON, S.W.19

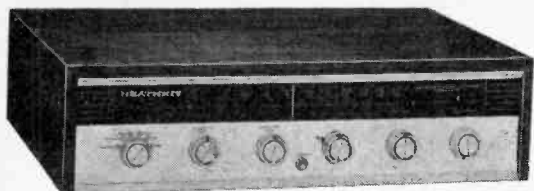
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Here's What's NEW from HEATHKIT in SOLID STATE RECEIVERS

AVAILABLE AS EASY TO BUILD KITS OR READY-TO-USE MODELS



Kit K/AR-14

£54.0.0

P.P.
13/6

Ready to use A/AR-14

£75.0.0

P.P.
13/6

Cabinet £4.10.0. extra

Top Value in a 30 Watt FM Stereo Receiver, AR-14

● 31 transistor, 10 diode circuit for cool, instant operation with the transparent, natural sound only transistors can deliver ● ± 1 dB, 15 to 50,000 Hz at 10 watts per channel continuous (20 watts total). 15 watts per channel IHF music power (30 watts total) ● Wide-band FM/FM stereo tuner plus two preamplifiers and two power amplifiers. ● Front panel stereo headphone jack. ● Compact—just 3½" H x 15½" W x 12" D. ● Custom install it in wall, your own cabinet, or use as a free standing unit. ● Build it in 20 hours.

Kit K/AR-14 (less cab.)

kit £54.0.0. P.P. 13/6

A/AR-14 (less cab.)

£75.0.0. P.P. 13/6

Cabinet extra: Teak or Walnut finish £4.10.0



Kit K/AR-17

£39.0.0

P.P.
10/6

Ready to use A/AR-17

£59.0.0

P.P.
10/6

Cabinet £3.10.0. extra

Unbeatable Value in a 14 Watt FM Stereo Receiver, AR-17

● 28 transistor, 7 diode circuit for natural transparent sound, instant operation, long trouble-free life. ● 14 watts music power, 10 watts RMS from 25–35,000 Hz at ± 1 dB. ● Automatic stereo indicator light. ● Adjustable phase control for maximum separation. ● Complete front panel controls. ● Flywheel tuning. ● All critical circuits including FM "front-end" factory assembled and aligned. ● Circuit board assembly. ● Compact 10½" D x 3" H x 12" W. ● Front panel stereo headphone jack.

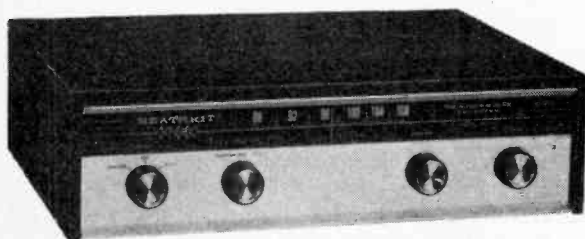
Kit K/AR-14 (less cab.)

kit £39.0.0. P.P. 13/6

A/AR-14 (less cab.)

£59.0.0. P.P. 13/6

Cabinet extra: Teak or Walnut finish £3.10.0



Kit K/AR-27

£22.10.0

P.P.
10/6

Ready to use A/AR-27

£32.0.0

P.P.
10/6

Cabinet £3.10.0 extra

A Quality Table Radio FM Mono Receiver, AR-27

● 13 transistor, 6 diode circuit for high-fidelity sound reproduction, long life, low heat, freedom from hum, and service-free operation. ● 7 watts music power. ● ± 1 dB, 25 to 60,000 Hz at 5 watts. ● Input connectors for phonograph and auxiliary signals. ● Complete front panel controls. ● Flywheel tuning. ● Preassembled and prealigned FM tuner, all other critical parts factory aligned. ● Easy, circuit board assembly. ● Compact bookshelf size. ● 3-way installation... wall, free standing or in a suitable cabinet. ● 117 v. A.C. or 210/240 v. A.C., 50 Hz operation.

Kit K/AR-27 (less cab.)

kit £22.10.0. P.P. 10/6

A/AR-27 (less cab.)

£32.0.0. P.P. 10/6

Cabinet extra: Teak or Walnut finish £3.10.0



CHOOSE A QUALITY
HEATHKIT LOUD-
SPEAKER SYSTEM
TO GET THE BEST
FROM YOUR AUDIO
SET-UP.

BERKELEY LOUDSPEAKER SYSTEM

Use two for stereo. Best performance from a slim-line cabinet. Uses less than 1 sq. ft. of floor space. Available in Teak or Walnut finish.

Kit

£21.4.0

P.P.
13/6

Ready to use

£24.0.0

P.P.
13/6



See how easy it is to build any Heathkit model. Purchase a manual only. British manuals 10/- each. American manuals £1 each incl. P.P. Price of manual deductible from kit if you buy later.

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HEATHKIT Models for Family Entertainment

OFFERS THE BEST IN SPECIFICATION AT LOWEST COST

Latest STEREO TAPE RECORDER, STR-1



Fully portable—own speakers

Kit K/STR-1
£58.0.0. P.P. 10/6

Ready-to-Use A/STR-1
£72.0.0. P.P. 10/6

FOR THIS SPECIFICATION

$\frac{1}{2}$ track stereo or mono record and playback at 7 $\frac{1}{2}$, 3 $\frac{3}{4}$ and 1 $\frac{1}{8}$ ips. Sound-on-sound and sound-with-sound capabilities. Stereo record, stereo playback, mono record and playback on either

channel. 18 transistor circuit for cool, instant and dependable operation. Moving coil record level indicator. Digital counter with thumbwheel zero reset. Stereo microphone and auxiliary inputs and controls, speaker/headphone and external amplifier outputs... front panel mounted for easy access. Push-button controls for operational modes. Built-in stereo power amplifier giving 4 watts rms per channel. Two high efficiency 8 x 5in. speakers. Operates on 230V a.c. supply.

Versatile recording facilities. So easy to build—so easy to use.

Latest STEREO AMPLIFIER, TSA-12

12 x 12 watts output.

Kit K/TSA-12

£32.16.0. less cabinet. P.P. 10/6

Cabinet £3.16.0. extra

Ready-to-Use A/TSA-12

£39.10.0. P.P. 10/6



FOR THIS SPECIFICATION

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UXR-1

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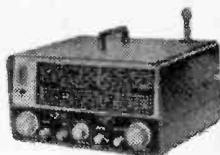
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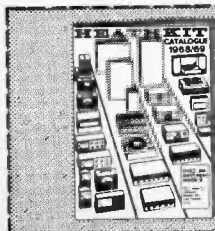


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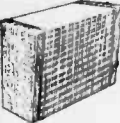
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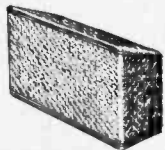
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6AQ5	4/9	30L15	14/-	EOC82	4/9	KT61	8/9	PY80	5/3	UY41	7/-
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6AU6	5/6	30P4	12/-	ECC84	5/6	N78	14/9	PY82	5/-	VP4B	10/6
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6B76	7/-	30PL1	12/6	ECF80	7/-	PC88	9/6	PY800	6/9	Transistors	
6BW6	13/-	30PL13	14/6	ECF82	6/9	PC86	8/6	PY801	6/9	AC107	3/6
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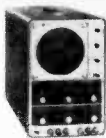
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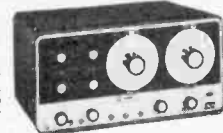


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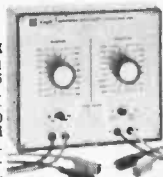
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6A86	6/	12AX7	6/	EB8C	12/6	EL41	9/9	PCJ84	8/	UL41	10/
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6AU6	5/9	12BH7	6/6	EAF42	9/6	EL84	5/	PLF20012/6		VR105/30	
6BA6	4/6	12C7	5/6	EB91	3/	EL85	8/6	PF26	10/6		5/6
6BE6	5/3	12C7	7/	EB94	8/	EL81	7/6	PL81	7/6	VR150/30	
6C6	3/6	19A05	6/	EBM1	7/	EL85	5/3	PL82	7/6		5/
6BR7	8/	20F2	14/	EBF80	7/6	EL90	7/6	PL83	7/		
6BR7	11/	20L1	13/	EFB83	9/	EM81	8/	PL84	8/6		
6BZ6	7/	20P1	12/	EFB95	7/6	EM84	7/6	PL500	14/6	MANY	
6C4	3/6	20P3	12/	ECOA0	11/6	EM87	7/6	PV33	9/9	OTHER	
6C8	4/	30P4	22/6	ECO81	4/	EV51	7/6	PV80	5/6		
6C8	20/	25L6	6/6	ECB82	8/	EV86	7/	PY81	8/	TYPES IN	
6C86	8/	28Z4	8/	ECB87	8/	EV87	7/	PY82	8/		
6CL8	10/	30C1b	13/6	ECB84	6/6	EZ41	8/6	PY83	8/6	STOCK.	
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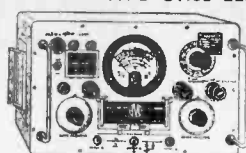
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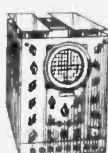
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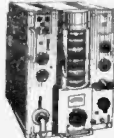


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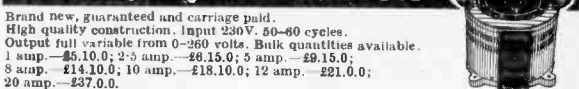


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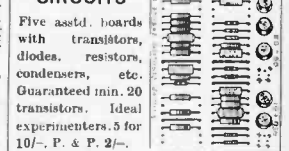
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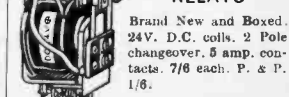


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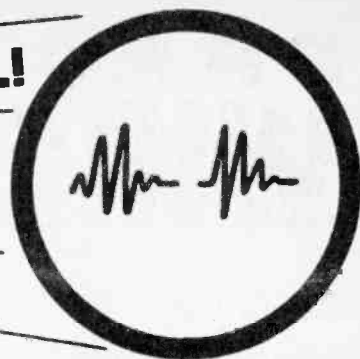
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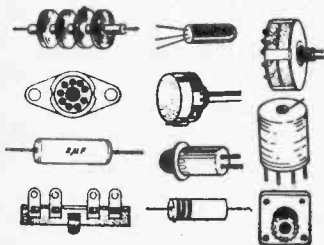


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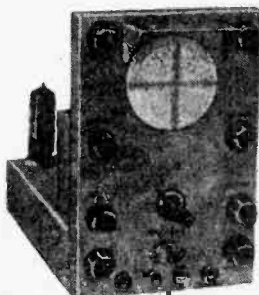
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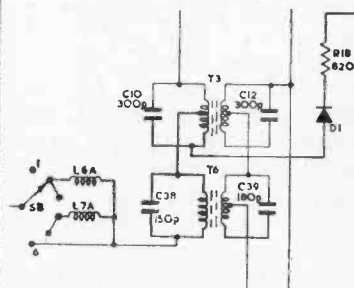
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PRACTICAL WIRELESS

VOL 44 No 9

Issue 743

JANUARY 1969

TOPIC OF THE MONTH

State-of-the-Art

SEMICONDUCTORS personify the modern image of radio and electronics, even for the home constructor, yet on looking back over the years some quite surprising facts emerge. We can, in fact, go back to Munk Af. Rosenshold who in 1835 discovered that certain solid substances possessed rectifying properties. As is so often the case, he was in advance of his times and the idea lay dormant until rediscovered by F. Braun in 1874.

A year before this, a checker working on underwater telegraph cables noticed that the resistance of a certain material varied according to the light falling on it. The material was selenium and three years later it was discovered that this material possessed the property of rectification.

These facts lay virtually untapped until the turn of the century when, strangely enough, thermionic valves and what we now call semiconductors vied with each other for popularity. For many years, however, it was the semiconductor which reigned supreme and it is interesting to note that in 1906 Pickard invented a silicon detector for use in wireless equipment, a device which was in fact a point-contact rectifier. Three years later Eccles devised a crystal diode oscillator. Later, in 1924, Lossev achieved oscillations with semiconductor diodes.

During the late 1920's and the 1930's the thermionic valve ousted semiconductors but during World War II crystal detectors were widely used in radar equipment. Then in 1941 came another landmark—the invention of the junction diode—and the way lay open for a remarkable comeback of semiconductors.

In December 1947, Bardeen and Brattain produced in the Bell Telephone Laboratories a crude prototype of a crystal triode and this device, named the transistor, was the one which can be said to have administered the *coup de grace* to the future of thermionic valves. From this starting point sprang the junction transistors and other modern semiconductor devices, leading to the integrated circuits now beginning to become a vital factor in the progress of radio and electronics.

The age of the solid state can, therefore, be said to have really begin 21 years ago, and in saluting the many pioneers who have made this possible we celebrate the occasion with a special feature starting on page 664.

W. N. STEVENS—*Editor*.

NEWS AND COMMENT

Leader	661
News and Comment	662
Radio Engineering and Communications Exhibition	669
Letters to the Editor	674, 677
CQ!CQ!CQ!CQ!CQ!CQ!	683
Practically Wireless by Henry	693
New Books	702
On the Short Waves by Christopher Danpure and David Gibson, G3JDG	705
Club Spot—Leyton and Walthamstow, G3WHY	709
MW Column by C. Molloy	710

CONSTRUCTIONAL

Miniature IC Hearing Aid Amplifier by L. McNamara, B.Sc.	670
Simple Capacitance Bridge by P. Cassidy	678
Pyramid—All Purpose System, Part 5 Three Waveband Superhet Tuner by F. G. Rayer	680
5—15Mc/s Converter by R. F. Graham	690

OTHER FEATURES

The Solid State by I. R. Sinclair	664
Repairing Radio Sets, Part 1 by H. W. Hellyer	684
P.W. Guide to Components Part 2—Capacitors by M. K. Titman, B.Sc.	694

FEBRUARY ISSUE WILL BE PUBLISHED
ON JANUARY 10th

All correspondence intended for the Editor should be addressed to: The Editor, "Practical Wireless", George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Phone: TEMple Bar 4363. Telegrams: Newnes Rand London. Subscription rates, including postage: 42s. per year to any part of the world. © George Newnes Ltd., 1969. Copyright in all drawings, photographs and articles published in "Practical Wireless" is specifically reserved throughout the countries signatory to the Berne Convention and the U.S.A. Reproductions or imitations of any of these are therefore expressly forbidden.

NEWS AND COMMENT...

TRUVOX INTEGRATED CIRCUIT STEREO TUNER



The first British f.m. stereo tuner using integrated circuits and field-effect transistors has been introduced by Truvox Ltd. (of Hythe, Southampton).

Designed from the outset specifically for stereo reception (mono reception is of course automatic when stereo is not being received), the new model is designated the Truvox Series 200 IC Stereo Tuner. It joins the recently introduced Truvox Series 200 range; hi-fi amplifier, tuner, loudspeakers, mono and stereo tape recorders.

Sensitivity is $2.0/\mu\text{V}$ for 30dB quieting IHFM, $1.5/\mu\text{V}$ for -3dB limiting, $5.0/\mu\text{V}$ for 200kc/s bandwidth. Frequency response is: 20c/s to $15\text{kc/s} \pm 1\text{dB}$ before de-emphasis and steep notch filters. Price is £59 10s. 0d.

ISWC ANNIVERSARY 1929-1968

Surely something to celebrate. The existence of the ISWC for 40 years. The ISWC image was created on 4th October, 1929, by a little band of short wave enthusiasts in the USA, among them Arthur J. Green, Jacob Kleimans, Joseph B. Session, Charles Schroder and George F. Brooks. To form a medium for the exchange of short wave station information and a contact among those who were interested. Short wave radio was a new thing. There were only a few experimental stations on the air. No one had ever thought to publish news on short wave stations. It was essential for the listeners who were interested to have some information on the stations that were to be heard if they were to have an equal chance of hearing them, for there was no other guide. No other short wave clubs. No World Radio Handbooks. No Sweden Calling DX-ers or the like. No DX Parliament or European DX Council. ISWC were publishing International Short Wave Radio and membership was spreading across the world, bringing with it a greater exchange of information and the fostering of international friendship through short wave radio and the ISWC. ISWC is a non-commercial organisation end for those who work for it, it is a labour of love.

RODING BOYS' SOCIETY: HOLLOWAY BRANCH

The active boys' Radio/Science Club based in Walthamstow, and known as the R.B.S. has a group going in the Holloway area now. Any keen young people in this area who would like to join in helping to build up the club room and facilities, are very welcome to contact us. Please write or call: David Huntly, 262 Hornsey Road, N.7.

Any boys in the other area (Waltham Forest) are, of course, very welcome to visit the Club there. Any enquiries concerning the Society can be sent to: Ken Smith, G3JIX (Leader), 82 Granville Road, Walthamstow, E.17.

RADIO 2 COVERAGE IN SCOTLAND

On 1st October the BBC opened two additional transmitters, at Dundee and Redmoss (Aberdeen) transmitting Radio 2 on 202 metres (1484kc/s). The cities of Dundee and Aberdeen, and their environs, are served by the new transmissions.

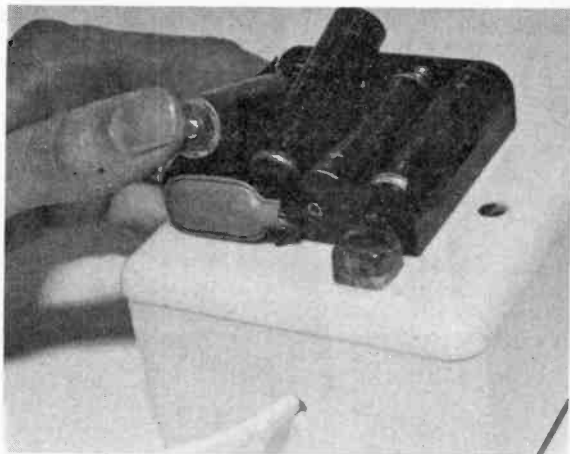
On the same date the wavelength of the existing Radio 3 transmitter at Dundee will change from 194 metres (1546kc/s) to 188 metres (1594kc/s).

The new transmitters at Dundee and Redmoss will join the existing stations at Edinburgh and Glasgow on 202 metres in augmenting the medium-wave coverage of Radio 2 in Scotland. The Edinburgh and Glasgow transmitters were recently increased in power to provide further improvements in the service. These four stations offer good reception of Radio 2 to many listeners who have difficulty in receiving the long-wave transmissions on 1500 metres (200kc/s) from Droitwich.

NEW RADIO 1 TRANSMITTER

On 3rd November the BBC opened a new Radio 1 transmitter to serve the Bournemouth area, on 202 metres (1484kc/s). This transmitter extends the coverage of Radio 1 to Bournemouth and Poole and their environs bringing the number of Radio 1 transmitters to seventeen.

PUT ON A CHARGE!



A low-priced battery charging system called "Pencil" is announced by DCB Instrument & Lighting Company of Austin House, Croft Road, Crowborough, Sussex.

Recent field tests have demonstrated that the MN 1500, the popular battery in the transistor radio and photographic fields, can be recharged between ten and thirty times (depending upon operation conditions) by the "Pencil" Battery Charger.

As a replacement set of alkaline manganese 1500 type cells costs 11s. and has a limited life in a transistor radio, it is apparent that the initial outlay of 79s. 6d. which includes four alkaline manganese 1500 type cells, is soon recovered. For further details contact DCB Instrument and Lighting Company, Austin House, Croft Road, Crowborough, Sussex.

NEWS AND COMMENT...

HOME ELECTRICIANS KIT



The new Bib Home Electricians Kit comprises of the new Model 5 self-opening wire stripper and cutter, a reel of insulating tape, 5 and 15 amp fuse wire, Ersin Multicore match melting tape solder (no soldering iron required), two Bib flex shorteners, for shortening leads and cables without cutting, and plug size screwdriver to suit all types of domestic plugs. Price is 14s. 6d.

GET IT TAPED LADS!

Philips Electrical have invited Britain's half-a-million Scouts to take part in a £1,000 tape recording contest.

Trips to Holland, tape recorders and accessories and special tours of recording studios are among the prizes offered. Cub Scouts (8-10 years), Scouts (11-15 years), Venture Scouts (16-20 years), adult leaders and regular supporters are all catered for in the various sections of the contest.

Typical recording assignments asked for by the organisers are: a tape-recorded report of an expedition, a dramatic or musical item including pop and folk music, a series of sound effects, a message for Scouts overseas and interviews with local personalities.

Entries have to be between three and five minutes' duration and recorded at $1\frac{7}{8}$ or $3\frac{3}{4}$ inches per second. Closing date is 1st March, 1969. Entry forms are available from all major Philips agents and Gilwell Park International Adult Leader Training Centre, Chingford, London, E.4.

CONCRETE-TRANSISTOR??

A "concrete-transistor" developed at the USSR Institute for Industrial Concrete Structure and Goods Prefabrication is employed at leading Soviet enterprises for reinforced-concrete element prefabrication. It is designed for controlling the strength and homogeneity of steel-concrete elements and structures and can be used for the defectoscopy of wood, ceramics and other building materials.

The instrument measures the rate of the diffusion of longitudinal ultrasonic waves in the material under investigation; quality can also be appraised by the magnitude of these waves. Errors in determining the strength of concrete lie within a narrow range, as compared with the results of compression tests by mechanical methods.

The measuring principle employed in the circuit does not require the use of an electron-beam oscillograph which is essential for measuring the time of supersonic diffusion. The system of discrete time count makes lower demands on the operator and precludes objective errors.

MW-DXers PLEASE NOTE

If you are interested in medium wave DX, please note that the fifteenth series of Medium Wave News is now being published. Issued to subscribers monthly from November to April, plus an extra one in June, this newsletter is packed with comprehensive and up-to-date news of medium wave DX happenings. It includes as regular features, the monthly DX log, World of Radio and Verification Section, together with such articles as Antenna Forum, Reception Analysis and other information features. This publication is essential for the keen MW-DX fan. Details from K. Brownless, 7 The Avenue, Clifton, York, YO3 6AS. Please enclose a s.a.e. Please note that we are starting our MW Column on page 710.

GERMAN STEREO



Two new mains operated stereo record players are announced by Bruns of Hamburg, Germany. They are model SH 41 St with a manual 4-speed deck and model WH 50 St with 4-speed autochange deck (see photograph). Double wide frequency response transistorised amplifiers feed separate $6\frac{1}{2}$ in. speakers through individual gain and tone controls. Output is 2×2 watts. The speakers are neatly housed in the twin cabinet lids. Dimensions: $17\frac{1}{2} \times 10 \times 5\frac{1}{2}$ in. Finish is dark walnut. Recommended retail prices: SH 41 St 30gns. (inc. P.T.); WH 50 St 40gns. (inc. P.T.)

OTLEY RADIO SOCIETY

Meetings are held every Tuesday evening at our own premises in Otley. The Society has its own call sign—G3XNO—which is on 160 metres every Tuesday evening. Four members recently passed the Radio Amateurs' Examination and are now learning morse while another nine members are running an RAE course for next year's examination.

On 10th September we held an open evening welcoming wives and friends of members, forty people in all being present. Members had been making radio and electronic equipment for several months to enter the Construction Competition which was judged by three visitors during the evening. The winner of the senior section was K. Pickard with an Electronic Time Switch with Binary readout, and in the junior section P. Fox with a Transistor Stereo Amplifier.

Further details about the Society are available from the Publicity Officer, M. T. George-Powell, G3NNO, 82 Forest Avenue, Starbeck, Harrogate.



PART 1

IT is now almost exactly twenty-one years since William Shockley, working at the Bell Telephone Laboratories, announced that he had constructed the first working transistor. In the intervening years that primitive point-contact laboratory curiosity has grown into a precision device produced in millions, and has bred a host of newer devices, including f.e.t.s, thyristors, tunnel diodes and diode lasers all of which were undreamt of only twenty-one years ago.

That discovery did more than 'produce a new device, a new technology and a new industry: it brought to the attention of everyone the remarkable advances in a branch of physics which had up till then been the province of a few researchers—the physics of the solid state. Those of us who had been familiar with the ideas of vacuum physics and their application in thermionic valves suddenly had to accustom ourselves to talking of holes, lattice defects, impurity conductivity, traps, tunnelling and all the rest of the language which solid state electronics developed. Since then it has been as much as electronics engineers could do to keep up with the circuit behaviour of new devices without having to cope with their theory of operation.

The time has come, however, when it is more and more difficult to understand the newer devices without at least a smattering of such understanding. The physics which we learned at school is of little use to us in this connection: even at "A" level it deals with very little which was not known in 1850. We must now learn the physics which has developed in this century, containing ideas which seem so strange as to be almost unbelievable but whose proof is all around us.

Electronics may be said to have started with the discovery that atoms, the basic units from which all substances are made, can be split into *nuclei*, which

are heavy and positively charged, and *electrons*, which are light and negatively charged. Before the end of the nineteenth century it had been shown that electrons were the same as the "cathode rays" which had been observed in gas discharge tubes, and their important properties, attraction to a positive plate and repulsion by a negative one, deflection by a magnet, heating a substance struck by them and fluorescence in certain minerals, were all well known.

At that time the atom was thought to consist of a core, the nucleus, with the electrons clinging to it tightly, but the work of Rutherford and others (including Geiger, of Geiger-Müller counter fame) showed that the structure behaved much more like a very small positive core, the nucleus, surrounded by electrons at a distance very large compared with the diameter of the nucleus (about 100,000 times). The nucleus was positively charged and the number of negatively charged electrons was just enough to balance the positive charge on the nucleus.

The problem which next arose was why the atom did not collapse due to the attraction of the positive nucleus and the negative electrons. The most obvious answer was that the electrons were spinning round the nucleus at such a speed that the centrifugal force exactly balanced the electrical forces, but this still did not explain why the electrons should not gradually spiral into the nucleus, just as a weight tied to a string and revolving round a pole gradually loses energy and moves in "ever decreasing circles" in the manner of the legendary oozlem bird.

This puzzle was solved by a series of guesses. Anyone can guess, but it takes a genius to guess correctly in matters of this sort, and the guessers in this case were called Planck, Bohr and Sommerfeld. In 1900 Planck had put forward his Quantum Theory which implied that *everything* was atomic, and that there were atoms of light, electrical and mechanical energy, and all radiated waves. These "atoms" of light and radiation he called "quanta". One quantum, he thought, was the least amount of energy change which could take place. At first sight this did not seem reasonable; it was like saying to an electrical engineer "You may have supplies of 200V, 220V, 240V etc., but never 210V, 230V etc." Nowadays we are accustomed to the idea of quantities varying in steps: we have tapped transformers, wire wound potentiometers, preferred value resistors, and although these are large steps the idea is there. The quantum is a *very* small amount of energy (6.6×10^{-27} erg/sec.) and our senses could hardly distinguish such small steps of energy from a smooth change. When we are dealing with atoms, however, the difference is important, and we must use the quantum theory. The quantum theory was extremely successful: it explained exactly the relation between the energy of radiation and the temperature of the radiating object, and was used by Einstein

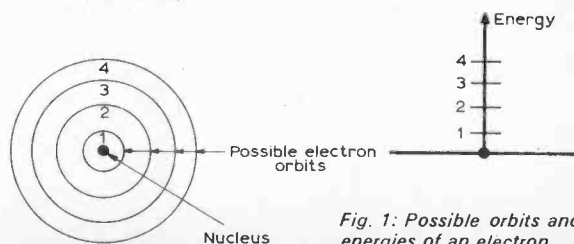


Fig. 1: Possible orbits and energies of an electron.

to explain photoemission—the idea being that one quantum could eject only one electron from a substance.

When Bohr and Sommerfield applied quantum theory to the atom (Fig. 1) they used the principle that the energy of an electron could only be one of a series of energies or energy states which were each a quantum of energy apart. This idea, dating from 1915, is one of the most important principles in physics. In its later form of Quantum Mechanics it has explained and led to the construction of such devices as masers, lasers and transistors in the field of electronics alone.

One more point remains before we can move on to the problems of solid state physics. Experiments in 1927 showed that beams of electrons could behave exactly like beams of short-wave light, and that there was a direct connection between the energy of the electron beam and its apparent wavelength. Mathematicians later showed that the same equations which were used to describe light and other forms of radiation could also be used to describe electrons, and this approach, founded by de Broglie and Schrodinger, has been immensely useful in work on the theory of solids.

PROBLEMS OF SOLIDS

To any physicist of the last century the structure of solids seemed to be one of the most difficult of all problems and one least likely to be solved. It was generally agreed that the difference between solids, liquids and gases was one of the spacing between the atoms, the atoms in liquids being rather farther apart than in solids, and the atoms in gases much farther (ten times) apart. This was sufficient to explain such matters as boiling and freezing and latent heat but many others could not be explained.

Among the inexplicable problems was electrical conductivity. If we compare the electrical conductivity of different solids, the most striking fact is the huge range of values. The conductivity of the best conductor at room temperature (silver) is about 10^{30} (a short way of writing the figure 1 followed by 30 zeroes) times the conductivity of the poorest (p.t.f.e.), yet both these substances are solids, made of atoms which are constructed of nuclei and electrons. If, as we believe, electrons are the means of carrying electric current in solids—and they certainly are in gases (at low pressure)—why is there this difference, which is the greatest span of difference in all measurable quantities?

Solids also differ greatly in their ability to conduct heat. Schoolboys used to be taught that a good electrical insulator was a good heat insulator, but experiments on the conduction of heat at low temperatures showed that sapphire crystals were better conductors of heat than any metals, though they were electrical insulators.

These questions were difficult enough, but there were many other curiosities to explain. Why should certain metals and alloys be strongly magnetic though the remainder of solids were only very weakly magnetic? What was so special about the arrangement of atoms which decided whether a substance was a metal or a non-metal? Why did some crystals (such as quartz) vibrate in an alternating electric field? These and scores of other questions had to be explained by any theory of the solid state.

BAND THEORY OF SOLIDS

The simplest possible case of atomic structure is the structure of hydrogen gas, whose atom consists of a nucleus with one electron. Simple here is a comparative term; neither the physics nor the mathematics of the problem is simple, but the basic ideas can be simply described. The electron belonging to one nucleus can have various possible values of energy but *no intermediate values* (Fig. 2). At room temperature most of the electrons are in the

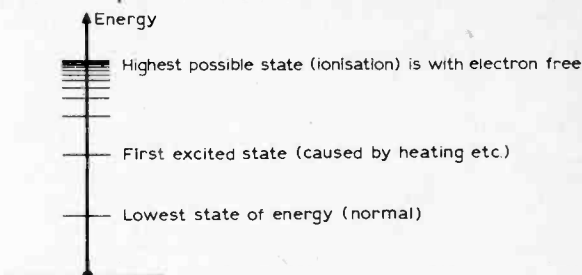


Fig. 2: Energy diagram for one electron in an atom. Note how the levels become crowded together until separate levels become indistinguishable when the electron is free (atom ionised).

lowest state of energy, but by very great heating or by the effect of light or electric current electrons can be made to have higher energies. Note particularly that they must change instantly from one energy value to another without ever having any intermediate value, and the amount of energy used to cause this change must be exactly the difference in energy between the two states. When electrons return to the normal low state, this energy is given out; in most cases this appears as light of a definite wavelength.

When we examine more complex atoms we find the same type of structure—a nucleus surrounded by electrons—but it turns out that there is a special restriction on the way electrons can be arranged. If we take a given energy level, which for convenience is described by a set of “quantum numbers” which act as map references, we find that only two electrons can occupy a level, and even these two are not identical in energy because they spin around their own axis in opposite directions. We may imagine the system as a ladder with the nucleus at the foot and two electrons on each rung (though the laws about the spacings of the rungs are rather more complex) so that electrons can climb up the ladder when a suitable amount of energy is put into the atom, and fall to the lowest unoccupied rungs when left alone, releasing energy in this process.

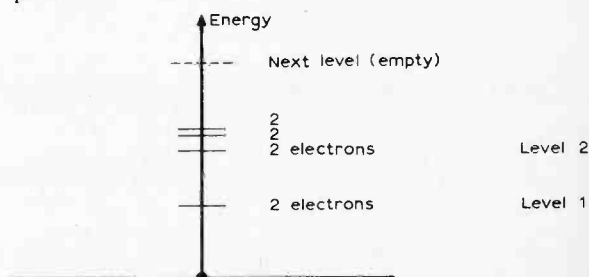


Fig. 3: Energy diagram for a nucleus with eight electrons (oxygen). Note that level 2 is split into three sub-levels each containing the maximum two electrons allowed.

This picture of the structure of a substance (Fig. 3) works well for gases, where the atoms are so far apart that each nucleus affects only its own electrons. In a solid, however, the atoms are so close that there is a considerable amount of interaction between one nucleus and the electrons belonging to the neighbouring nuclei, and this interaction holds the clue to the differences in the behaviour of solids. To deal accurately with the interactions of just two atoms is a problem in mathematical analysis of the greatest difficulty; to describe accurately the behaviour of millions of atoms is impossible, but a combination of experiment and theory has enabled us to arrive at ideas of solid structure which have fulfilled the most important test—that they work. The theory is called the *Band Theory of Solids*.

If we take two atoms at a considerable distance, each with its electrons arranged in their appropriate energy levels, and then force the atoms together, the energy levels do not remain unchanged. Instead the attraction of each nucleus for the other's electrons causes the levels to be displaced in such a way that a range of energies is possible for the electrons which formerly occupied the various levels in the two atoms (Fig. 4). When this happens, we refer to each range of energies as a *band*.

When a large number of atoms is arranged in a regular way in a crystal of a solid the bands of energy are fairly wide and contain a large number of electrons. If the energy levels of each atom which has contributed to the band are completely occupied by electrons then the band also will be completely occupied.

However, if the energy levels are *not* filled either because the atom naturally had these levels unfilled or because the electrons have moved to a higher level because of energy changes, then the band formed by the atoms coming together will also not be filled. In general if a band is formed from a given number of atoms then it will be full if it

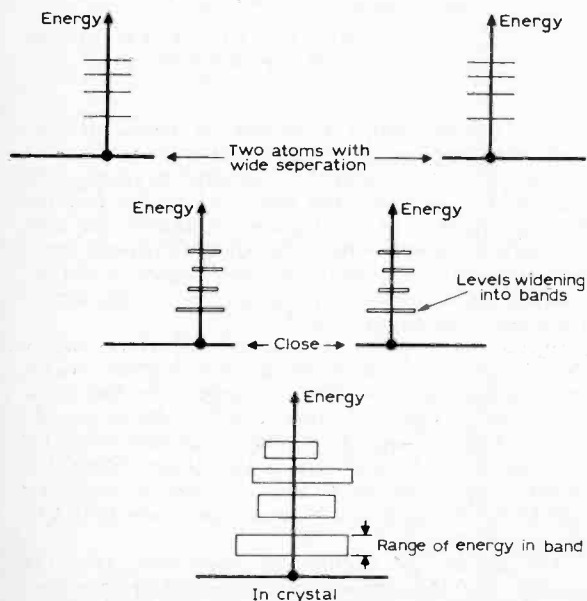


Fig. 4: How the energy levels broaden into energy bands as atoms approach.

is occupied by exactly twice that number of electrons.

There is a vitally important difference between a filled band and an unfilled band. When a band is filled, there is no possibility of electrons moving from one nucleus to another. A full band is like a road completely jammed with cars; unless some gap occurs, no movement is possible except some shunting. In a band which is not filled, however, there is no restriction on electron movement. There is no change needed in energy for an electron to move from one nucleus to another, providing that there is not another electron of the same energy there, and in an unfilled band there need not be. When this occurs, then the solid is a *conductor* of electricity. A metal could, in fact, be defined as a substance containing unfilled energy bands. Conversely a substance with its energy bands completely filled is an *insulator*. If we heat such a substance sufficiently we can give the electrons sufficient energy to move to a new band which is unfilled, so causing the insulator to conduct, a fact which is known and used.

ENERGY GAPS, OVERLAPS, HOLES

The theory that the energy levels of single atoms merge with each other to form bands does not ignore the differences in energy between different levels in the same atom. When atoms come together, the energy bands may still be separated from each other—our ladder rungs may have become sloping platforms—but there may still be a jump from the top end of one platform to the bottom end of another. In some substances, however, the bands may overlap, allowing electrons which had been at the lowest level in one atom to reach a higher level of another with no jump. There may on the other hand be large gaps between the bands, and no electron can ever have an amount of energy corresponding to an amount in a gap, just as no one can stand on a rung which is missing! If the gap between bands is large a large amount of energy (heat, light etc.) must be put into the substance to move electrons from one band to another; if the gap is small, very little energy is needed.

This then is the difference between insulators and semiconductors. Both have filled energy bands, but higher energy bands exist which are empty. In an insulator the gap between the top filled band and the empty band is large; in a semiconductor this gap is small and even at room temperature a few electrons can make the crossing to the unfilled band to cause some degree of conductivity.

This is not the whole story, however, as it turns out that electrons in the unfilled band do not form the only contributor to conductivity. Since the electrons have come from a filled band they have caused vacancies in this formerly filled band allowing some movement in that band; i.e. gaps have appeared in our traffic jam. Since it is easier to think of one gap moving in a band rather than millions of electrons shuffling around, we talk of this gap or *hole* as if it were an object with mass and a positive charge, and in fact it behaves as if it were just this (Fig. 5).

The contributions of holes to conductivity were discovered by measurement of the Hall effect, which was predicted in the last century. If current is

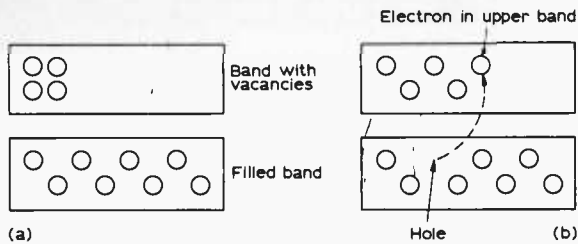


Fig. 5: How a hole is formed in semiconductor material.

passed through a slab of material to which a magnetic field is applied at right angles to the direction of current, the electrons moving in the material are deflected in exactly the same way as the electrons in a cathode-ray tube are deflected by a deflection coil (Fig. 6). This deflection causes one side of the slab to be more negative than the opposite side, because of the deflection of electrons to that side. The voltage difference is extremely small so that accurate measurements of Hall effect were not possible until comparatively recently, but it is detectable and the predicted negative voltage can be found in several metals. In other metals, however, the voltage is *positive*, indicating that the charge carriers are either positive or moving in the opposite direction.

It is sometimes argued that holes are not real particles having mass and charge and that it is misleading to write as if they were. Such fictions are often desirable, however. Electrons in semiconductors often respond to voltages as if they had less mass (even negative mass, if such a thing can be imagined) or charge than normal free electrons and it is easier to keep the usual equations of movement and use the effective mass or charge of the electron as if it were real. In the same way, the hole is a convenient way of treating a problem and for practical purposes it is no less of an experimental reality than is the electron.

SEMICONDUCTORS

In a pure specimen of semiconductor crystal there is a vacant energy band which is only slightly separated from a full band. The gap between these

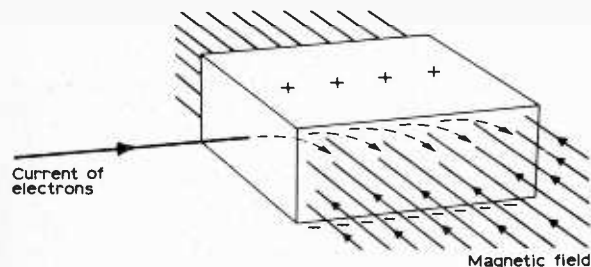
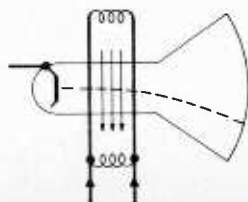


Fig. 6: The Hall effect. A magnetic field (above) causes the path of current in a material to be deflected just as electrons in a c.r.t. (right) are deflected, causing a difference in voltage between opposite sides of the material.



bands varies from one material to another (and is less in germanium than in silicon) but is small enough to allow some electrons to be kicked into the vacant band even at room temperature. Increasing the temperature of the crystals causes very many more electrons to cross over so increasing the conductivity rapidly as temperature rises. It is for this reason that all semiconductor devices are sensitive to temperature changes (as would be valves if they had to work in an atmosphere which was at the same temperature as their cathodes), germanium being more sensitive than silicon because of its smaller energy gap.

Heating a semiconductor increases the number of electrons contributing to conduction and also increases the number of holes since each electron leaves a hole in the otherwise full band. This type of conductivity in pure or "intrinsic" semiconductor crystals is called electron-hole pair production and is not caused by heat only. Electron-hole pairs can also be produced by light (photoconductors) or by radioactive bombardment (radiation detectors). It should be noted incidentally that electrons and holes do not contribute equally to conductivity; the electrons move faster than the holes and so carry a greater share of the current.

What transformed the study of semiconductors into a technology which has changed the whole of electronics is the effect of impurities on the semiconductor crystal. Each germanium or silicon atom in a crystal of germanium or silicon has four electrons in its highest energy level. If we introduce as an impurity among a set of germanium or silicon atoms a material which has *five* electrons in its

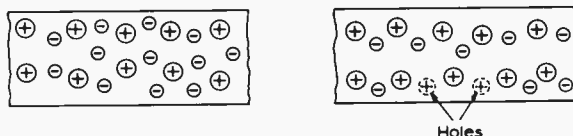


Fig. 7 (left): N-type material has more free electrons than nuclei; a surplus of negative carriers.

Fig. 8 (right): P-type material has fewer free electrons than nuclei—the "holes" will act as carriers (positive).

highest energy level, this causes an excess of electrons in the crystal and so makes for a great increase in conductivity by electrons. The amount of impurity required is very small; one atom of impurity in every hundred million of semiconductor causes the conductivity to increase by a hundred thousand times. In this case we say that the conductivity is *n-type*, because the main or *majority carriers* of the current are negative electrons (Fig. 7).

In the same way the addition of atoms which have only three electrons in the highest energy levels causes gaps—holes—to appear in the semiconductor crystal structure and so increases the conductivity, though by a lesser amount since the majority carriers are now holes. Such material is called *p-type* (Fig. 8) because the majority carriers are the holes which behave as if they were positively charged particles.

The action of adding the impurities is called *doping*, and the amount of doping which has been carried out can be measured most accurately by measuring the electrical resistance of the doped material in comparison with an undoped sample.

THE DIODE

We are now in a position to understand how a semiconductor diode works. Imagine a single crystal in which one half has been doped to p-type material and the other half to n-type material. This constitutes what is called a p-n junction and may be made by a variety of methods; in fact the main developments in transistors during the last fifteen years have been better methods of creating such junctions. The normal state of such a junction when no bias is applied is shown in Fig. 9, with an excess

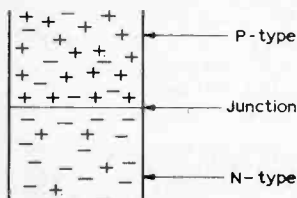


Fig. 9: An unbiased p-n junction. The + and - symbols denote holes and electrons only; nuclei are not shown since they do not transfer but are fixed in the crystal.

of electrons on the n side and an excess of holes on the p side. When a negative bias is applied on the p side and a positive bias on the n side (Fig. 10) the positive holes are attracted towards the negative bias and the negative electrons to the positive bias and the result is that there are practically no carriers left near the junction. This lack of carriers means that there cannot be any movement of carriers across the junction and hence the diode does not conduct; it is said to be *reverse biased*.

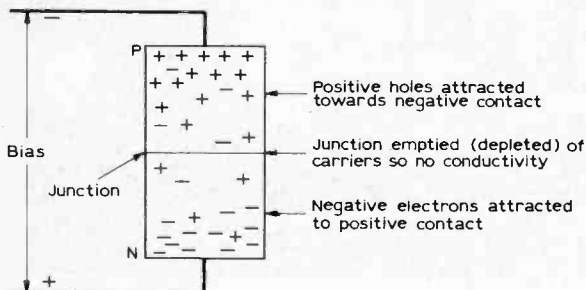


Fig. 10: When a diode is reverse biased as shown here it does not conduct.

As the reverse bias is increased a voltage is reached at which holes from the n region and electrons from the p region can be attracted across the junction and the movements of these carriers causes collisions allowing other pairs of electrons and holes to move. This is the *breakdown* of reverse-biased junctions called the *avalanche* effect; a similar *zener* effect occurs at a sharply defined voltage which is utilised as a stabilised voltage in the zener diode.

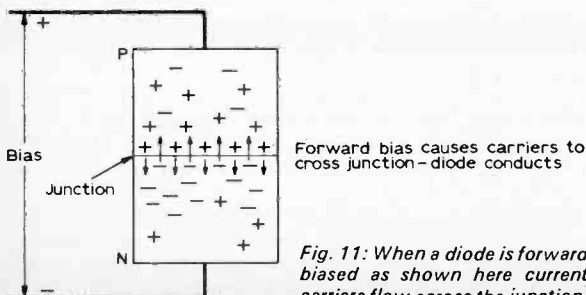


Fig. 11: When a diode is forward biased as shown here current carriers flow across the junction.

When the diode is *forward biased* (Fig. 11) so that the p side is positive and the n side negative both types of carriers move over the junction carrying their charge with them and so producing conductivity. It is important to note that both the p-type and n-type regions must be formed in a single piece of crystal; it is impossible to form an effective diode by putting separate pieces of n and p type material in contact since the atoms can never be made to approach the close spacing which they have in a crystal, and without this spacing the energy bands of the material are quite different.

THE JUNCTION TRANSISTOR

The first transistors made were not junction transistors, nor are all diodes junction diodes. A point contact made with wire of a suitable composition on to a semiconductor crystal can produce a rectifying contact when a large current is passed in what later becomes the forward direction. It is thought that the action is that of transforming some of the metal from the wire into the semiconductor, so producing a doped region around the point contact. Although point-contact diodes behave in essentially the same way as junction diodes, the long-obsolete point-contact transistor differed from the junction transistor in one very important respect: it had current gains of more than unity when operated in the common-base connection, and was extremely unstable in the common-emitter connection. For these reasons and because the commercial production and development of junction transistors was more promising, the point-contact transistor is today a museum piece—a good reminder of the rate of scientific progress.

A junction transistor has three separate and

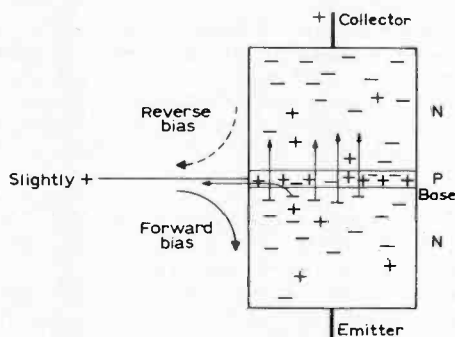


Fig. 12: A junction transistor consists of two p-n junctions back-to-back as shown. When biased as shown here current flows through the transistor.

distinct regions in its crystal. Two regions of similar doping form the bread of a "sandwich" whose meat is a region of opposite doping. The sandwiched region is very lightly doped, compared to the other two regions, and is also very thin, with widths measured in millionths of an inch.

In Fig. 12 the principle of the n-p-n transistor is shown. One n region is designated the emitter and the other the collector, while the middle p region is the base. The emitter and collector could be interchanged for low current work, but commercial transistors are usually built so that the n region designated as collector is better able to dissipate the power of operation.

—continued on page 701

1968 INTERNATIONAL Radio Engineering and Communications Exhibition



THE organisers, sponsors and exhibitors were all pleased at the support given to the 1968 RSGB exhibition at the Horticultural New Hall, London, which ran from 2nd to 5th October. Although attendance figures were some 400 down on last year, more than 8,000 enthusiasts passed through the turnstiles, many of them from overseas. As usual, the exhibition provided a good opportunity to meet fellow enthusiasts and judging by the many groups of amateurs gathered around the stands or chatting over a coffee or glass of beer it still retains the atmosphere of an annual reunion. There was also a series of lectures this year, which were fairly well attended.

The exhibition was formally opened on 2nd October at noon by W. J. Sharpe, CBE, the Director of Communications, Diplomatic Wireless Service, Foreign Office, standing in for the Postmaster-General who was unable to attend due to pressure of business. Mr. Sharpe commented on the very important role that Amateurs can still play in the field of radio communications. We were all more than a little disappointed that the expected announcement on the proposed new Beginners' Licence did not materialise and could get no satisfaction from the GPO.

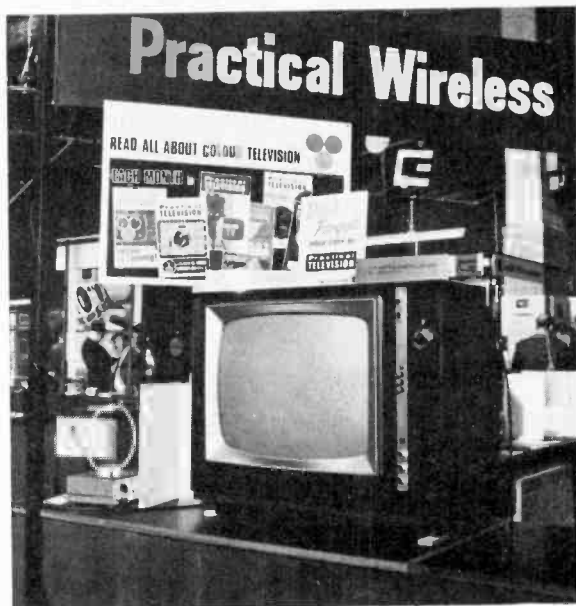
Exhibitors occupied 38 stands, ranging from component and equipment manufacturers, publishers, associations and Services. The RSGB had the largest-ever display and featured the latest edition of the *Radio Communication Handbook*, a fine new publication which will shortly be reviewed in these pages.

The three *Practicals*—*Wireless*, *Electronics* and *Television*—shared a large stand, displaying equipment and providing an opportunity for readers to meet members of the staff. On the P.W. section were previews of various constructional projects scheduled for publication in the near future. These

included a new f.m. tuner (to be published in February), a progressive superhet receiver (March), a calibration oscillator (April), a comprehensive audio mixer and a transistor tester. Look out for these on our future-announcement notices.

The theme of the *Practical Television* display was "colour television" and this was backed up by an operational GEC 2029A colour receiver, which gave excellent results under often adverse viewing conditions. It was running from an 18-element J-Beam aerial mounted on the roof of the exhibition hall and it was a matter of some surprise that the signals being radiated from the forest of aerials on the roof from the various amateur stations operating throughout the exhibition caused virtually no interference.

Another regular feature of the exhibition was the presentation of awards for various pieces of home



Part of the Practical Television display showing the GEC 2029A colour television receiver.

constructed equipment in different categories. Those awarded this year were:

The Exhibition Organisers Award (G4KD Plaque), awarded for the best piece of equipment on display went to B. C. Seedle, G3UIT/G6ACJ/T for his four metre a.m./c.w. transmitter and 28Mc/s s.s.b. converter.

The Horace Freeman Trophy, awarded for the most original piece of equipment went to S. Weber, G8ACC for his solid state 432Mc/s transmitter.

Merit prizes were awarded as follows:

For the best transistorised equipment; C. Sharpe, G2HIF (144Mc/s solid state linear amplifier).

For the best valved equipment; G. R. Jessop, G6JP (The 2-50 transmitter).

For the best ancillary equipment; C. F. Dorey, BRS16468 (Filter response curve, display unit).

Special Merit Prize for the "Amateur-Amateur"; R. C. Arnold, BRS29738 (All band communications receiver).

We very much enjoyed the show, not only as exhibitors but as an opportunity to meet old friends and make new ones. Thank you, RSGB, and we look forward to another successful exhibition next year.



Here can be seen some of the constructional projects that will be featured in Practical Wireless in the near future.

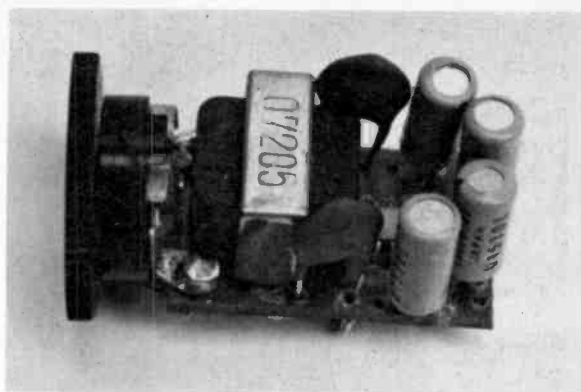
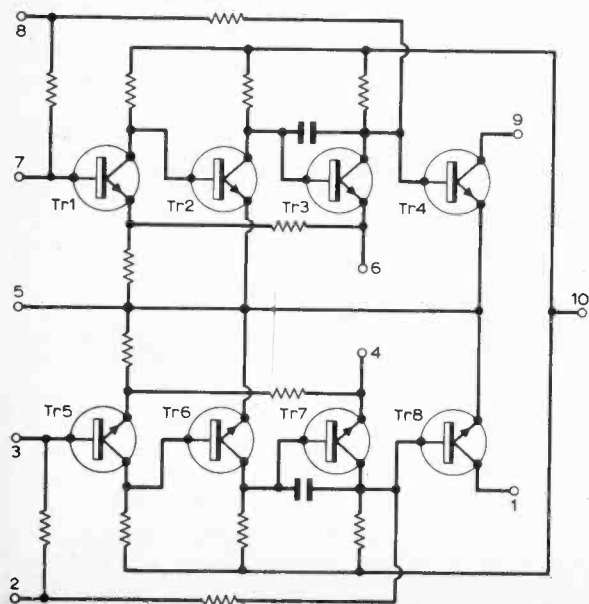
miniature i. c. hearing aid amplifier

L. Mc Namara B. Sc.

THE use of integrated circuits in amateur equipment is becoming more popular especially since their prices have come more into line with their discrete counterparts. The amateur can now decide to use them on their own merits. Their small physical size, durability and ruggedness make them ideal in applications where they are liable to get rough handling. The present article describes the construction of a miniature hearing aid amplifier which compares in performance and cost with commercial units more than double its size.

CIRCUIT DESCRIPTION

The prototype amplifier was built around a Westinghouse type WC183 integrated circuit. The circuit as shown in Fig. 1 consists of an eight transistor balanced amplifier whose operation can best be understood by considering it as two independent four transistor amplifiers fabricated on a single silicon chip. The input signal is fed to Tr1 which acts as a common-emitter amplifier stage whose output is directly coupled to Tr2 which also operates in the common-emitter mode. Biasing for Tr1 is provided by the d.c. feedback loop from the collector of Tr3 which in turn also provides a certain amount of degeneration or negative feedback since



the output of Tr3 is opposite in phase to the input signal applied to Tr1. The emitter of Tr3 will usually be decoupled to earth in a practical amplifier circuit. Direct coupling is also provided between Tr3 and the output transistor Tr4 which in the present design operates in conjunction with Tr8 as a class AB output stage. Tr5, Tr6 and Tr7 operate in a similar fashion and since the whole unit is direct coupled throughout there are no frequency limiting components and the unit can operate well above the audio range of frequencies.

Figure 3 shows the circuit diagram of the complete amplifier. The input from the microphone is fed to pins 3 and 7 of the i.c. via two isolating capacitors C1 and C2. As the input impedance of Tr1 and Tr5 is fairly low the use of a magnetic microphone with an impedance in the range of 10-50k Ω is recommended for really satisfactory operation. If a crystal microphone is to be used an external emitter-follower stage would be needed to provide proper matching.

OUTPUT TRANSFORMER

The primary winding of transformer T1 forms the load for the output pair Tr4 and Tr8, each terminal being bypassed by an 0.01 μ F capacitor. These help to stabilise the circuit by preventing spurious high frequency oscillations. Choice of output transformer is not critical and any surplus transformer with a primary coil resistance between 100—500 Ω will suffice. Its output impedance should match the type of earphone used to ensure maximum efficiency and a crystal earphone was found to work quite satisfactorily with a high output impedance transformer. The transformer specified

Fig. 1 (left): Complete circuit of the Westinghouse WC183 integrated circuit.

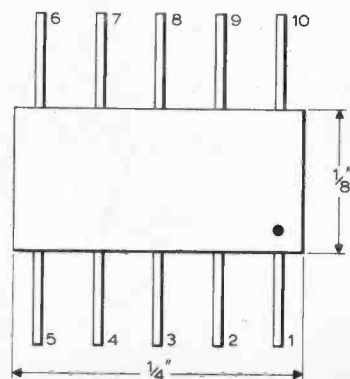


Fig. 2 (right): Physical dimensions and outline of the i.c.—top view of the unit. Lead 1 is identified by the spot of paint adjacent to it.

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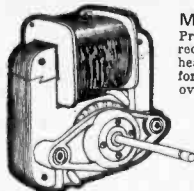
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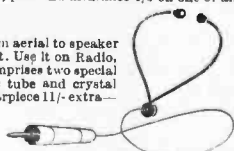
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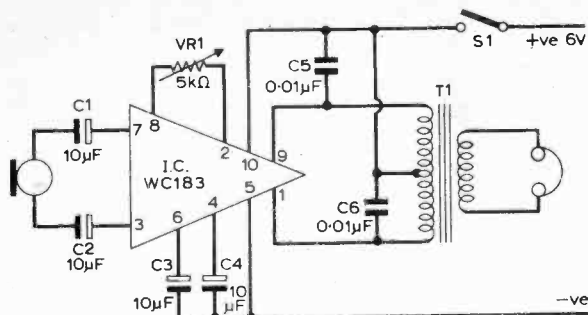


Fig. 3: Circuit diagram of the miniature hearing aid amplifier incorporating the WC183 i.c.

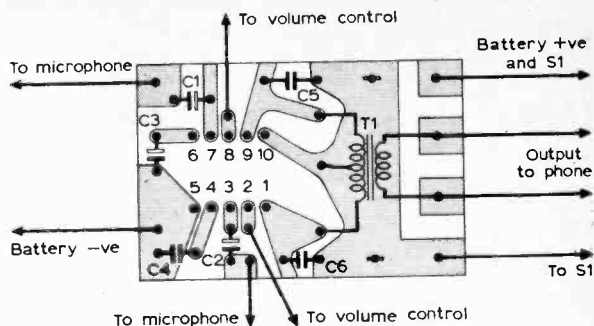


Fig. 4: The printed circuit pattern of the copper laminate board used in the prototype. Actual board size 1 x 1/4 in.

is a driver transformer used in reverse, i.e. with its primary winding feeding the earphones and its centre-tapped secondary being the load for Tr4 and Tr8.

CONSTRUCTION

The layout for the printed circuit board is shown in Fig. 4. The design should be carefully painted on a piece of copper laminate board 1 x 1/4 in. and then dry etched in the usual manner in a solution of ferric chloride.

As the WC183 i.c. in the flat pack version measures a mere 1/4 x 1/8 in. great care should be taken in bending its leads to enable them to fit through the mounting holes, and of course these holes must be reasonably accurately drilled to prevent straining the leads.

Some constructors may wish to dispense with the volume control and operate the unit by inserting a fixed value resistor with a modified jack socket acting as an on-off switch. The value of this resistor will depend on the sensitivity of the microphone but its optimum value can easily be found by connecting a 5kΩ variable resistor between pins 2 and 8 and finding the value which just prevents positive feedback. In the prototype the volume control was soldered directly to the copper board through the terminals of the on-off switch.

The unit is quite versatile in its operation and will give very satisfactory results from power supplies between 4.5 and 9V. On a 6V supply it drew 5mA and so small batteries will give a reasonably long operating life. The manufacturers claim for the unit an efficiency in excess of 55% with an overall gain of 90dB.

★ components list

Capacitors:

- C1 10μF 6V miniature electrolytic
- C2 10μF 6V miniature electrolytic
- C3 10μF 6V miniature electrolytic
- C4 10μF 6V miniature electrolytic
- C5 0.01μF miniature
- C6 0.01μF miniature

Others:

- VR1 5kΩ miniature pot with switch
- T1 Type LT44 transformer (Henry's Radio) or any suitable alternative with 100-500Ω primary winding
- WC183 Westinghouse linear integrated circuit

The amplifier could also be used as a miniature audio preamplifier and if the two channels are considered as completely separate amplifiers and suitable load resistors are inserted between pins 1 and 9 and the positive supply it could provide a very neat stereo preamplifier. ■

PRACTICAL TELEVISION

★ INSTRUMENT C.R.T.s

The requirements of an oscilloscope tube differ widely from those of the well-known receiver picture tube. This article provides a detailed account of instrument c.r.t.s including such sophisticated types as multi-gun and multi-trace tubes. Design improvements in recent years are described, giving at the same time an insight into the associated equipment. How bandwidths of 1,500 Mc/s and over are achieved is explained.

★ TV RECEIVER TESTING

Basic fault diagnosis techniques in the timebase generator stages and also how to check the operation of the field output stage.

★ CONVERTING 405-ONLY SETS to 625-LINE OPERATION

Remarkably good conversions of 405-only receivers for 625-line operation are possible using readily available surplus u.h.f. tuners and i.f. panels. This article, the first of two, provides detailed guidance on the problems involved and the best approach to adopt.

★ COLOUR SERVICING

Continuing our series on this important subject, in the current issue the topic of what servicing equipment is necessary for colour work is dealt with.

★ R.F. AMPLIFIERS

The characteristics that determine the performance of an r.f. amplifier are set out and the various common TV r.f. amplifier circuits described.

**ALL IN THE JANUARY ISSUE
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LETTERS...

The Editor does not necessarily endorse the views expressed by correspondents.

The Beginner's Licence

I read the letter by Mr. Curtiss with a great deal of interest. May I be permitted to add a few comments to redress the balance?

There are a great many people who aspire to holding an Amateur Radio Licence and who would be prepared to study hard to achieve this. At the same time, the conditions under which they live and work may make this aim virtually impossible. For example, people whose work entails shifts or a great deal of travelling precludes their attendance at night classes or even severely curtails the working of a Postal Study Course.

Are we all to be singled out as lazy and illiterate as Mr. Curtiss (whose opinion I respect) would have us believe?

An "easy" licence would do nothing but harm to the Amateur Radio Movement. On the other hand a "Beginner's" licence could do a great deal of good by raising the standard of the RAE and therefore of the Movement as a whole.

Such a licence could be based quite simply on the following terms and conditions:

1. A written examination comprising: (a) The compulsory Section One of the RAE as it exists at present.

(b) Part Two based entirely on (i) Frequency control and measurement. (ii) Interference, types of interference, the causes and the suppression thereof. (iii) Operating Procedure. (Which by the way, may help relieve Mr. Meacham from long dissertations on warts etc!!)

2. The GPO Morse Test.

3. (a) The Licensee to be restricted to a very small part of one of the Amateur Bands. (b) Very low Power Emission (not more than say 2 watts). (c) c.w. telegraphy only. (d) The allocation of a Beginner's Prefix.

4. Closer supervision by the GPO to be paid for by

5. A £3 Licence Fee.

The conditions of such a licence would, by their very nature, urge the willing and genuine Amateur to climb from what could be regarded as a sort of Limbo to the Elysian Fields that the Full Licence permits, while the lazy, the incompetent and the less enthusiastic would fall by

the wayside or get sent off the air or just go QRT, rather than scrape up the licence fee for another year.

I could weep tears of caustic soda for poor Mr. Curtiss who, after such a fantastic achievement, does not append either his call sign or the number of his Amateur Radio Certificate! — "Aspiring GW3" (Llanberis).

Keep the morse test

I must disagree with Mr. Wright's suggestion that the morse test be abolished (November issue). If this came about the result would be hundreds of Amateurs using 'phone only and, as 'phone takes up broader bandwidth, a MORE overcrowded band. Does Mr. Wright want to kill Amateur morse? If he does the result will be chaos with people using c.w. at two words a minute.

I see no reason why the "B" licence should not be extended to cover all bands. Those with the "A" licence would still have the advantage of c.w. operation which is the best form of emission when conditions are bad or bands overcrowded.—R. A. Dixon (Glasgow W.4).

Anti-loudness

Congratulations on your interesting "Audio Supplement" in the October 1968 issue. Quite correctly you caution readers on the use of loudness controls. I would like to go one step further if I may and ask enthusiasts to avoid them altogether.

Some manufacturers include them on cheaper amplifiers as a sales gimmick but other manufacturers of high quality equipment include a loudness control out of a sincere belief in a misconceived theory. This theory states that because the sensitivity of the ear falls in the lower frequency range, some compensation should be provided which boosts the low frequencies when the volume is reduced.

The misconception is this. If one were at a live concert and moved from a front seat to a back seat in the concert hall the sound intensity would appear to fall with a more noticeable loss in the lower frequencies. Therefore to produce a natural sound a system should give the impression of being at a greater

distance from the source when the volume is turned down, without frequency compensation!

With a loudness control one gets the impression of low register instruments being near while the rest of the orchestra is in the distance, which is hardly natural! And the murky obscure sound which results from the use of a loudness control can hardly be called hi-fi. To give a natural sound, which is what is required, the system must give a *natural* tonal balance.

Why then use tone controls at all you might argue? Fair comment, but I would say that tone controls should really be set flat. Any adjustment to compensate for a system deficiency should not cause a deviation from a flat response. Once set for a particular condition they should remain at that setting regardless of the sound level used.—Iain Smith (Rugby).

Thank you Scotland

Thank you for printing my request for information on converting TVs to oscilloscopes in your "CQ" column in the November 1968 issue. Would you please extend my thanks to an anonymous Scottish reader who sent me some information on how he did it. If he has any further hints or anyone else has any advice I would be glad to hear from them.—G. Johnson (3 Bixley Road, Ipswich, Suffolk).

I agree

May I fully endorse the views of Jonathan Wates (November issue) regarding the Beginner's Licence.

I too am a keen s.w.l. who is also tied up with "O" level studies, making it very difficult for me to allot enough time to study for the RAE.

I feel that it would be a great help for Jonathan and I, and a great many others, to be given the opportunity to transmit on the Amateur bands, as this would be a very good grounding for when we get our full licence.

So, you licensed experts, spare a thought for the volume of our school work before you heartily condemn the Beginner's Licence and all s.w.l.s—C. Williams, A5376 (Brierly Hill, Staffs.).

Wharfedale High Fidelity single unit speaker - Super 8



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It is simplicity itself to install in a home-built cabinet, needing no special skills.

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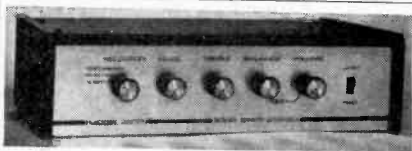
Plinth WB1	Garrard 1025	p/p 7/6	£8. 0.0
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LETTERS

The Editor does not necessarily endorse the views expressed by correspondents.

Modifying V.H.F. portables

My attention has been drawn to the article "Modifying V.H.F. Portables" in your October issue.

British Standard 905 quotes limits for oscillator radiation from such receivers and manufacturers make considerable efforts to keep radiation down to acceptable levels. Modifications such as those described are liable to increase the levels of radiation. Any spurious oscillations and the extension of the tuning range would increase the number of services liable to suffer interference.

This is a practical matter: some of your readers will no doubt be aware that we have been investigating complaints of serious interference in the v.h.f. range caused by excessive radiation from certain receivers. Measurements have shown that this sort of interference can occur at surprisingly large distances and that a variety of radio services may be affected, including those concerned with safety of life.

I should also point out that in this country unlicensed use of radio receivers is an offence. Broadcast receiving licences are valid only for reception of transmissions from authorised broadcasting stations and licensed amateur stations, and we do not issue licences to overhear private services such as those your writer describes (not entirely correctly) as "Commercial".

I should be grateful if you would make these facts known to your readers in the next issue.—**T. Dawson, Director of Public Relations, GPO (London, E.C.1).**

* * *

The Author Replies:

I can quite understand how excessive oscillator radiation from a set modified as shown in my article could possibly occur, due

to the increased coupling between the oscillator and aerial tuned circuits. If, however, the home-made capacitors are replaced by conventional components of similar values, it does seem unlikely that the limits quoted in British Standard 905 would be exceeded.

The question of extending the tuning range, to cover say 75 to 90Mc/s, causing interference does seem rather strange to me. With the modified set the oscillator will now cover a range of 86 to 101Mc/s approximately. If we examine the oscillator frequencies used in a standard television receiver covering Band I we find that they cover a range of 89 to 111Mc/s and to my mind would be of greater amplitude than those emitted from a transistor portable utilising a simple rod aerial at ground level.

As Mr. Dawson states my broadcast receiving licence allows me to tune into authorised Broadcasting stations and licensed Amateur stations. Does this then mean that it is illegal to tune into the aircraft, satellite, USA "CB" and Short Wave commercial bands? If this is so it seems strange that receivers are openly on sale covering one or more of these frequency segments.

In the past, articles have appeared, from time to time in the popular radio publications making direct reference to such reception, and I can personally recall articles in the national press stating that a particular person or persons have monitored a pilot's last words before an air crash, and of groups of school-children tracking Russian satellites.

I believe that further clarification concerning illegal reception of stations is badly needed and may have been overshadowed in recent years by the excellent publicity given to the illegal use of imported transceivers. **L. Case (Widnes, Lancashire).**

Top band echo

I was very interested to read, amongst your readers' letters in the November issue of P.W., about the use of "one man bands" and "echoes" on Amateur frequencies.

Being a little tired of the "old man—Rig here is—Antenna here is—best 73s and BCNU" routine, I fixed an extra replay head to my tape recorder and produced a very pleasing 3-time delay and variable intensity echo.

I had been on the air for only 25 minutes, the station worked saying that the echo was like "a breath of fresh air", when I was visited by a Wireless Telegraphy Officer from the GPO, who advised me that I was almost certainly violating the licence conditions and I should return to normal "plain" speech rather than use echo, which he said was unpleasant to listen to.

It appears that, as the echo is not "plain" language and as amateurs are not supposed to play recordings of their own voices on the air (though some do this for CQ's), the echo is not permitted.

It seems rather sad that, when amateur radio is supposed to encourage experiment and ingenuity, such audio experiments as echo and, presumably, tremolo, and phase, should not be allowed.—**John R. Green, B.Sc., G3WVR (Brentwood, Essex).**

Anyone help?

In the September 1963 edition of PRACTICAL WIRELESS, there is a constructional article on a simple stroboscope.

The circuit is built round a NSP1 or NSP2 which I cannot obtain. I would be very grateful if any readers could inform me where I might get one from, and the price.—**N. Lord (53 Keepers Drive, Norden, Rochdale, Lancs.).**

Merry Christmas and a Happy New Year
from the staff of Practical Wireless

W. N. STEVENS

L. E. Howes, G3AYA

T. R. Preece, G3TRP

J. A. Reddihough

C. R. Riches

H. W. Moorshead

A SIMPLE CAPACITANCE BRIDGE

P. CASSIDY

THE instrument to be described is very simple in design and construction but is nevertheless a very useful addition to the workshop especially when one is confronted with variable capacitors whose values are not known.

The Circuit

The circuit is based on the Wheatstone Bridge Circuit and in fact compares the a.c. resistance of the unknown capacitor with that of a capacitor whose value is known. Since the a.c. resistance of a capacitor is proportional to its capacitance then by comparing the a.c. resistances we are effectively

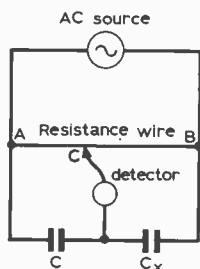


Fig. 1: The basic principle of the unit which is based on the Wheatstone Bridge. The a.c. resistance of the unknown capacitor C_x is compared with that of a capacitor C of known a.c. resistance. The bridge is completed by the resistance wire ACB . The value of C_x is found from the formula

$$C_x = C \frac{AC}{CB}$$

comparing the capacitances. The theoretical circuit is as follows (Fig. 1).

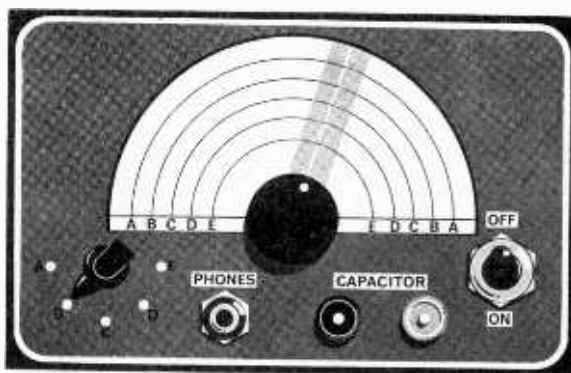
The capacitor C represents the known capacitance and C_x represents the unknown one. The pointer is moved along the resistance wire until a null point is reached. At this point the a.c. resistance and therefore the capacitance of C and C_x are in the ratio:

$$\frac{C}{C_x} = \frac{CB}{AC}$$

For a standard capacitance C the ratio $\frac{CB}{AC}$ will change with the value of C_x i.e. the null point will move along the resistance wire. Hence the instrument may be calibrated against a standard capacitance using different known values of C_x .

The instrument, then, consists of two separate parts, the a.c. source and the bridge circuit. Let us first consider the a.c. source. This simply consists of a free running multivibrator about which little need be said. The transistors used were OC72 and the circuit was built on Veroboard.

In this circuit the resistance wire of the theoretical circuit is replaced by a 100Ω linear pot. The detector is replaced by a set of headphones and the standard capacitance is replaced by the switched arrangement which allows the standard capacitance to be varied from 10pF to 0.1μF in five switched ranges. The range may be extended to about 10μF if desired without altering the circuit. The multivibrator is connected across the potentiometer and capacitances in parallel as shown and the unknown capacitance is connected across the terminals T1 and T2.



Construction

The instrument was mounted in a small wooden case with a paxolin front panel. The potentiometer, range switch, terminals T1 and T2, jack socket for headphones and on/off switch were mounted on the front panel. The capacitances C3 to C7 were wired directly to the range switch. The circuit board for the multivibrator and battery were then mounted inside the case. A cursor and scale were then prepared as follows. The scale consisted of a semi-circular piece of stiff white paper with five semicircles shown on it marked A to E. This was pasted on to the front panel in the appropriate position. The cursor consisted of a piece of clean plastic with a line drawn along it with a sharp tool. Small holes

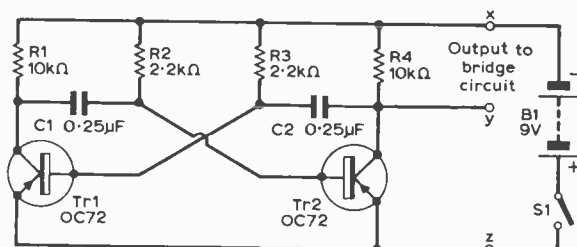
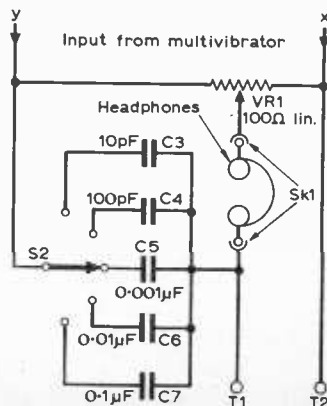


Fig. 2: In the practical circuit used in this equipment the free-running multivibrator circuit Tr1, Tr2 provides the a.c. source for the bridge whilst a pair of headphones (preferably high impedance) is used as the detector.



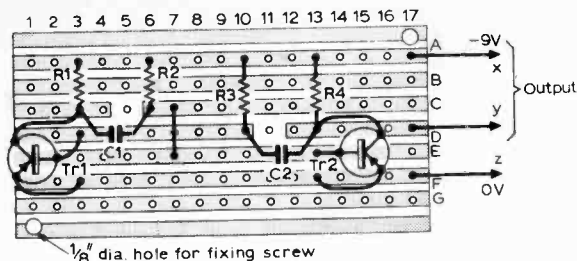


Fig. 3: Veroboard layout and wiring details of the multivibrator circuit.

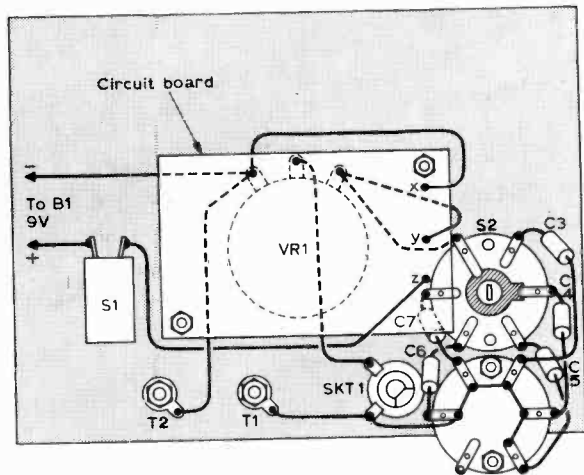


Fig. 4: Layout of the components mounted on the front panel and wiring of S2. For convenience a two-wafer switch is used in position S2.

★ components list

A—MULTIVIBRATOR CIRCUIT

Resistors:

R1 10k Ω	R3 2.2k Ω
R2 2.2k Ω	R4 10k Ω

all 10% $\frac{1}{2}$ W miniature.

Capacitors:

C1 0.25 μ F	C2 0.25 μ F
-----------------	-----------------

Transistors:

TR1 OC72	TR2 OC72
----------	----------

Miscellaneous:

Single pole on/off switch, Veroboard, PP9 battery.

B—BRIDGE CIRCUIT

Potentiometer:

VR1 100 Ω linear w/w potentiometer

Capacitors:

C3 10pF	C6 0.01 μ F
C4 100pF	C7 0.1 μ F
C5 0.001 μ F	all close tolerance

Miscellaneous:

T1 and T2 post terminals; jack socket for headphones; S2 single-pole 5-way switch (two-wafer type used by author for convenience); headphones; cabinet.

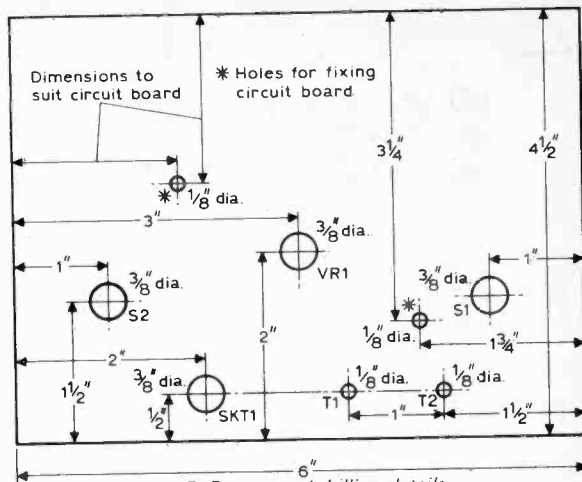


Fig. 5: Front panel drilling details.

were drilled along it to coincide with the semicircles on the scale. The cursor was then glued to an instrument knob and fixed on the spindle of the potentiometer.

If a metal front panel is used it will be necessary to insulate the components mounted on the front panel.

Calibration

The instrument was then calibrated as follows. The range switch was set to its lowest position—10pF and the instrument switched on. A known small capacitance (about 20pF) was placed across the terminals T1 and T2. The knob of the potentiometer was then moved until a null point was heard in the headphones. The point was marked on the scale by inserting a sharp-pointed pencil in the small hole in the cursor. This process is then repeated using different known values of capacitors until all five ranges have been calibrated. It may seem that quite a number of capacitors are needed for the calibration but this can be avoided. If a capacitance substitution box is available this will prove invaluable. Failing this, placing capacitors in parallel and in series will greatly reduce the number of capacitors required for calibration purposes. ■

CORRIGENDA NOVEMBER ISSUE

UNIJUNCTION TRANSISTOR CIRCUITS

The connections to the base of the 2N2646 unijunction transistor used in the circuits in this article were not shown. These are as shown in Fig. 1 below.

In Fig. 2 in the article a positive-going instead of a negative-going pulse output was shown at the base 2 connection of the unijunction transistor.

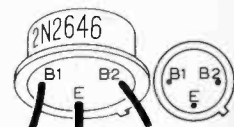


Fig. 1: 2N2646 base connections.

TRANSISTORISED SIGNAL GENERATOR

VC1 referred to in the text and components list is shown on the diagrams as C8. R6 referred to in Fig. 6 is VR1.

PYRAMID

ALL PURPOSE SYSTEM

By F. G. RAYER



PART 5—THREE WAVEBAND SUPERHET TUNER

THIS tuner covers approximately 20-580 metres in three switch-selected bands 5-15Mc/s (60-20 metres); 1-67-5-3Mc/s (180-57 metres); 515-1,545kc/s (580-194 metres).

The 515-154kc/s range is the usual "medium wave" band, while the other bands include the more useful short wave frequencies 80, 160 metres, ship-ping transmissions, etc.

The tuner is designed to operate in conjunction with the "Pyramid" amplifier, but could be used with almost any other amplifier.

Mixer Circuit

This is shown in Fig. 1. L1, L2 and L3 are the aerial coils, and selected by means of a three-way switch. One switch pole transfers the aerial to the required coil, another pole switches the tuning capacitor VC1, while the third pole selects the coupling winding for the OC170 mixer base.

To avoid the need for several pre-set trimmers, a panel trimmer VC3 allows peaking up the aerial circuit on each band throughout the tuning range. This allows maximum efficiency with any aerial, and simplifies trimming.

L4, L5 and L6 are the oscillator coils, tuned by VC2. The emitter, collector and VC2 circuits are switched to the required coil by a second wafer of the switch (also three-pole three-way). TC1 is the oscillator circuit trimmer.

Each oscillator coil has its own padder, Cp1, Cp2 and CP3. Each of these capacitors is of different value, and is connected to a different coil pin, as shown.

The mixer section is assembled on an aluminium chassis, and the i.f. amplifier strip is wired on a paxolin panel and fitted to the chassis at a later stage.

I.F. Strip

Figure 2 shows the circuit using two AF117 transistors with double-tuned intermediate frequency transformers, i.f.t.1 and i.f.t.2. I.f.t.3 is single-tuned, and incorporates the detector diode and by-pass capacitor. Using these transistors, and five tuned circuits, high gain and selectivity are achieved.

Automatic volume control bias is applied to the first AF117, through R9, in the usual way. When the tuner is plugged into the "Pyramid" amplifier, the 5k Ω audio gain control is present in circuit from pin 5 of i.f.t.3 to the chassis. If the tuner is employed with a different amplifier, and the amplifier input circuit is not as used in the "Pyramid" equipment, a fixed resistor of similar value (around 5k Ω) must be wired from i.f.t.3 pin 5 to chassis.

Mixer Wiring

Layout of components under the chassis appears in Fig. 3. Six $\frac{1}{4}$ in. holes are drilled for the coils L1 to L6.

The ganged capacitor must have an efficient reduction drive. This may be a ball drive, be integral in the capacitor, behind the panel, or of any other usual type; the ball drive is the least expensive. The capacitor is also given as 365pF each section, but may be 315pF each section, or of similar value. This merely alters the tuning range slightly but this is of no importance as there is some overlap at the band ends.

The ganged capacitor is bolted to the chassis. Leads from front and rear sections pass down through holes to the nearest switch tags, Fig. 3. TC1 is soldered in parallel with VC2, above the chassis.

Wiring is most easily undertaken by placing the coils so that the pins all come in the same relative positions, Fig. 3. Each coil is then wired to the

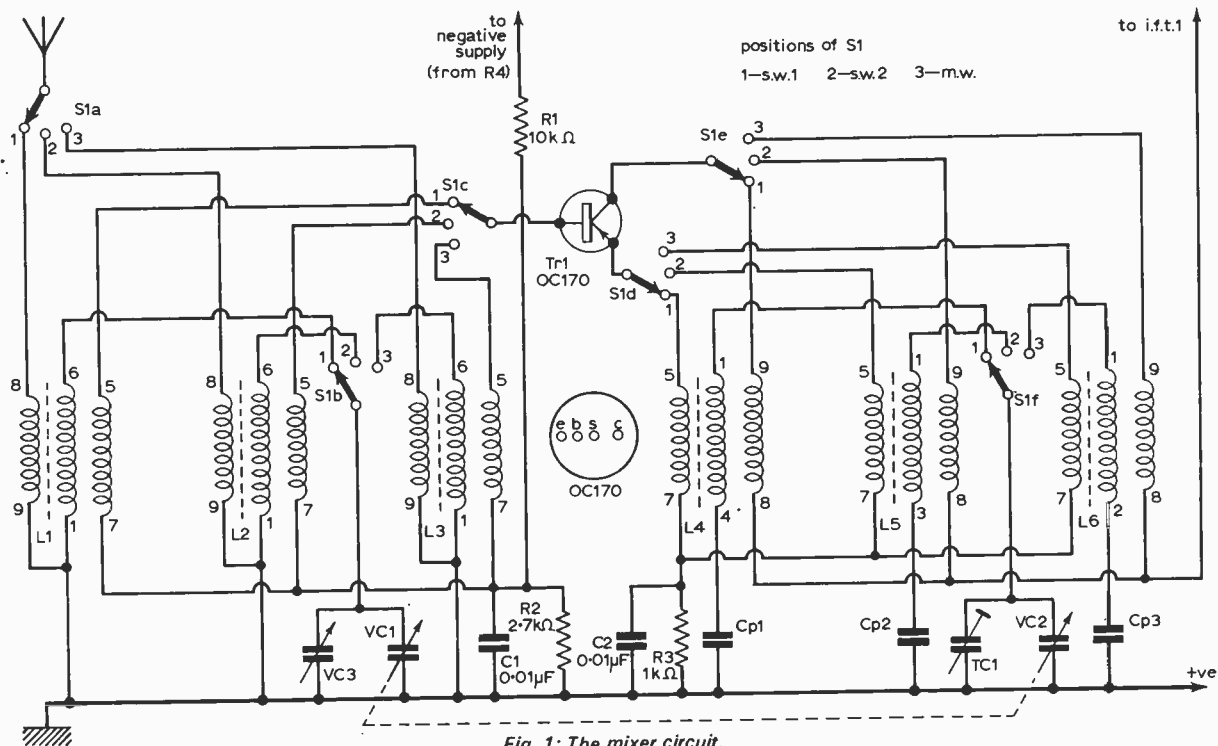


Fig. 1: The mixer circuit.

switch, following Fig. 4. Leads should be short and direct, especially to the short-wave coils.

If this wiring is done systematically, and with care, no error should arise. If preferred, the chances of making a mistake can be reduced by placing only L3 and L6 in, and wiring these first. With the switch in the appropriate position, medium-wave reception should then be obtained. L2 and L5 can then be added and tested. Finally, L1 and L4 may be connected.

Figure 3 shows transistor and other coil connections. Padders Cp1, Cp2 and Cp3 go directly from the correct coil pins to chassis, a lead running between the MC connections for this purpose. The transistor leads, and wires from C1 and C2 should be quite short. Other connections from L1, L2 and L3 (Fig. 4) run to the front wafer of the switch and are clear of wires to L4, L5 and L6 which go to the rear wafer.

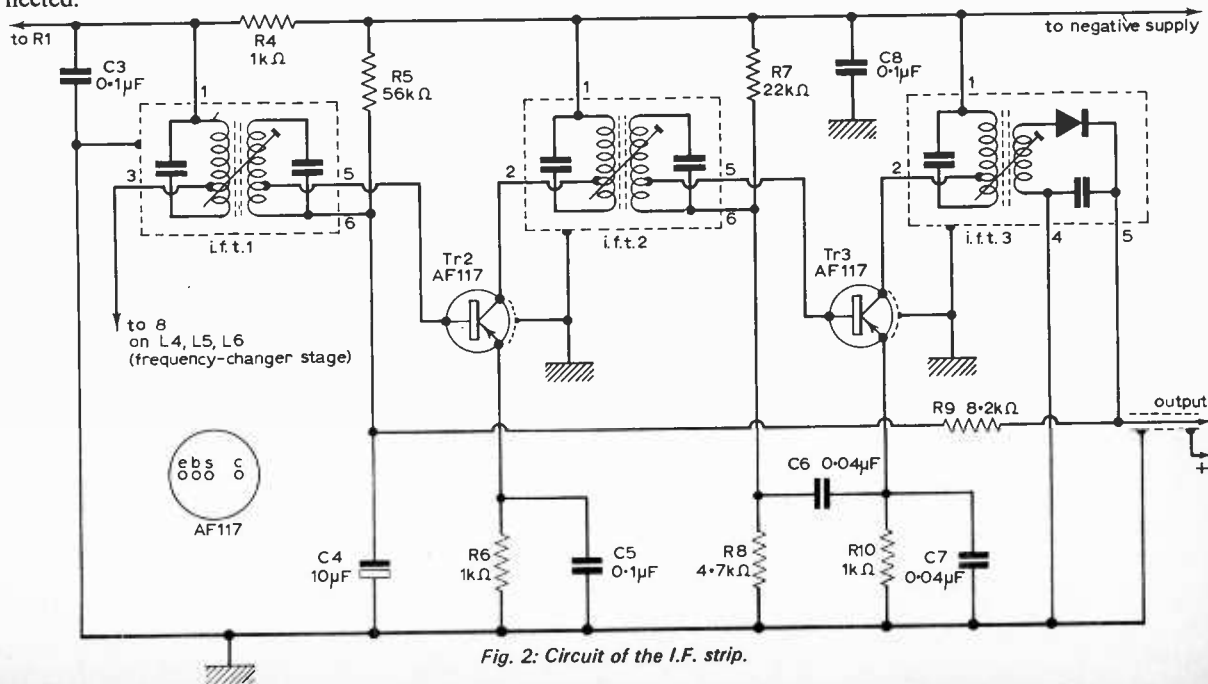


Fig. 2: Circuit of the I.F. strip.

I.F. Amplifier Construction

This section is wired completely on a piece of $\frac{1}{16}$ in. thick paxolin, $4 \times 2\frac{1}{2}$ in. Small holes are drilled so that the resistor leads and other parts may be fitted as in Fig. 3.

The paxolin panel is turned over and wired as in Fig. 5. One end of each i.f.t. is earthed to the positive line, which is in turn soldered to a tag. When the strip is completed, it is held in the chassis by two bolts, each with extra nuts to allow clearance for wiring. The i.f. strip positive line is thus common to the metal chassis, Fig. 3.

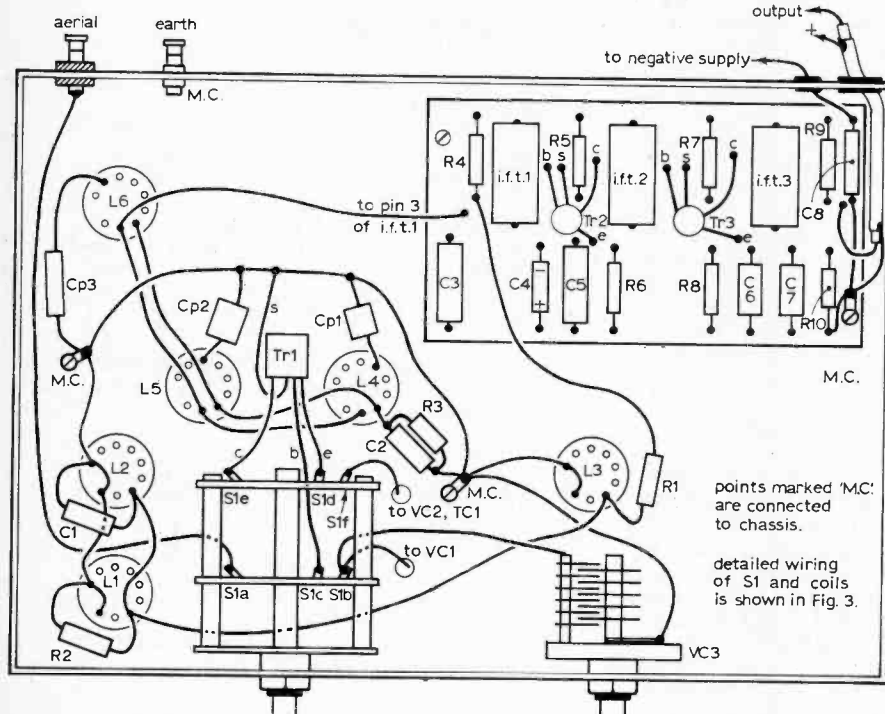


Fig. 3 (above): Under chassis wiring. Note that leads should be short and direct.

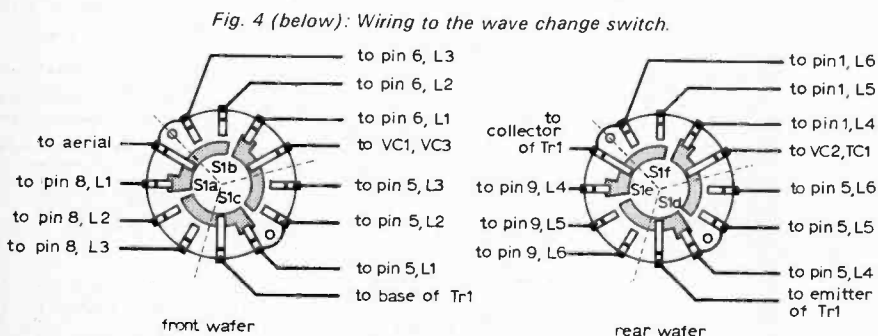


Fig. 4 (below): Wiring to the wave change switch.

Sleeving should be put on the transistor wires to avoid short-circuits. It is helpful to use different colours for identification, e.g. red for collectors, green for emitters, yellow for bases, with shield wires left bare. It is then much easier to check connections when the transistors are in position. Their leads should be quite short, and must be soldered rapidly in the usual way to avoid overheating.

External Connections

These are shown in Fig. 3. For the "Pyramid" amplifier, the negative supply is drawn from a socket on the panel. The negative lead, Figs. 3 and 5, shows a plug to insert in this socket. If the tuner is used with other equipment a supply of about 6V is required.

Audio signals go from pin 5 of i.f.t.3 to the amplifier input (volume control). The outer braiding of the screened or coaxial lead forms the positive or "earth" return between tuner and amplifier. This is provided automatically when plugging into the "Pyramid" amplifier.

If an earth is available, this can be connected to the chassis via a socket or terminal. The aerial goes to a socket or terminal insulated from the chassis, Fig. 3.

Aligning the I.F.T.s

If a signal generator is available, set it to provide a modulated output on about 470kc/s. Connect the output to pin 5 of i.f.t.2, and adjust the core of i.f.t.3 for best results. Then transfer the generator lead to pin 5 of i.f.t.1, and adjust both cores of i.f.t.2. Finally, inject at the mixer base and adjust i.f.t.1 cores.

The input level should be kept down to avoid overloading. Output can be shown by a meter in one battery lead to the amplifier, but when trimming for maximum current, reduce audio gain so that this is not unnecessarily heavy (say not usually over 30mA).

If the i.f.t.s are pre-aligned, and are not badly off frequency, a signal will be obtained at once through the whole amplifier, by injecting at the mixer base, and aligning all cores. However, if some cores are much out of position, this may result in no signals being obtained and the procedure previously described should then be taken.

If no generator is available, it is necessary to tune into a transmission, and adjust the cores for best results, each core should tune quite sharply. A properly shaped and fully insulated trimming tool is necessary. Cores should be touched up finally, with a weak signal, when the strip is fixed in the chassis.

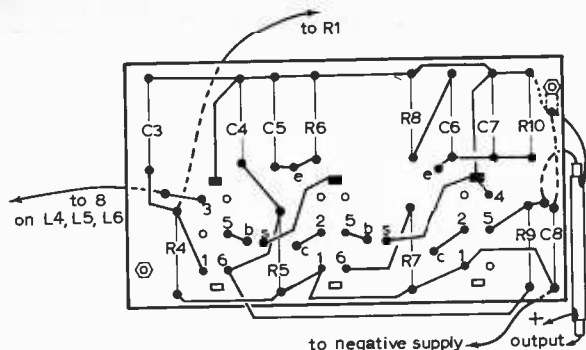


Fig. 5: I.F. board wiring (underside).

Mixer Alignment

Screw TC1 about half-way down. With the switch in the medium wave position, adjust the core of L6 for suitable band coverage. At the high-frequency end of the band (VC1/2 nearly open) VC3 should peak for best sensitivity around one-third to one-half closed. Tune towards the LF end of the band, and adjust the core of L3 for best results, and to make necessary the least re-adjustment of VC3.

The 1.67-5.3Mc/s range should be dealt with next by adjusting the cores of L2 and L5. Finally, switch to the highest frequency range, and adjust the cores of L1 and L4.

The actual coverage of each band depends on the settings of the oscillator coil cores, L4, L5 and L6, but if VC3 can be peaked up for maximum results, and is not fully open or fully closed, satisfactory efficiency will be obtained. A signal generator is most convenient for aligning the mixer coils, and obtaining suitable frequency coverage for each band.

With the highest frequencies it is possible to tune L1 to the wrong side of the oscillator coil frequency, this is usual with a superhet. Where L1 can be peaked to two frequencies, each giving maximum performance, the correct setting is the lower frequency of the two, so that the oscillator is working

at a higher frequency than that of the aerial circuit.

It may be noted that the coil manufacturer specifies 3,000pF for P1, and 1,100pF for P2. Should these values be available, they furnish the same results in this circuit as the 2,700pF and 1,000pF capacitors listed.

Should it be found during alignment that VC3 always needs to be nearly open, at the h.f. ends of all bands, then screw down TC1 a little.

If the aerial is at all long, results are improved by placing a small capacitor between aerial lead and receiver, a 50pF pre-set should usually be suitable. ■

★ components list

Mixer Section:

R1	10kΩ	C2	0.01μF
R2	2.7kΩ	Cp1	2,700pF
R3	1kΩ	Cp2	1,000pF
C1	0.01μF	Cp3	350pF

VC1/VC2 2-gang 365pF or similar.

VC3 50pF variable. TC1 30pF beehive pre-set.

Denco Coils: "Blue" "Red"

L1	Range 4T	L4	Range 4T
L2	" 3T	L5	" 3T
L3	" 2T	L6	" 6T

Chassis 8×5½×2in. OC170. Two-wafer switch, three-pole three-way each wafer. Drive, Knobs, etc. "Dinkicase" 10×6×6in. (Electroniques).

IF Strip:

R4	1kΩ	C3	0.1μF
R5	56kΩ	C4	10μF 6V
R6	1kΩ	C5	0.1μF
R7	22kΩ	C6	0.04μF
R8	4.7kΩ	C7	0.04μF
R9	8.2kΩ	C8	0.1μF
R10	1kΩ		

Paxolin 4×2½in. Repanco i.f.t.s: i.f.t.1 XT50/1, i.f.t.2 XT50/2, i.f.t.3 XT50/3. Two AF117s. Screened lead, etc.

CQ! CQ! CQ! CQ! CQ! CQ!

ISSUES WANTED

- ... *Practical Wireless* 1963 to 1967. State prices. All letters answered. — M. D. Ellse 86 Bennethorpe, Doncaster.
- ... February 1967 issue of *Practical Wireless*. — H. S. Clark, "Cromford", 24 Broadmoor Lane, Upper Weston, Bath, Somerset.
- ... Sell or loan the September 1967 issue of *Practical Wireless*, also the issue, containing mods. to the 19 set (issued in one of the last issues of 1967). — B. M. Oddy, 27 Gimble Way, Pembury, Kent.
- ... Sell or loan May 1963 issue of *Practical Wireless*. — K. Portman, 23 Fell Wilson Street, Warsop, Mansfield, Nottinghamshire.
- ... Copies of 1961 August and September *Practical Wireless*. All expenses met. — J. Watson, 20 Watson Road, Sheffield 10.
- ... November and December 1964 issues of *Practical Wireless*. Also, will anyone sell or give me any of the i.f.t.'s and coils for the "Ten-Five" receiver, contained in these issues. — P. Hudson, 338 Bennett Street, Long Eaton, Nottingham NG10 4JD.
- ... January 1967 issue of *Practical Wireless* containing details of the "Explorer" v.h.f. receiver. — S. Kendall, "Handsel", Peel Crescent, Ashton, Chester.
- ... March and April 1966 issues of *Practical Wireless* containing mods to the 19 set. — A. M. Laird, The Tower, Patra Road, Kirkmichael, Ayrshire.
- ... Copies of *Practical Wireless* from October 1953 to July 1954, containing the P.W. Electronic Organ. — A. D. Varley, "Belfairs", 252 Liverpool Road, Penwortham, Lancashire, PR1 0LY.
- ... June 1967 issue of *Practical Wireless*. Buy or loan. — C. M. Davos, 1 Willesden Road, Hughesdale 3166, Victoria, Australia.
- ... Any issues of *Practical Wireless* containing circuits, constructional articles on electron music instruments, particularly P.W. Electronic Organ, published in the 1950s. — D. E. Bray, 104 Fulmerston Road, Theford, Norfolk.
- ... October 1966, November 1966, and all issues of 1964 and 1965 which had information on the R.A.E. — C. J. Bourne, 11 Woodhouse Lane, Bishop Auckland, Co. Durham.
- ... October 1962 issue of *Practical Wireless* containing the "Tudor" 4-valve battery portable. — M. J. Darby, 266 Canley Road, Coventry, Warwickshire, CV5 6AP.
- ... January-December 1964, January-August 1965, November-December 1965, January-June 1966 (all inclusive) and August 1966 issues of *Practical Wireless*, preferably including any blueprints. — D. L. Edwards, 18 Parkdale Crescent, Worcester Park, Surrey.

... January 1967 issue of *Practical Wireless* containing "Explorer" v.h.f. i.m.-a.m. receiver and any other issues with same details. — S. Marklew, 4a George Street, Wombwell, Nr. Barnsley, Yorkshire.

... Does any reader remember the periodical in which an article about the conversion of W.S.38 to top band appears? If so, please let me have issue number. — A. Carter, "Rosemary", Shakespear Avenue, Langdon Hills, Basildon, Essex.

... June 1965 issue of *Practical Wireless* or descriptive text of Hawaiian Guitars. — N. Taylor, 21 Tower Mill Road, Millfield Estate, Bungay, Suffolk.

... Anyone sell or loan April 1966 issue of *Practical Wireless* dealing with the second part mods. to the 19 set. — T. R. Smith, 50B Aldershot Road, Guildford, Surrey.

... Issues of *Practical Wireless* from 1961 to 1967 on exchange basis of Indian novelties and curios of equivalent amount. — K. B. Tendulkar, 94/3 Jaiprakash-Nagar, Goregaon (East), Bombay 63(NB), India.

... I would be very grateful if any reader could sell me the July 1963 issue of *Practical Wireless* and the September 1967 issue of *Wireless World*. — S. Saethern, Box 336, N-3101 Tonsberg, Norway.

... the issue of P.W. with the article on a domestic "colour organ". — 4269206 S.A.C. Swift D.G. "B" (S.C.S.), R.A.F. Stanbridge, Leighton Buzzard, Bedfordshire.

... the issue of P.W. containing E. J. Wootton's T.R.F. receiver. — V. Reed, 25 Arlington, Ashford, Kent.

ISSUES FOR DISPOSAL

... *Practical Wireless*, from December 1963 to February 1966. Most blueprints included. Sell or exchange for components suitable for transistorised circuits. — A. Beveridge, The Schoolhouse, Tiffmore, Perth.

... *Practical Wireless* 1951-1966 for disposal. — L. W. Levell, Popes Hill, Newnham, Gloucestershire.

... 57 issues of *Practical Wireless* from 1961 to 1966 in excellent condition, and 47 copies before 1961 (reasonable). Any reader wanting these please send 25s. and stamped addressed envelope (for return of money). — M. Pardoe, 3 Dunwell Avenue, Newby, Scarborough, Yorkshire.

... Quantity of *Practical Wireless* and *Television* for sale. — J. Foy, 101 Sandringham Road, Birmingham 22B.

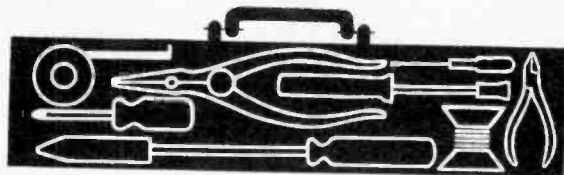
... *Practical Wireless* from January 1956 to April 1968 inclusive and would sell or swap for anything interesting electronic or otherwise. — I. R. W. Bram, 38 Muirfield, Perth.

Items in this section are included free of charge.

repairing radio sets

PART 1 (Third Series)

The first series ran from April-September 1967 and dealt with repairing sets with valve circuits. The second series, running from April-September 1968, dealt with transistor sets. We now present a short third series covering the repair of sets with unknown circuits.



Gordon J King

OWING to requests by readers of this series for a final, two-part article dealing with the non-theoretical and practical approaches of servicing valve and transistor sets of unknown circuit, it has been decided to extend the series by two articles adopting the same pattern as the previous ones. That is, one by my pen on the circuit and fault-diagnosing side and the other by my colleague H. W. Hellyer on practical matters.

DETERMINING THE CATEGORY

Starting first with the valve models, these can be divided into four primary categories: (i) the a.c.-only model, (ii) the a.c./d.c. model, (iii) the battery (all-dry) model and (iv) the mains/battery model. Thus, the first thing to do when an unknown species comes into our hands is to put it into one of the above classifications.

The true a.c.-only set is easy to identify because it possesses a rather hefty mains transformer, often carrying on its top metal cover some means of adjusting the mains input voltage requirement. This, of course, must always be adjusted to correspond as closely as possible to the household mains voltage on which the set is to be operated. As this still tends to vary about the 240-volt "standard" from district to district the correct tapping must be selected at the place where the servicing is to be undertaken.

This type of set is generally the least "lethal" from the servicing point of view because the mains supply is fully isolated from the circuits and metal chassis by a primary winding on the mains transformer. Secondary windings deliver power for the h.t. rectifier (usually a valve in older models and a metal or semiconductor unit in more recent ones) and for the heaters of the valves. This sort of set, therefore, can be worked on quite safely without taking undue precautions against electric shock, though it is desirable to connect a good earth to the earth terminal or socket, so that a mains supply short to chassis will blow a fuse rather than encouraging the flow of current through the body of the repairer touching the metal chassis while being "earthed".

SAFETY PRECAUTIONS

At this juncture it must be stressed that there is a variety of a.c.-only set which employs a mains transformer arranged rather in the form of an auto-transformer for the h.t. supply—having isolated

windings only for the heaters of the valves. Here the primary winding, which is connected via the on/off switch to the mains supply, is tapped to give the necessary voltage for the h.t. rectifier, and one side is connected to h.t. negative and/or the metal chassis of the set. In other words, one side of the mains supply is connected to chassis, and if this happens to be the "live" side the repairer is likely to receive a nasty shock on touching it while being in circuit with earth.

The a.c./d.c. set is completely devoid of a mains transformer, for such a device can only work on a.c. If d.c. is connected across the primary of a mains transformer, there would be no transformer action and the supply current would be limited only by the resistance of the winding. The transformer would almost certainly blow up! The mains current is reduced to a value suitable for the heaters of the valves—series-connected heaters being used here instead of the parallel-connected heaters of a.c.-only models—by a large, wire-bound resistance unit, called a "mains dropper". The "anode" of the h.t. rectifier is connected to the mains supply either direct or more usually through a low value, wire-wound resistor, called the "surge limiter" (as it limits the initial switch-on current through the h.t. circuits), and is often a part of the mains dropper. This sort of set, of course, can be lethal to work on when it is connected to the mains supply so that the "live" side is in termination with h.t. negative or chassis.

The battery-only set is perfectly safe to work on since the h.t. supply rarely exceeds 90 volts. Such sets of the last two decades have employed small low-consumption valves with 1.4-volt filaments, and they run either with their filaments connected in series or in parallel, and a l.t. battery corresponding to the mode of connection is then employed.

The battery/mains model is basically the same as the battery-only set but with additions for working the valves—h.t. and l.t.—from the mains supply. The usual plan is for the filaments of the valves to be switched to series-connection on mains and then to be connected across the h.t. supply via a series resistor. The h.t. supply is derived either via a small mains transformer or, more usually, from a mains dropper, with a valve or metal rectifier. As the latest all-dry valves require only 25mA of filament current, the load the series-chain presents to the h.t. supply can easily be catered for, bearing in mind that the total h.t. current is little more than 20mA, anyway.

In the mains mode, therefore, this sort of set

can also have a chassis which is "live" with respect to earth; but possibly the biggest servicing problem lies in protecting the very delicate 25mA filaments of the valves while servicing, for one false move with a meter test prod can often result in a substantial rise in filament current—especially with the set switched to mains—either straining the valves so they no longer work with the correct current or burning out their filaments altogether.

POINTS OF DETAIL

Mains sets—both a.c.-only and a.c./d.c.—mostly have long and medium wavebands, while many also incorporate one or several short wave bands. This sort of detail is revealed by the tuning scale. Sets within the last two decades have also tended to cater for the v.h.f. f.m. transmissions in Band II as well as for the ordinary a.m. transmissions in the long, medium and short wavebands. A.m./f.m. sets are basically the same as their a.m.-only counterparts, but carrying a v.h.f. tuner, a f.m. detector of some kind (usually a ratio detector—a pair of diodes in series) and i.f. stages which can be switched between 470kc/s for a.m. and 10.7Mc/s for f.m.

The switching in this variety of set is somewhat complex because several parts of the set as a whole have to be switched simultaneously. A long, slider type of switch—with switching sections along its length—is often arranged along the length of the chassis, thereby allowing local switching of the v.h.f. tuner, the a.m. frequency changer to an additional i.f. stage on f.m., the a.m. local oscillator, the i.f. transformers and the a.m. and f.m. detectors.

The majority of the battery-only and battery/mains models cater only for the long and medium wavebands, with a few carrying a short waveband in addition. There were very, very few models of this kind with facilities for f.m. as well as a.m.

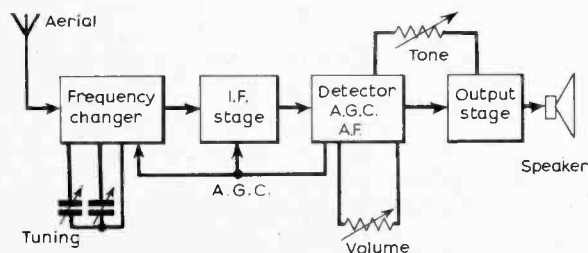


Fig. 1: Block diagram of typical valve a.m. receiver.

Typical mains sets, as well as most of the battery and battery/mains models, have four main "receiving" valves plus either a valve or metal rectifier, as shown by the block diagram in Fig. 1. If there is a "magic-eye" tuning indicator, this represents an

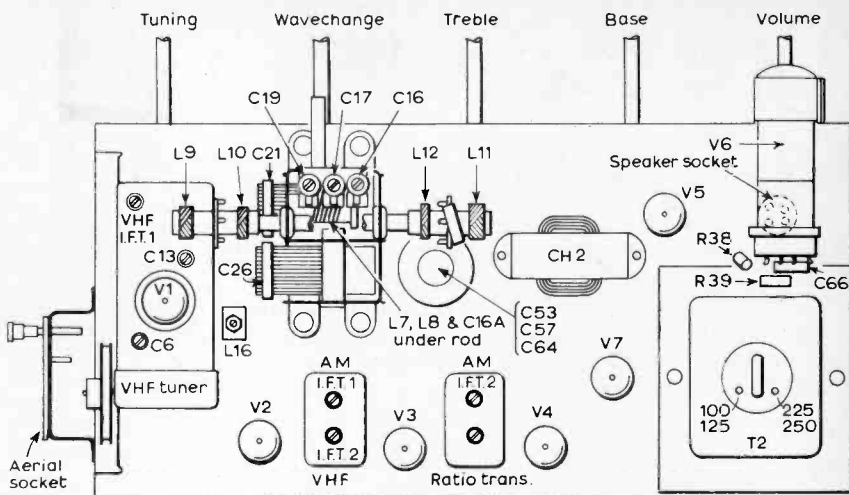


Fig. 2: Typical layout for an a.m./f.m. valve receiver. Note the placing of the a.m. and f.m. tuning components, the i.f. sections, the mains and output transformers and the smoothing choke.

extra valve, but which if missing or faulty will not usually cause the set to cease working. There is also an extra valve in those models which cater for f.m. as well as a.m., this being in the v.h.f. tuner.

COMPONENT IDENTIFICATION

A typical example layout of an a.m./f.m. a.c.-only model is given in Fig. 2. V1 is a double-triode in the v.h.f. tuner (ECC85), one section working as the v.h.f. amplifier and the other as the self-oscillating frequency changer. V2 is the a.m. frequency-changer (ECH81), a triode-heptode, with the heptode as mixer and the triode as local oscillator. On f.m. the triode is muted and the heptode is arranged to work as an extra 10.7Mc/s i.f. stage. V3 is the i.f. amplifier (EF89) working in conjunction with a.m. and f.m. i.f. transformers, as already mentioned. V4 is the a.m. and f.m. detector, one diode for the former and two for the latter (the norm in this sort of set-up), combined with the a.f. triode amplifier, the valve thus being a triple-diode-triode (EABC80). V5 is the output valve (EL84), invariably a pentode. V6 is the tuning indicator (EM34)—not directly concerned with the operation of the set. And, finally, V7 is the h.t. rectifier (EZ80).

Points to note are (i) the location of the two-gang tuning (a.m.) capacitor in relation to the frequency-changer valve, (ii) the siting of the v.h.f. tuner and the way that its mechanical tuning is often ganged to the two-gang a.m. capacitor, (iii) the position of the i.f. transformers between the frequency-changer and i.f. valves and between the i.f. and detector valves, (iv) the mains transformer (T2) as far as possible removed from the front-end of the set, (v) the position of the output (or speaker) transformer (T1, but below the chassis) adjacent to the output valves, (vi) the smoothing choke (CH2) close to the h.t. rectifier, (vii) the tuning indicator arranged to show at the front of the set and (viii) the relative positions of the controls. The tuning and wavechange controls are always towards the front-end, while the volume is as close as possible to the a.f. amplifier. Not all models feature both

bass and treble controls, but most have one "tone control" which, at least, provides a variable degree of treble cut!

A.c./d.c. sets follow closely in layout, but using a mains dropper instead of transformer, while battery-only models are that much less complicated to service—the vulnerability of the filaments apart—due to the lack of power supply components. The top-view of a typical a.c./d.c. model is depicted in Fig. 3, where V1, V2, V3, V4 and V5 respectively are the frequency-changer, i.f. amplifier, detector/a.f., output and rectifier valves. The mains dropper is R10, shown also in inset. The overall mains dropping resistance appears between tags 1 and 4, while the two taps along the resistance, given at 2 and 3, produce a volts drop suitable for lighting a small dial bulb; tag 3 also connects to the anode of the h.t. rectifier, thereby making the top two resistance sections the surge limiter.

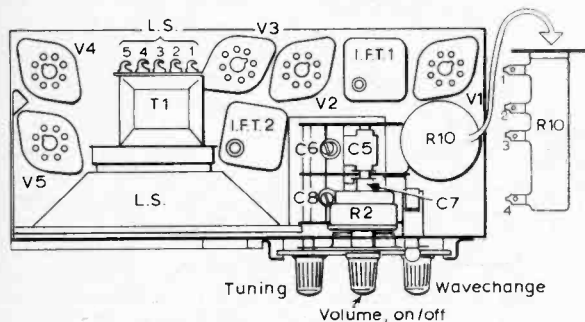


Fig. 3: Layout of a typical a.c./d.c. radio.

A battery-only portable top-of-chassis layout is given in Fig. 4, with V1, V2, V3 and V4 representing the frequency-changer, i.f. amplifier, detector/a.f. and output valves—respectively DK96, DF96, DAF96 and DL96. Notice again the location of the wavechange switch close to the front-end (frequency-changer), with the volume control at the far end, close to the a.f. stage. OP1 is the speaker transformer in this diagram, with the primary and secondary windings represented by L9 and L10.

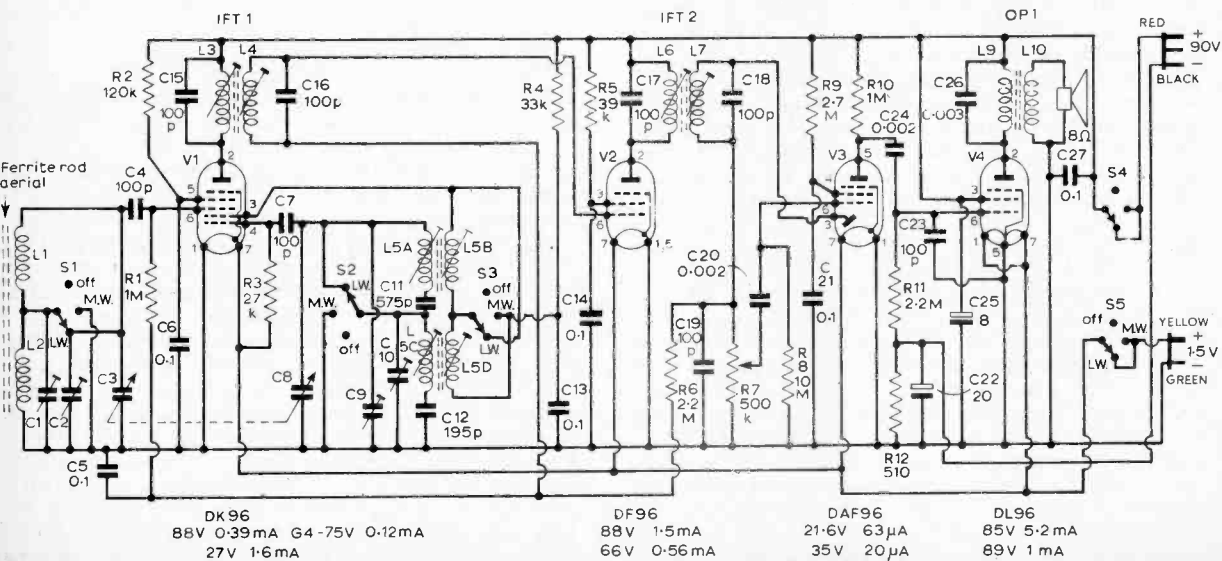


Fig. 5: Typical circuit of a two waveband battery portable; note the arrangement of filament wiring.

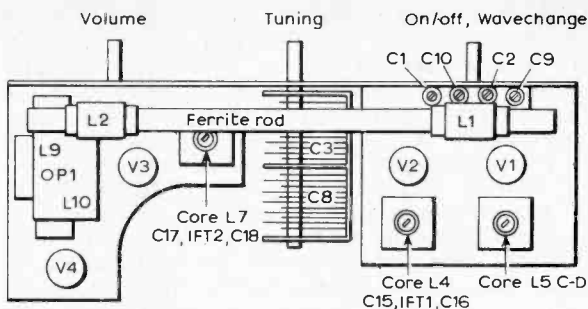


Fig. 4: Common layout of a valve battery portable radio.

As with battery/mains versions and some a.c.-only and a.c./d.c. table models, the battery portable now always uses a ferrite rod aerial (for a.m. and medium-frequency signals) in place of the former frame aerial. The ferrite rod aerial in Fig. 2 is shown above the a.m. tuning-gang, carrying windings L9, L10, L11 and L12. This works, of course, on a.m. only (not f.m.). The aerial in Fig. 4 runs the whole length of the chassis—the longer, the greater the signal pick-up—and carries m.w. winding L1, which is connected in series with winding L2 for l.w. reception. The wavechange switch performs the connection changes, while also changing over the local oscillator coil or adding parallel capacitance to a single coil for l.w. working, depending on the actual design.

ALL-DRY PORTABLE CIRCUIT

The circuit of a battery-only set, corresponding to the chassis layout in Fig. 4, is given in Fig. 5. This set has all the filaments in parallel, thereby requiring 1.5 volts l.t. Notice that the output valve, V4, has a tapped filament, and that the tap is connected to l.t. negative, while the two outer connections are joined. This puts the two half-sections in parallel. In series-connected filament circuits, the two half-sections, of course, remain in series to give the correct filament current balance.

A characteristic fault in this scheme is lack of oscillation brought about by (a) low l.t. battery and (b) low emission or strained V1 or both. Another defect is low sensitivity often caused by increase in value of R9 or R10. Distortion is invariably caused by a leaky C24 or a low emission V4, while severe microphony usually means either that V3 is in need of replacement or that the l.t. battery is nearing the end of its useful life.

An even older battery/mains model (Decca), using a frame aerial, is shown circuit-wise in Fig. 6. On mains the small metal rectifier feeds d.c. to the anodes and screen grids of the valves, while also feeding a small filament current to the series-connected chain via Rx. Sets of this kind suffer badly during the winter months with muted local oscillators due to mains power cuts, for even a small reduction in mains voltage is often sufficient to drop the filament current sufficiently to prevent the local oscillator from working.

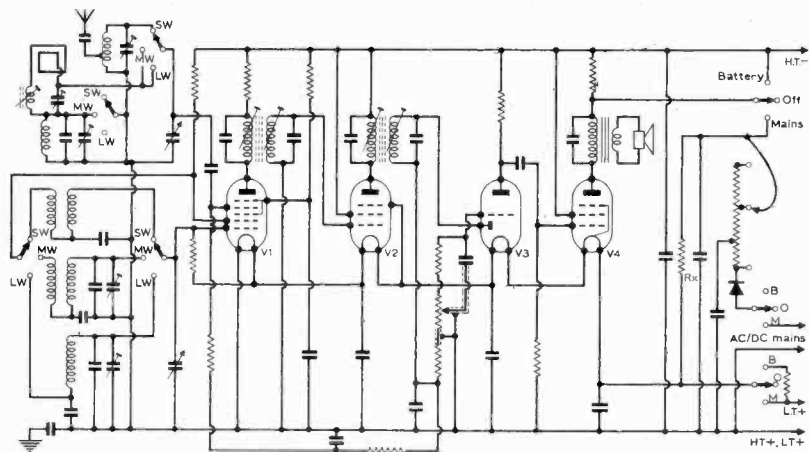


Fig. 6: Circuit of an older type battery/mains model.

The trouble is aggravated by a worn V1 and metal rectifier or by attempting to run the set with the mains tapping adjusted to a value above the input mains voltage. Sadly, if the tapping voltage is reduced, the filaments will be likely to suffer permanent damage on upward surges of mains voltage. Fortunately, sets like this have long since been superseded by the economic transistor model. Even so, there are still many thousands in use, repaired yearly by the amateur, so no excuses are offered for their brief inclusion in this text!

SERVICING HINTS AND TIPS

To summarise on valve models: one, check in which category it falls; two, make absolutely sure that it is safe to handle, especially when of the a.c./d.c. kind—make sure that the chassis is in connection with the *neutral* side of the mains and check with a neon tester, which will glow when the chassis—or anything else pertaining to the set—is “live”; and avoid becoming “earthed”—wear rubber-soled shoes; three, locate the primary components and valves so that the circuits around them can also be identified, and then proceed with the servicing exercise along the line expounded in the previous articles.

The following hints and tips will also be useful to keep in mind when handling an unknown valve model for the first time. When the set is a.c.-only make sure that all the heaters are lit. If one (or more) is out the valve will almost certainly be in need of replacement. Look out for overheating of a valve when first switching on. If the h.t. rectifier glows red hot and the set is dead a h.t. short—electrolytic capacitor failure—will almost certainly be responsible, though, sometimes, a short in the rectifier itself causes this symptom.

If the components are suffering no apparent discomfort after the set has been powered for several minutes, check the temperature of the valve envelopes with a finger; a barely warm h.t. rectifier could indicate open-circuit of that valve, even though the heater is lit, while a cool output valve could mean lack of screen grid or anode voltage. The latter trouble, invariably caused by open-circuit of

the speaker transformer primary, results in the screen grid of the output valve glowing red hot. This is a good point to check on a dead set.

With a.c./d.c. sets, one open-circuit valve heater will remove power from all the other heaters, so no valves will be alight. Check each valve in turn with an ohmmeter or, with the set switched on, check with an a.c. voltmeter from the heater connected to the mains dropper relative to chassis along the heater chain back to chassis. A.c. volts will be indicated at the start of the chain and fall to zero at the far side of the valve whose heater is open-circuit. Of course, the same symptom will result with an open-circuit mains dropper, on/off switch, fuse, thermistor (if used) and so forth, but the use of an

a.c. voltmeter will soon bring this sort of trouble to light.

UNKNOWN TRANSISTOR SET

So much, then, for valve models, now let us glance at the unknown transistor set. The typical transistor set follows similar lines to the basic valve set. There is one transistor working as a self-oscillating frequency-changer, one or more operating as the i.f. amplifier, a semiconductor diode for detection followed by an audio section comprising either a single driver transistor transformer—coupled to a push-pull pair or two pre-push-pull transistors *without* transformer coupling. There are numerous variations of these two themes, especially in the a.f. stages, whose details just cannot be given within the compass of a single article. However, up to the a.f. sections or detector most sets have a great deal in common. Earlier models, employing OC45 transistors, generally have two i.f. stages, while more recent designs, using the AF117 transistors, can secure virtually the same overall gain with just one i.f. transistor. The majority of models have six transistors and two semiconductor diodes in total, the second diode working in a signal overload protection circuit,

coming into action with the a.g.c. and damping down the signal at the output of the frequency-changer.

General layout is not at all "standardised" as it is with valve sets. This is because printed-circuit boards are invariably adopted, as distinct from the wired-circuits of valve designs. The trend now is towards the employment of circuit board "modules" or sub-sections, and these are sited in the cabinet more to suit the mechanics of the situation rather than the electronics. Fortunately, great liberties can be taken over well-designed circuit boards, so the earlier problems of instability and the like now rarely occur.

The predominant feature of all transistor sets is the ferrite rod aerial, which takes pride of place. The coils on this constitute the aerial tuned circuits, and one section of the two-gang tuning capacitor resonates these over the l.w. and m.w. bands. The frequency-changer transistor will always be found close to the aerial side of the tuning gang. In sets with two i.f. stages there are three i.f. transformers—much smaller than those of valve sets—and two transformers when only one i.f. stage is employed. The local oscillator coil or transformer is connected between the collector and emitter of the frequency-changer transistor, and one isolated winding on the assembly serves to swing the oscillator frequency in conjunction with the oscillator section of the tuning gang. The oscillator coil then usually taps into the primary of the first i.f. transformer, thereby coupling the i.f. signal to the base of the first i.f. transistor. Earlier models feature some kind of neutralisation in the i.f. stages to prevent them from oscillating, but this is no longer necessary with the latest, high-gain, low-capacitance transistors.

The detector diode is sometimes hidden within the screening can of the final i.f. transformer, and the d.c. voltage that this yields after rectification of the signal constitutes the a.g.c. bias. This is fed back to the base of the i.f. transistor as an increasing (with increasing signal strength) positive voltage when the controlled transistor is a p-n-p type. The a.g.c. bias pulls down the emitter current, thereby reducing the gain of the stage. This, called "forward

a.g.c.", requires a negative voltage when the controlled transistor is an n-p-n type. Some transistors, however, are designed for so-called "reverse a.g.c.", where the bias causes an increase in emitter/collector current and, sometimes, an increasing volts drop across a resistor, suitably decoupled, and connected in series with the collector circuit. The

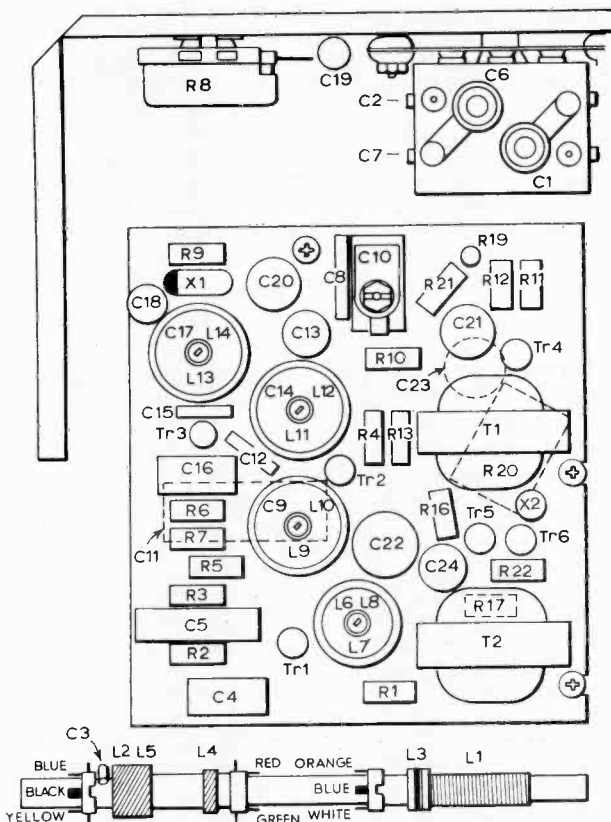
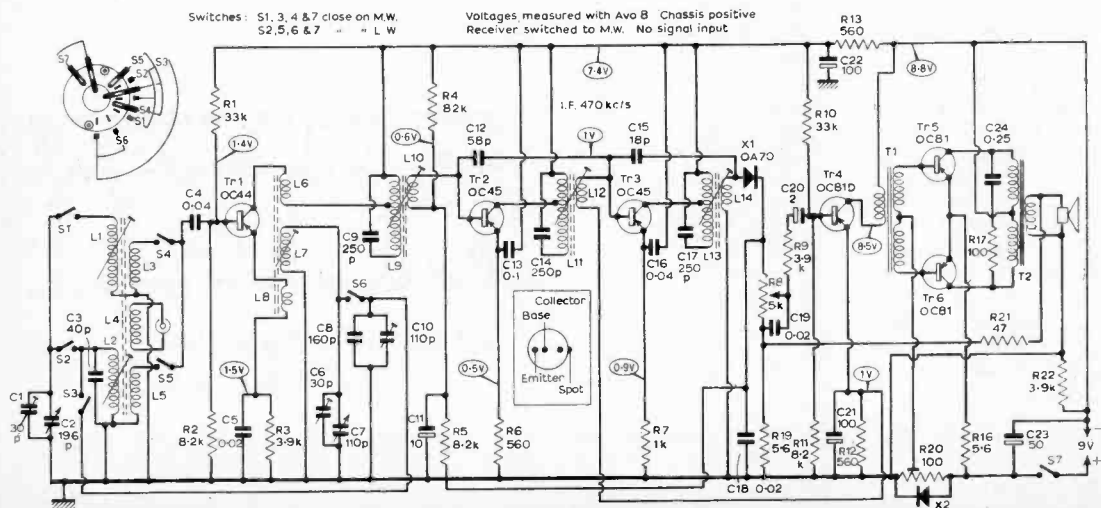


Fig. 7: Showing the circuit (a) and the layout (b) of a six transistor super radio.



stage gain in this case is reduced by the effectively falling collector voltage.

Audio from the detector is developed across the volume control—which is only about 5k, compared with the 500k of valved circuits—and the slider, ganged to the spindle, taps off the required level of signal to the audio amplifier.

One transistor set design is shown in Fig. 7, the circuit at (a) and the board layout at (b). This adopts a three-transistor audio section, with TR4 driver transistor coupled to the push-pull pair (TR5 and TR6) through transformer T1. The output transistors are biased towards class B working—with a vestige of quiescent current to minimise crossover distortion—by the preset potentiometer R20. The diode across it serves to stabilise the selected working point. In this circuit the speaker, too, is transformer-coupled to the collectors of the output transistors by T2. Negative feedback is applied to the base of the driver transistor TR4 from the secondary of T2.

TIPS FOR TRANSISTOR SERVICING

The theme of this particular article implies that we have no circuit of the defective set and that we have not come across the model before. What, then, do we do when we are presented with a "dead" set of this kind? The best plan first of all is to get some idea where the various stages are located on the printed-circuit board or modules.

We can easily locate the major components and then identify the transistors on terms of stages from these. We can trace the wiring from the ferrite rod aerial to the frequency-changer transistor and next locate the oscillator coil and its trimmers relative to the collector circuit of the frequency-changer transistor. It will not be very difficult then to trace through to the i.f. stage or stages, thence to the detector diode, remembering that it may be hidden in a can, and on to the volume control. After that we come to the audio stages and, as already mentioned, this could take a variety of forms, but they all end up with the speaker, either transformer-coupled as in Fig. 7(a) or coupled capacitively through a fairly large value electrolytic.

Keep in mind that complete failure following the dropping of a transistor set—and this is not particularly uncommon!—will almost certainly be caused by a fracture of the printed-circuit board somewhere, but with the knowledge that we have now acquired this should not take long to locate. Distortion creeps on as the battery gradually falls in power; but excessive distortion at normal battery voltage with abnormally high total, quiescent current should immediately lead to a check of the output stage biasing preset—such as R20 in Fig. 7(a). Conversely, too little quiescent current will emphasise crossover distortion, which would also point to maladjustment of the biasing preset. A fair value for the output transistors of an ordinary transistor portable is 5mA quiescent at normal room temperature—about 18° C.

Well, then, that takes care of the circuit and general theory side of the unknown set.

Next month Mr. H. W. Hellyer will be dealing with the practical aspects of the unknown. ■

NEXT MONTH IN P.W.

F.M. TUNER

Full details are given of an f.m. tuner covering the B.B.C. stations between 87 and 108Mc/s, including the new local ones. Designed for easy construction and simple alignment, this tuner is ideal for the less advanced constructor.

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CONVERTER

R. F. GRAHAM

THE output of this converter is inductively coupled to the aerial circuit of any ordinary transistor receiver having only medium wave or medium and long wave coverage, giving short wave reception over a band of approximately 5-15Mc/s (60-20 metres). Though it has primarily been used with the "Experimenters' 6" it will operate perfectly with similar receivers.

Figure 1 shows the circuit; the OC170 frequency changer provides an output in the order of 1.6-1.4Mc/s, the broadcast receiver being permanently tuned to the output frequency near the high end of the medium wave band. The overall circuit becomes that of a double superhet. First conversion is by the OC170 to the receiver frequency; second conversion is by the receiver frequency changer, generally to about 470kc/s. The detector, audio and output stages of the receiver operate in the usual way, with reproduction from the receiver speaker, or headphones if there is provision for these.

Freedom from second channel interference is greater than with the popular all-wave receivers using a 470kc/s i.f. Sensitivity, selectivity and results generally are very good.

Construction of the single OC170 stage is simple and straightforward, but a few points should be noted.

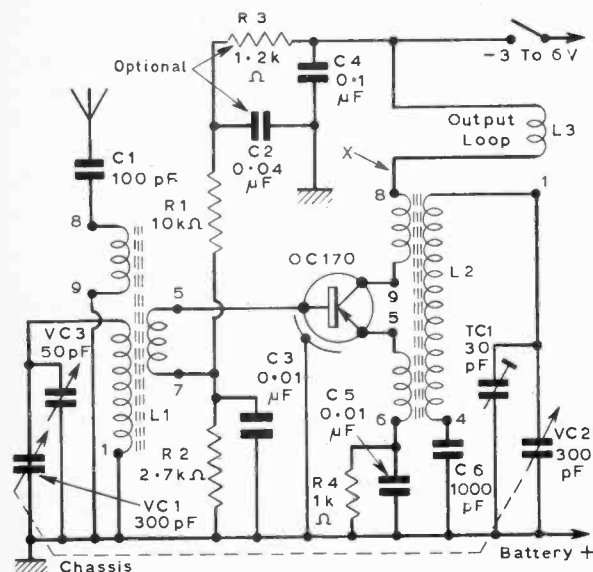


Fig. 1: Circuit of the converter.



VC1/VC2 is a ganged capacitor for tuning, and though a double 300pF or similar component is recommended, larger values give the same results except for some extending of coverage towards the low frequency end of the band. VC3 allows aerial circuit trimming, so the actual converter output frequency (and the frequency to which the receiver is set) is not critical. L1 is the aerial coil and L2 the oscillator coil, C6 being the padder. For 1.6Mc/s with the listed coils, a 960pF padder is specified, but in the present circuit either 960pF or 1,000pF may be fitted.

It was found that the inexpensive surplus type of OC170 varied somewhat, and C2 and R3 are optional, these items being required to avoid excess oscillation. One OC170 tried also operated best with a 470 ohm resistor at X. It is also worth trying 3V, 4.5V and 6V as a supply voltage, though 4.5V was generally best.

It is probably best to wire the converter without C2 and R3, and no changes need be made if excess oscillation does not spoil reception.

CHASSIS AND CONSTRUCTION

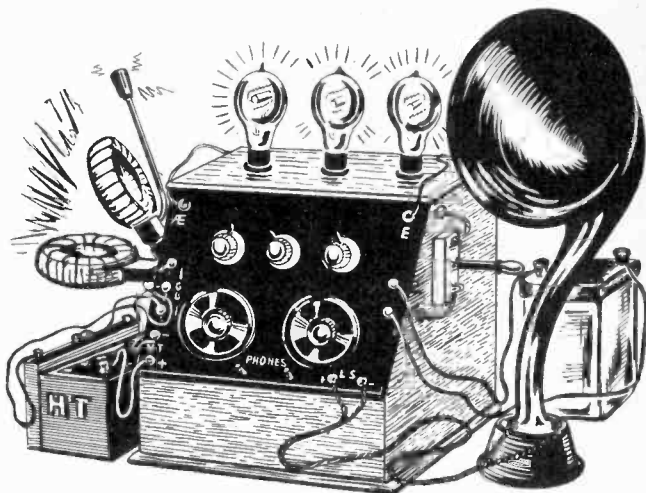
Figure 2 shows layout of components and wiring, only the battery, ganged capacitor and coils being on top of the chassis; the capacitor is bolted directly to the chassis.

An efficient reduction drive is necessary; the capacitor fitted had such a drive incorporated. A separate drive, behind the panel or fitting the capacitor spindle on the front of the panel, would be equally satisfactory.

In Fig. 2, C2 and R3 are omitted, for the reason explained. TC1 is soldered to a tag bolted to the chassis. Insulated leads pass through holes to VC1 and VC2.

L3 is 25 turns of thin insulated wire (about 32 s.w.g.) wound on a 1/2 in. diameter former, afterwards removed. Turns were bound with thin tape. Two pieces of thin flex, about 6 to 8 in. long, are soldered to the coil ends, joints being covered with sleeving.

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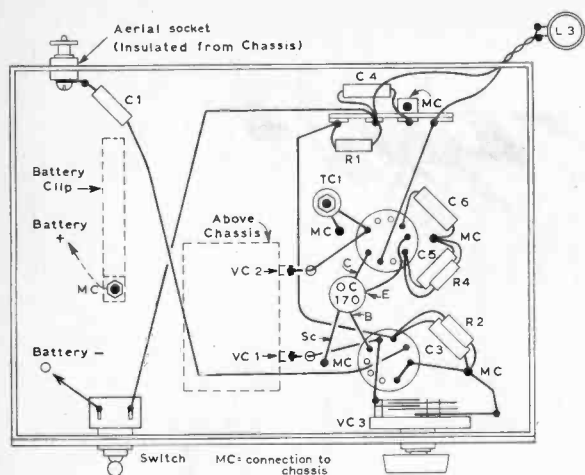


Fig. 2: Under chassis wiring.

The flex is twisted together, to pass through a hole and connect as in Fig. 2.

COUPLING

This is from L3 to the transistor receiver ferrite rod aerial winding, achieved by slipping L3 onto the ferrite rod. Coupling was sufficient with L3 on the end of the rod opposite to that bearing the medium wave winding.

Some receivers have a coupling winding, for external aerial. This generally has roughly ten turns, and can be used as L3. It is then possible to arrange that the converter can be plugged into the receiver aerial socket. A long flexible or screened lead should not be used between converter and receiver.

With a miniature and enclosed receiver, coupling can be obtained by situating L3 near the end of the ferrite rod, adjacent to the m.w. winding, but outside the case. It is also possible to put a ferrite rod or core in L3, and situate this near the receiver aerial rod.

The "Experimenters 6" receiver has variable aerial trimming, so no loss of sensitivity results from misalignment. But with other receivers coupling needs to be fairly loose, or alignment of aerial and oscillator circuits will be upset.

NOTES ON USE

The receiver is tuned to a point near the high frequency (low wavelength) end of the m.w. band where no station is heard. This will generally be around 1.6 to 1.4Mc/s (188-210 metres).

All tuning is then done on the converter. VC3 should be adjusted to peak for best volume throughout the band. Incorrect adjustment of TC1 or L1 and L2 cores will not normally cause lack of efficiency provided VC3 peaks up for best volume and is not fully open or fully closed.

For correct alignment and band coverage, adjust L1 and L2 cores near the l.f. end of the band, and TC1 near the h.f. end, until little adjustment of VC3 is needed.

If a medium wave transmission is received when the converter is switched off, output from the converter will beat with this signal when the converter

is in use, causing whistles on all signals. This is avoided by tuning the receiver carefully to avoid any signal when the converter is off.

The high i.f. gives reasonable freedom from second channel whistles, but some always become apparent on high frequency short wave ranges. Generally, they are not particularly troublesome.

Should any form of continuous oscillation be experienced, keep the converter aerial lead away from the broadcast receiver. If this continues it is worth trying an earth on the converter. Also place the receiver to avoid unnecessary coupling between its coils etc. and the converter. With a receiver close to the converter chassis and coils, it was found helpful to use the coil cans and lids as screens for the coils. With the same receiver clear of the coils, screening the latter was unnecessary.

As mentioned previously some receiver circuits require a resistor at X, see Fig. 1. If soldered directly to tag 8 of the coil holder, this can greatly help reduce whistles from excess oscillation.



Top view of completed converter.

★ components list

Resistors:

R1 10kΩ	R3 1.2kΩ
R2 2.7kΩ	R4 1kΩ
All 10% ½ watt miniature	

Capacitors:

C1 100pF	C4 0.1μF
C2 0.04μF	C5 0.01μF
C3 0.01μF	C6 1000pF
VC1/VC2 Twin gang air-spaced variable 300pF or similar	
VC3 50pF small air-spaced variable	
TC1 30pF beehive trimmer	

Coils:

L1 Denco Blue Range 4
L2 Denco White Range 4
L3 See text

Miscellaneous:

Reduction drive, two B9A valveholders, OC170 transistor, chassis (about 7 x 5 x 2½ in.), on/off toggle switch, knobs, tagstrip etc.

practically wireless

commentary by HENRY

No. 52

Up
to
Spec.

TEARING up some back copies of *Electronics Weekly* for the local chip-shop, Henry came across an article previously overlooked.

It seemed a pity to wrap a cod fillet and six-pennorth in anything as tantalising as 'The art of specification'. The use of the word 'art' again proved the value of serendipity, and Charles Gunner of GEC-AEI certainly made this scribe think twice about what he had always taken to be a science.

As a Member of the Institute of Measurement and Control, Mr. G. may be excused for saying, provocatively: 'Electronic engineers are perfectly familiar with specifications, but the individual engineer probably has never stopped to consider either why specifications are necessary or what they really expect a specification to tell them.'

Overlooking his own lack of control over the tensing of that statement, we must ask what the top lad of Inspection requires a specification to tell him. And we find that even a simple resistor amasses a dossier as involved as a holly roth plot. When Joe calls: 'Chuck us over a forty-seven-K, mate,' you can make him feel it would be easier to go and fetch it himself by simply querying all of the fourteen different limiting tolerances one by one. No

wonder the Stanmore Laboratories report that test time for a 'simple item' like a resistor costs more than the bill for making it!

Now, please—before you descend on Henry for belittling the need for specifications, let's see what else Mr. Gunner had to say about the gentle art. Specifications are necessary, he says, for quality control, reliability assessment and economy of effort. All concerned with production should try to convince laboratory and design staff that specs are not just a tool for the convenience of production staff. They are as much a part of production as a set of drawings . . . a good laboratory engineer will consider the specification to be as much an end product of his work as the unit or component which he has designed.

Those are my italics, not Mr. Gunner's. They make one realise, if one discounts the slight whiff of sour grapes, that the airy world of upper-echelon electronics is as much beset by inter-departmental war as the factory floor. As one who did his stint in the inspection department of a couple of radio factories, as well as the cosier regulated world of the Services, Henry can speak with some feeling on the bending of specifications to suit the Production Manager's bonus chart.

A small hint of this is gleaned from a later example quoted in the article which is currently giving us a subject to chew over. Component engineers, while admitting that a sales sheet for their product states it 'complies with an American MIL specification', go on to tell you that 'in that particular case', whole sections of this very comprehensive specification have 'been conceded'.

Lovely term—conceded. Can you not see it on the brochure of a 'High Fidelity System'? The equipment conforms with British Standard XYZ:1969:47Q, sections 3a to 45 conceded. Mr.



The slight whiff of sour grapes

Gunner would probably wave a deprecatory hand toward such unimportant gear as our domestic music-boxes, but the consumer industry needs someone as dedicated as he, especially in the field of so-called high fidelity.

Let us conclude with one beautiful example, from M. Horowitz' book: 'Measuring Hi-Fi Amplifiers'. By means of juggling the output power ratings, he tells us, it can almost be proved that no low-power amplifiers exist! Take a modest 12-watt stereo amplifier. Two 12 watts r.m.s. can be said, tongue-in-cheek, to equal a total of 36 watts IHFM 'Music Power'. Now the specifications of music power assume no power supply voltage change with signal change and define test conditions. Sinewave power at a predetermined distortion level is measured. But peak IHFM power is twice the sinewave power, so the copy-writer can fairly legitimately double his figures, to get a 72-watt 'Peak-IHFM Amplifier'.

What about the distortion level? Well, if we come back along the roll-off curve, and carefully forget to state that the frequency response figure was measured at a different power level, you can get away with calling this modest amplifier an 80-watt job. Look carefully at those 'specifications' before buying!



Wrap a cod and six-pennorth in it

P.W. GUIDE TO COMPONENTS

PART 2

M. K. TITMAN, B.Sc. (Eng)

CAPACITORS are essential components in electronic circuits. They function as tuning, smoothing, timing and d.c. blocking components. The basic unit of capacitance is the farad, though microfarads (μF or m.f.d.) and picofarads (pF) are in practice used: they are farads divided by 10^{+6} and 10^{+12} respectively. Nanofarads and kilopico farads are also in use: $1\text{nF}=1\text{kpF}=1,000\text{pF}=0.001\mu\text{F}$.

Values and Tolerances

Capacitors are frequently marked numerically with their capacitance value, usually together with the voltage rating and polarity if any. However microminaturisation has resulted in an increase in the use of colour coding. Due to the diversity of shapes and sizes of capacitors colour coding is not standardised and the manufacturer's data should be consulted. As a general rule the value is given as for the resistor coding but with the capacitance in picofarads. Tolerance and voltage ratings are given special colours by the manufacturer.

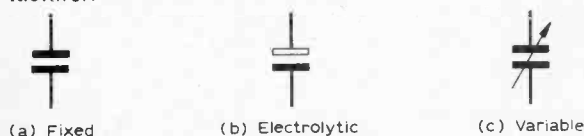


Fig. 1: Capacitor circuit symbols.

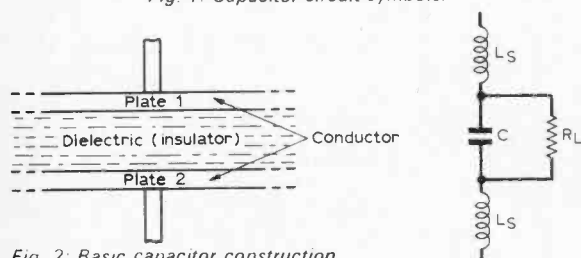


Fig. 2: Basic capacitor construction.

Fig. 3 (right): Capacitor equivalent circuit: the inductance of the leads and resistance of the dielectric affect the performance of a capacitor in practice.

Capacitors are available in the capacitance range 0.5pF to $500,000\mu\text{F}$ and with tolerance ratings of better than $\pm 1\%$ to $+100\% -20\%$. Tolerance generally increases with the larger values of capacitance. Cost increases for miniature styles, high capacitance values, and very high voltage working.

Commonly low value capacitors are available in the values given in Table 1. This cannot be regarded as a definite standard as in the case of resistors, and for the higher values of capacitance above approximately $1,000\text{pF}$ many non-standard values appear. Most

manufacturers follow the values of Table 2 for the higher values of capacitance.

Notable exceptions are values such as 200pF and 500pF which appear in the various ranges up to $0.5\mu\text{F}$. For electrolytic capacitors above $0.1\mu\text{F}$ many non-standard values appear. As electrolytics are mainly used for smoothing or coupling and their tolerance is often $+50\% -10\%$ these variations are insignificant as the absolute value is rarely important.

Ideal Capacitor Characteristics

Ideally a capacitor is constructed as shown in Fig. 2, with two conducting plates separated by a perfect insulator or dielectric. As the plates are isolated they effectively block the passage of direct currents and the resistance of the dielectric determines the usefulness of the capacitor for this purpose. Capacitors do however transmit alternating currents. This is because of the large area of the plates which require a large increase of charge to give a change of voltage across them. Thus the voltage across a capacitor cannot change instantly,

Table 1: Generally Available Capacitors 2.2pF—1000pF

Common Values	Other Values	Common Values	Other Values
10	—	39	—
15	—	47	50
18	20	56	—
22	25	68	75
27	30	82	—
33	—	100	—

Table 2: Generally Available Capacitors—High Values (values in microfarads— μF)

Non-Electrolytic		Electrolytic		Electrolytic	
Common Values	Other Values	Common Values	Other Values	Common Values	Other Values
0.001	0.0015	1	1.5	500	—
0.0022	0.002	2	4	1000	1250
0.0033	—	5	6	2000	1500
0.0047	0.005	10	8	2500	—
0.0068	—	15	16	5000	—
0.01	—	25	32	10,000	12,500
Up to 10	Up to 5	50	60	25,000	20,000
		100	—	50,000	—
		150	200	100,000	—
		250	—	500,000	—

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AR8 5/-	ECF85 8/6	L63 6/-	TT15 55/-	W118 10/-	6/-	384 5/8	5Y3GT 5/8	6AM5 2/6	6F23 14/8	12AU7 4/8	83 14/-
ARTP1 6/-	ECF86 8/6	MH41 8/-	TR31 45/-	VU39 7/-	11A 2/6	3V4 6/6	5Y3WGB 15/-	6AM6 3/6	6F32 3/-	12AT7WA 84 5/-	
ATP4 2/3	ECF87 7/-	MH16 7/6	TZ40 60/-	W118 10/-	11A6 6/8	3D1 4/-	5Y3WGB 15/-	6AN5 20/-	6F33 20/-	12AX7 5/8	85A2 7/6
AZ31 9/-	ECF88 10/-	M16 6/-	TZ50 40/-	W119 9/-	11C6 7/-	4D1 4/-	5Y3WGB 15/-	6AN5 2/6	6G6G 3/8	12AX7 5/8	282A 100/-
BD78 40/-	ECF89 10/-	N34 8/-	TZ60 18/-	X65 5/-	11H4 4/-	5A173G 5/-	6AX5 5/6	6H6GT 1/8	12B6A 6/-	12AY7 10/-	307A 5/6
BL163 10/-	ECF90 3/4	N78 15/-	U12/14 7/-	X66 7/8	184 5/-	5B251M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12BA8 6/-	310C 25/-
BT35 55/-	ECF91 3/4	OA2 6/-	U25 14/6	X118 8/-	174 3/-	5B252M35/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12BB7 5/8	350B 8/-
BT45 150/-	ECF92 8/-	OB2 6/-	U26 14/6	X145 8/-	211 3/-	5B253M15/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12BH7 3/6	357A 7/-
BT83 35/-	ECF93 8/-	OB3 7/-	U27 8/-	Y63 6/8	243 5/-	5B254M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12C8 3/-	368A 5/-
CV102 3/-	ECF94 9/-	OC3 6/8	U28 14/6	Y63 6/8	243 5/-	5B255M35/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12E1 17/-	368B 30/-
CV103 4/-	ECF95 10/-	OD3 6/-	U52 4/8	Y65 4/8	2D21 4/8	5B256M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12H6 3/-	393A 27/6
CV315 (matched pair)	ECF96 4/6	OZ4A 5/-	U81 18/-	Z800U 28/-	344 4/-	5B257M35/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12J7GT 6/8	408C 80/-
CV315 (5m- gle)	ECF97 4/6	OD5 5/-	U191 14/-	Z801U 25/-	344 4/-	5B258M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12K5M 10/-	445A 8/-
DA100 28	ECF98 6/3	P41 7/-	U404 6/-	Z802U 12/-	344 4/-	5B259M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12K7GT 5/-	408C 80/-
DAF96 6/-	ECF99 3/6	PACB80 7/8	U801 9/6	Z803U 28/-	344 4/-	5B260M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12K8M 10/-	446A 8/-
DD41 4/-	ECF100 2/6	PC86 10/3		Z804U 28/-	344 4/-	5B261M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12L7GT 5/-	703A 80/-
DET20 2/-	ECF101 2/6	PC87 9/6		Z805U 28/-	344 4/-	5B262M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12M7GT 5/-	705A 20/-
DET35 10/-	ECF102 2/6	PC88 9/6		Z806U 28/-	344 4/-	5B263M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12N7GT 5/-	705B 20/-
DF91 3/-	ECF103 2/6	PC89 9/6		Z807U 28/-	344 4/-	5B264M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12O7GT 5/-	706A 20/-
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DF96 7/8	ECF105 2/6	PC91 9/6		Z809U 28/-	344 4/-	5B266M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12Q7GT 5/-	708A 20/-
DY86 6/-	ECF106 2/6	PC92 9/6		Z810U 28/-	344 4/-	5B267M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12R7GT 5/-	709A 20/-
DY87 6/6	ECF107 2/6	PC93 9/6		Z811U 28/-	344 4/-	5B268M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12S7GT 5/-	710A 20/-
EB80C 18/-	ECF108 2/6	PC94 9/6		Z812U 28/-	344 4/-	5B269M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12T7GT 5/-	711A 20/-
EB80D 18/-	ECF109 2/6	PC95 9/6		Z813U 28/-	344 4/-	5B270M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12U7GT 5/-	712A 20/-
EB80E 18/-	ECF110 2/6	PC96 9/6		Z814U 28/-	344 4/-	5B271M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12V7GT 5/-	713A 20/-
EB80F 18/-	ECF111 2/6	PC97 9/6		Z815U 28/-	344 4/-	5B272M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12W7GT 5/-	714A 20/-
EB80G 18/-	ECF112 2/6	PC98 9/6		Z816U 28/-	344 4/-	5B273M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12X7GT 5/-	715A 20/-
EB80H 18/-	ECF113 2/6	PC99 9/6		Z817U 28/-	344 4/-	5B274M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12Y7GT 5/-	716A 20/-
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EB80W 18/-	ECF128 2/6	PC114 9/6		Z832U 28/-	344 4/-	5B289M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12N7GT 5/-	731A 20/-
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EB80C 18/-	ECF134 2/6	PC120 9/6		Z838U 28/-	344 4/-	5B295M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12T7GT 5/-	737A 20/-
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EB80G 18/-	ECF138 2/6	PC124 9/6		Z842U 28/-	344 4/-	5B299M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12X7GT 5/-	741A 20/-
EB80H 18/-	ECF139 2/6	PC125 9/6		Z843U 28/-	344 4/-	5B300M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12Y7GT 5/-	742A 20/-
EB80I 18/-	ECF140 2/6	PC126 9/6		Z844U 28/-	344 4/-	5B301M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12Z7GT 5/-	743A 20/-
EB80J 18/-	ECF141 2/6	PC127 9/6		Z845U 28/-	344 4/-	5B302M40/-	5Z4G 7/3	6AX6 6/-	6H6M 3/-	12A7GT 5/-	744A 20/-
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EB80L 18/-	ECF143 2/6	PC129 9/6		Z847U 28							

Table 3: Comparison of Capacitor Types

Type	Value	Tolerance	Voltage	Temperature	Insulation Resistance	Cost
PAPER Tubular E.H.T.	1000pF—10 μ F 1000pF—100 μ F	$\pm 10\%$ to $\pm 25\%$ $\pm 20\%$	200V—800V 200V—2500V	-55°C to +100°C -55°C to +100°C	2000M Ω/μ F or > 2,000M Ω	8d.—4/- up to 30/- 11/- £7 10s.
PLASTIC	10pF—1 μ F 1 μ F—10 μ F	$\pm 0.1\%$ to $\pm 20\%$ $\pm 20\%$	30V—500V 30V—63V	-40°C to +125°C	From 1,000M Ω to 1,000,000M Ω	8d.—5/3 up to 15/- 2/-—7/3 up to 35/-
CERAMIC	0.5pF—220pF	$\pm 0.25\%$, $\pm 5\%$ $\pm 10\%$	500V—12kV	-55°C to +85°C	> 7,000M Ω	8d.—2/-
	200pF—10,000pF	+40% -20%	500V—750V	-55°C to +85°C		7d.—2/6
	0.01 μ F—0.47 μ F	+50% -25%	6V—30V	-40°C to +85°C		10d.—4/6
SILVER MICA	1pF—10,000pF	$\pm 1\%$	350V	-40°C to +100°C	25,000M Ω	7d.—17/-
ALUMINIUM ELECTROLYTIC	0.5 μ F—300 μ F	-20% to +100%	250V—500V	-25°C to +85°C	0.15CV* or not less than 100 μ A	1/6—17/-
	0.5 μ F—10,000 μ F	and	3V—150V	-25°C to +70°C		1/3—42/-
	10,000 μ F—500,000 μ F	-20% to +50%	3V—70V	-25°C to +70°C		40/-—200/-
TANTALUM ELECTROLYTIC Metal Case Resin Coated	0.1 μ F—330 μ F	$\pm 20\%$	6V—75V	-55°C to 125°C	0.02mA/CV*	3/6—42/-
	0.1 μ F—50 μ F	+50% -20%	3V—40V	-40°C to +85°C		3/-—5/-
VARIABLE	2pF—500pF	—	100V upwards	-50°C to +100°C	1,000M Ω upwards	1/- upwards

* Permissible leakage current where C=capacitance in μ F and V=working voltage.

and at high frequencies it acts as a short-circuit.

The ideal capacitor should therefore have a perfect insulator as the dielectric, and the plates and leads should be perfect conductors with no resistance or inductance. In practice parasitic elements are present as shown in the equivalent circuit of Fig. 3. They consist of a series inductance (Ls) formed by the lead inductance and the wound construction, and a parallel leakage resistance (RL) which is due to the resistance of the dielectric and any discontinuities and impurities in it. The inductance limits the upper frequency at which the capacitor may be used and the leakage resistance limits the impedance of the circuits in which it may be used.

Design Limitations

Other design limitations are maximum voltage rating, tolerance, operating temperature range, reliability, noise generation, temperature coefficient, maximum ripple current capability, humidity rating, size and cost.

Table 3 gives the more important parameters for the various types of capacitor available. This should be used as a rough guide only, since the range of types of capacitor in each section can be very wide.

The capacitance value of a capacitor is determined by the area of the plates and the thickness of the dielectric. Capacitance is increased by increasing plate area or decreasing the dielectric thickness. Each form of construction and dielectric has particular properties and these will now be considered in greater detail.

Paper

Foil and paper capacitors were one of the earliest forms of capacitor. They are formed by winding two strips of foil with a layer of thin paper between as an insulator, as shown in Fig. 4. The foils are made to extend at either end so that foil 1 overlaps the paper dielectric and forms one end connection while foil 2 overlaps at the other end to form the other connection.

This construction used to be insulated by wax and paper, but now either resin or plastic moulding is utilised. Oil-filled and metal encased capacitors are used for e.h.t. working. Metallised paper capacitors are also available, and these generally give smaller dimensions.

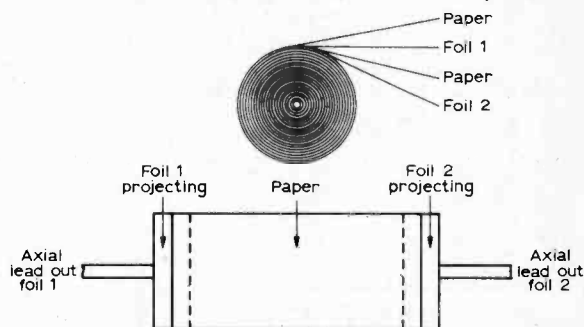


Fig. 4: Construction of a wound foil and paper capacitor, a widely used general purpose type.

Paper and foil capacitors are used as general purpose capacitors and have high working voltages, low leakage, and low cost. Oil-filled capacitors are used for e.h.t. voltage applications. They tend, however, to be bulkier for the same capacitance and voltage rating than modern plastic capacitors.

Plastic Film

Plastic film and metallised capacitors are the natural development of paper capacitors, and they have the same basic construction. Many types of plastic film are used as the dielectric, and each type has properties such as stability or smaller size which constitutes an improvement on the foil and paper styles. Metallising of both paper and plastic film has also considerably reduced the size.

Most plastic capacitors employ metallised film which

is a process whereby the film is coated with a thin film of metal by vacuum deposition. Two such rolls of film are wound together to form the capacitor as shown in Fig. 5. The end-overlapping technique is used to provide end connections and a metal is sprayed on to these overlapping ends to provide a solid base for joining the wire connections by soldering or other methods. Encapsulation is usually with plastic, though some of the flat types use lacquer.

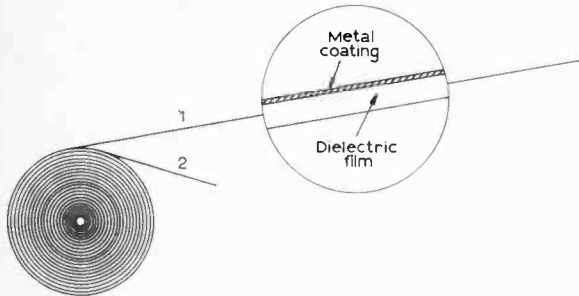


Fig. 5: Metallised film capacitor construction.

Metallised paper capacitors are used for general purpose applications and are smaller than foil and paper types. Polyester capacitors are also used as general purpose capacitors and are low cost, small size, medium voltage (400V) capacitors. They have a wide operating temperature range, close tolerance, and excellent stability. Polystyrene dielectric capacitors, although generally larger than polyester types, are excellent replacements for silver mica capacitors. They are extremely stable, have a negative temperature coefficient, high reliability, extremely high insulation resistance (greater than 10^6 MΩ), close tolerance ($\pm \frac{1}{2}\%$) and have excellent high frequency characteristics (1,000Mc/s). Polycarbonate capacitors have similar performance to the polyester capacitors but are appreciably smaller in size, though their cost is higher. They are useful for miniature circuits and are used in space satellites and rocket equipment. Teflon capacitors are high quality capacitors with high insulation resistance and wide temperature range with a low temperature coefficient. They can be supplied to $\pm 0.1\%$ tolerance and matched for temperature coefficients of 5 p.p.m./°C.

Plastic capacitors therefore are of many sorts and are suitable for most applications provided the correct dielectric material is chosen. Polyester capacitors are now utilised as the general purpose low leakage capacitor for medium and low voltage applications over the capacitance range 0.001 μ F to 10 μ F.

Ceramic

Ceramic capacitors are found in both tubular and disc form. Figure 6 illustrates the construction of a low value tubular capacitor. The capacitance is formed by silvering a ceramic cylinder or disc, the ceramic forming the dielectric. Wire connections are made to each separate coating and the whole construction is insulated with synthetic resin. They are therefore rugged in construction.

The main advantages of this type are extremely small size, low cost, and high frequency of operation. They have a high insulation resistance and can be used up to e.h.t. voltages. The main disadvantage is a very poor temperature coefficient (800 p.p.m./°C) which renders them unsuitable for critical applications. They should

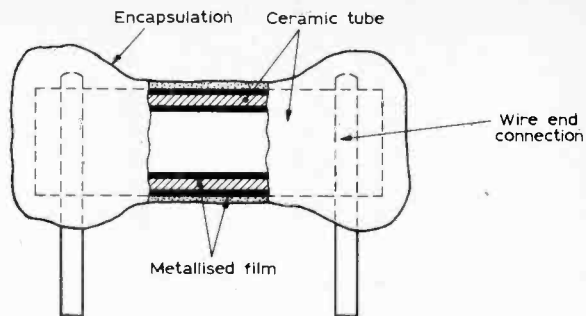


Fig. 6: Tubular ceramic capacitor construction.

not be used for tuning or timing circuits. However they are extremely useful as coupling, decoupling and bypass capacitors, and also as feed-through capacitors up to 5,000Mc/s. Low voltage microminiature plaquette types the size of a match-head are now available.

Silvered Mica

Silvered mica capacitors are manufactured as shown in Fig. 7 by utilising plates of mica with fired-on silver electrodes. The sheets of coated mica are bonded together and the wire connections soldered at each end of the plates. The whole structure is then dipped in resin to give a robust finish.

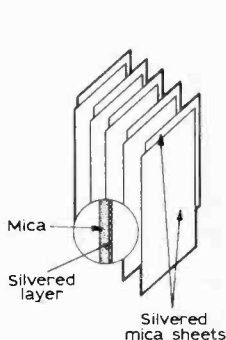


Fig. 7: Construction of a silvered mica capacitor.

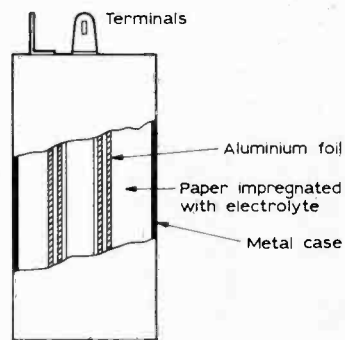


Fig. 8: Construction of an aluminium electrolytic capacitor.

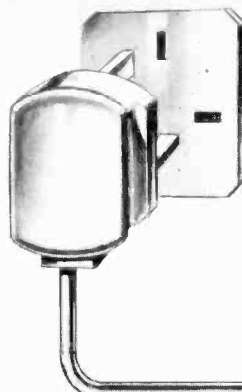
These capacitors are produced in the range 1–10,000 pF, usually with $\pm 1\%$ tolerance. They exhibit great stability, reliability and have a high insulation resistance. Hence they are very suitable for critical applications such as timing and oscillatory circuits.

Electrolytic

Two basic forms of electrolytic capacitor are in common use: the aluminium electrolytic and the tantalum electrolytic.

The aluminium electrolytic is the general purpose electrolytic capacitor and is produced over the range 0.5 μ F to 500,000 μ F. They are constructed as shown in Fig. 8 by rolling two strips of aluminium foil with paper dipped in electrolyte as the dielectric. The construction is sealed in a metal case to which one electrode (usually negative) is connected. The case is insulated if required by a plastic sheath. As the electrolyte is a corrosive paste sealing is important to prevent leakage.

These capacitors operate by electrolytic action and are analogous to batteries. They have definite polarities to d.c. voltages and oppose a.c. voltage changes by



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chemical reaction in a similar fashion to a battery. Generally they are of large physical size, and have a definite lifetime which is determined by the drying up of the electrolyte. By this action very high values of capacitance are achieved. The voltage ratings must be strictly observed, as must the polarities. Since their insulation resistance is low large leakage currents can flow. The explosion of an under-rated electrolytic capacitor is dangerous and very messy. It is worth mentioning that reliability of these capacitors is increased by operating them near to their rated voltage.

Generally these are only used in non-critical applications such as smoothing and decoupling. Tolerances are very large, usually $+50\%$ -20% .

Tantalum capacitors, although they employ electrolytic action, use a solid electrolyte. They are considerably smaller than aluminium electrolytics, though more expensive, and are extremely useful for low voltage miniature circuits. Until recently they were only available in a metal-cased form but are now available in a resin encapsulation which has resulted in a considerable price reduction.

Variable Types

Both air spacing and mica dielectric types are available. The capacitance variation is obtained by varying the proximity of the movable vanes to the fixed vanes as shown in Fig. 9. The larger types, which have capacitance

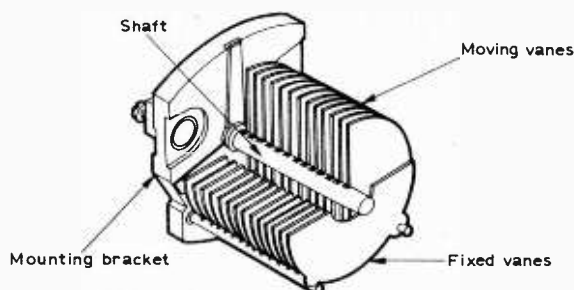


Fig. 9: Typical larger type of air-spaced variable capacitor for oscillator and tuned circuit tuning.

variations of 5–500pF, are used for oscillator and tuned circuit tuning purposes and are available in dual and triple ganged configurations. The smaller flat, beehive, or cylindrical types are used as trimming capacitors and after initial tuning are locked in position. These generally have a capacitance range of 2–60pF.

Summary

Metallised paper and polyester capacitors are suitable as general purpose capacitors, with polycarbonate as a miniaturised alternative. Ceramic capacitors are useful for coupling and decoupling at medium and high frequencies, and electrolytic capacitors for these functions at low frequencies. Silvered mica and polystyrene capacitors are ideal for critical applications.

The Future

Trends will be towards the development of cheap, close tolerance, high stability capacitors, probably through the use of modern plastic films. The present types of capacitors will continue to shrink in size and improve in quality. Miniaturisation in the electrolytic sphere will be a continuing trend.

TO BE CONTINUED

THE SOLID STATE

—continued from page 668

Consider the device of Fig. 12 biased as shown. The positive bias on the base relative to the emitter means that current is flowing between the emitter and base. Since the emitter has a considerable surplus of conduction electrons (being heavily doped) and the base has only a slight surplus of holes (being lightly doped) most of this current is carried by electrons.

The other junction, between the base and collector, is reverse biased. Electrons on the n side and holes on the p side are pulled back from the junction and no current would be expected to flow. The base region, however, is very thin, and the electrons which are moving rapidly from the emitter to the base come under the influence of the much higher positive bias at the collector than at the base. Thus most of the electrons from the emitter keep moving straight on, cross the base-collector junction and end up in the top n region to be collected at the positive bias connection of the collector. If the base region is thin enough, a very large proportion of the electrons moving from emitter to base will end up at the collector. For example, we might have an emitter current of $1,000\mu\text{A}$ ($=1\text{mA}$) with $10\mu\text{A}$ flowing through the base contact and the remaining $990\mu\text{A}$ appearing at the collector. This gives us a ratio of collector current to base current of $990/10=99$ and this is the quoted figure of current amplification given the symbol h_{fe} . This figure is not absolutely constant: it usually reaches a maximum at some value of collector current (Fig. 13)—

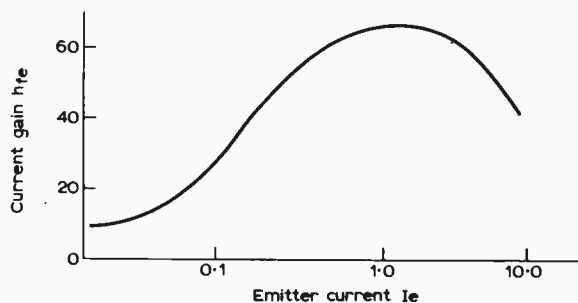


Fig. 13: Typical graph of current gain against emitter (or collector) current for small transistors (common emitter circuit).

usually 1mA in small transistors—so that perfectly linear amplification is not possible though good linearity is possible if the graph of h_{fe} against collector current is flat-topped and the operating conditions are within this region.

The maximum values of h_{fe} which can be obtained depend on how thin the base region can be made, and in this respect very great improvements in performance have been achieved by modern techniques. Probably the most important advance has been the discovery that a crystal of semiconductor exposed to the vapour of the same material will grow in the same crystalline form, but at a slow controllable rate, so that very thin layers can be grown which are still part of the original crystal. This technique is called epitaxy, and the word epitaxial occurs in nearly every description of recent transistor construction.

TO BE CONTINUED

new books



STEREO HANDBOOK
By G. W. Schanz. Published by Iliffe Books Ltd.
135 pages. Size 8½ x 5½in. Price 16s.

THERE have been so many books on stereo that one more may seem something of a luxury. By producing it as a stiff paper-back and keeping the cost reasonable, Iliffe have made this Philips original a luxury we can all afford. The considerations we must apply are thus: does it say all it should, and, does it add anything new?

On both counts we can recommend this book. Without getting too technical, yet without talking down to the interested reader with babytalk explanations of fundamentals that too often introduce such volumes, the principles of stereophony from the 1,550 experiments of Adraan Willaert with two choirs to the present-day multiplex broadcasts, are intelligently discussed. In particular, the treatment of stereo broadcasting, various methods of decoding and testing decoders will be of interest to PW readers.

The early part of the book quotes some interesting data on room acoustics (we particularly liked the illustration describing reverberation and the frequency dependency of absorption of various materials). Tape and disc recording processes are outlined and practical stereo connections to DIN standard are shown in detail. It is in such matters that the average man, perhaps convinced by a demonstration that stereo is an undoubted advantage, finds the stumbling block. Numerous practical facts on microphones, tape recording and pickups will be found scattered through these early pages. As may be expected, examples of constituent parts of the stereo chain are drawn from Philips products; but this is no deterrent. The overall impression is of a book written with a true desire to impart knowledge, and an undoubted ability to do so.—BRG.

POINTS ON PICK-UPS
By P. Wilson. Published by A. C. Farnell. 140 pages.
8½ x 5½in. Price 10s. 6d.

VERY often, the best work on a particular subject is a manufacturer's brochure, or, in some exceptional case, the service manual. Here we have a reference work by a distributor who must originally have commissioned the paperback—some ten years ago—to foster the sales of the goods he handled. Now, though we could not go so far as to say the sales of the book have outstripped the sales of the goods, they must certainly form a pleasing entry in the ledger.

There have been five previous editions of *Points on Pick-ups*, and this, the sixth, has been brought fairly well up to date. It is impossible to keep abreast with innovations in this field, so ripe for development as new materials and newer techniques come along, but the majority of the well-known and popular pickups, cartridges and stylis are illustrated.

The method is to list the cartridges alphabetically as to maker, with a photograph and basic details.

On a facing page the stylus appropriate to that cartridge is drawn, with details such as colour code and tip size. Head shells for some cartridges are included, and one section is devoted to pickup arms where these are complete with a particular cartridge. Accessories also receive attention, again with photographic illustration wherever possible.

The introduction to this edition debates the case against compromise while describing the main requirements for compatible (mono-stereo) cartridges, and a two-page note on stylis includes a number of tips on their use (if you will pardon a pun almost as provocative as the title of the book!)

This is such a regular part of the bookshelf of a radio and hi-fi dealer that one tends to forget its additional usefulness to the ordinary chap, who merely wants to identify his stylus before he can order a replacement, or who may, perhaps, be wondering what changes of cartridge he can make. There are omissions: a section on cartridge connections, and a few notes on matching may save unwitting expense for the unwary. But at the price, who can carp? Well worth anyone's half-guinea.—HWH.

FUNDAMENTALS OF DIGITAL MAGNETIC TAPE UNITS
By Univac. Published by Foulsham-Sams Technical Books Ltd.
96 pages. Size 8½ x 5½in. Price 21s.

WHO is this bloke Univac, you may ask? This book, whose title is almost as long as the authorship credit, has that classic formulae of having been written by a committee. Well, almost. It was prepared by the Field Engineering Department, Univac Data Processing Division, of the Sperry Rand Corporation, and, as ever, has the introductory chapter for we poor foreigners who cannot understand American, contributed by our old friend, W. Oliver.

Let it be stated at the outset, that digital magnetic tape units are a different proposition from our humble domestic tape recorders, although the fundamental principles remain. Which is not to say that the book is of no interest to the tape recording enthusiast. It may serve as a fruitful source of ideas especially if circuits are studied with care and a trifle of inspiration. This reviewer can see some possibilities in an amplitude detector and a two-polarity RZ "write" circuit for future experiment.

The early chapters deal with magnetic theory, tapes and heads, and the middle section goes into some well-illustrated detail of mechanisms. Again, this is unlikely to be of direct use to the amateur, and it is to be hoped that the professional will have a deeper knowledge than this book endeavours to test.

Nevertheless, the method of writing, with terminal questions to each chapter and an absence of ponderous overstatement, makes the book an interesting addition to the enthusiast's library—if he feels that his marginal interest will justify the layout of a guinea.—AWB.

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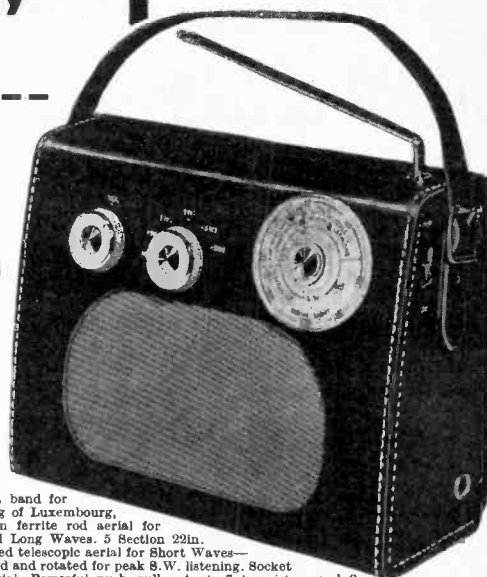
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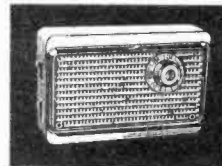
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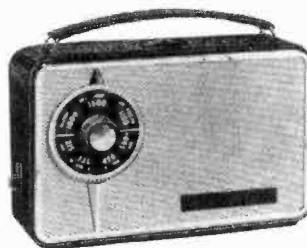


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U8	50 Sil. Planar Diodes 250mA OA/200/202	10/-
U9	20 Mixed Volts 1 Watt Zener Diodes	10/-
U11	30 PNP Silicon Planar Transistors TO-5 sim. 2N1132	10/-
U12	12 Silicon Rectifiers EPOXY 500mA up to 800 PIV	10/-
U13	30 PNP-NPN Sil. Transistors OC200 & 2S104	10/-
U14	150 Mixed Silicon and Germanium Diodes	10/-
U15	30 NPN Silicon Planar Transistors TO-5 sim. 2N697	10/-
U16	10 3-Amp Silicon Rectifiers Stud Type up to 1000 PIV	10/-
U17	30 Germanium PNP AF Transistors TO-5 like ACY 17-22	10/-
U18	8 6-Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	10/-
U19	30 Silicon NPN Transistors like BC108	10/-
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U21	30 A.F. Germanium alloy Transistors 2G300 Series & OC71	10/-
U22	10 1-Amp Glass Min. Silicon Rectifiers High Volts	10/-
U23	30 Madt's like MAT Series PNP Transistors	10/-
U24	20 Germanium 1-Amp Rectifiers GJM up to 300 PIV	10/-
U25	25 300 Mc/s NPN Silicon Transistors 2N708, BSY27	10/-
U26	30 Fast Switching Silicon Diodes like IN914 Micro-min	10/-
U28	Experimenters' Assortment of Integrated Circuits, untested. Gates, Flip-Flops, Registers, etc. 8 Assorted Pieces	20/-
U29	10 1 Amp SCR's TO-5 can up to 600 PIV CRS1/25-600	20/-
U30	15 Plastic Silicon Planar trans. NPN 2N2924-2N2926	10/-
U31	20 Sil. Planar NPN trans. low noise 2N3707	10/-
U32	25 Zener diodes 400mW DO-7 case mixed Vols. 3-18	10/-
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Code Nos. mentioned above are given as a guide to the type of device in the Pak. The devices themselves are normally unmarked

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OC82	2/6
OC140	5/-
OC170	2/6
OC171	3/6
OC201	7/6
ORP12-60	8/6
OCPT1	8/6
OA5-10	2/6
OA47	2/6
OA70	1/3
OA79	1/9
OA81-85	1/6
OA91	1/3
OA95	1/9
OA900	3/6
OA202	3/6
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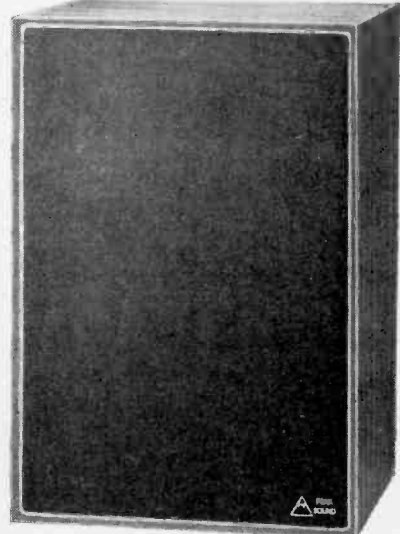
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MONTHLY NEWS FOR DX LISTENERS

Times GMT
Frequencies in kc/s

THE BROADCAST BANDS by CHRISTOPHER DANPURE

MANY of you may be DX-ing over the Christmas and New Year periods and may be wondering what stations put out good seasonal programmes. Well *R. Japan* usually puts out some interesting programmes round about Christmas and New Year in Japan. On Christmas Day I usually listen to *R. Sweden*, *R. Nederland*, *R. Australia*, *R. Japan*, *Voice of Germany*, *Cologne*, *Swiss Shortwave Service*, *R. South Africa*, *R. Portugal* and *R. Canada*.

Here now are the circuit predictions for December.

West Africa: 1000-1400 25, 21, 17 and 15Mc/s; 1400-1600 25, 21, 17, 15 and 11Mc/s; 1600-1800 21, 17, 15, 11 and 9Mc/s; 1800-2000 21, 17, 15, 11, 9, 7, 6 and 5Mc/s; 2000-2200 17, 15, 11, 9, 7, 6, 5 and 4Mc/s; 2200-2400 15, 11, 9, 7, 6, 5 and 4Mc/s; 2400-0200 15, 11, 9, 7, 6, 5 and 4Mc/s; 0200-0600 11, 9, 7, 6, 5, 4 and 3Mc/s; 0600-0800 15, 11, 9, 7 and 6Mc/s; 0800-1000 25, 21, 17, 15 and 11Mc/s.

South Africa: 0800-1400 25, 21 and 17Mc/s; 1400-1600 25, 21, 17 and 15Mc/s; 1600-1800 21, 17, 15, 11 and 9Mc/s; 1800-2000 21, 17, 15, 11, 9, 7 and 6Mc/s; 2000-2200 17, 15, 11, 9, 7, 6 and 5Mc/s; 2200-2400 15, 11, 9, 7, 6 and 5 Mc/s; 2400-0200 11, 9, 7, 6 and 5Mc/s; 0200-0400 11, 9, 7 and 6Mc/s; 0400-0600 11 and 9Mc/s; 0600-0800 17 and 15Mc/s.

East Africa: 0800-1200 25, 21, 17 and 15 Mc/s; 1200-1400 25, 21, 17, 15 and 11Mc/s; 1400-1600 25, 21, 17, 15, 11, 9 and 7Mc/s; 1600-1800 21, 17, 15, 11, 9, 7, 6 and 5Mc/s; 1800-2000 17, 15, 11, 9, 7, 6 and 5Mc/s; 2000-2200 15, 11, 9, 7, 6 and 5 Mc/s; 2200-0200 11, 9, 7, 6 and 5Mc/s; 0200-0400 11, 9, 7 and 6Mc/s; 0400-0600 11 and 9Mc/s; 0600-0800 17, 15 and 11Mc/s.

South Asia: 0800-1000 25, 21, 17, 15 and 11Mc/s; 1000-1200 25, 21, 17, 15, 11 and 9 Mc/s; 1200-1400 25, 21, 17, 15, 11, 9 and 7Mc/s; 1400-1600 17, 15, 11, 9, 7, 6, 5, 4 and 3Mc/s; 1600-1800 11, 9, 7, 6, 5, 4 and 3 Mc/s; 1800-0200 9, 7, 6, 5, 4 and 3Mc/s; 0200-0400 9, 7, 6 and 5Mc/s; 0400-0600 9 and 7 Mc/s; 0600-0800 21, 17, 15 and 11Mc/s.

South East Asia: 0800-1000 25, 21, 17 and 15Mc/s; 1000-1200 25, 21, 17, 15 and 11Mc/s; 1200-1400 25, 21, 17, 15, 11 and 9Mc/s; 1400-1600 21, 17, 15, 11, 9, 7, 6, 5, 4 and 3Mc/s; 1600-1800 11, 9, 7, 6, 5, 4 and 3Mc/s; 1800-2000 9, 7, 6, 5 and 4Mc/s; 2000-2200 9, 7, 6 and 5Mc/s; 2200-2400 9 and 7Mc/s; 2400-0200 9Mc/s only; 0200-0600 circuit closed; 0600-0800 21, 17 and 15Mc/s.

North East Asia: 0800-1000 17, 15 and 11Mc/s; 1000-1200 11 and 9Mc/s; 1200-1800 9Mc/s only; 1800-2400 try 9 and 7Mc/s; 2400-0600 9Mc/s only; 0600-0800 11 and 9Mc/s.

Australia via Asia: 0800-1000 21 and 17Mc/s; 1000-1200 21, 17 and 15Mc/s; 1200-1400 21, 17, 15, 11 and

9Mc/s; 1400-1600 21, 17, 15, 11, 9, 7, 6, 5 and 4Mc/s; 1600-1800 11, 9, 7, 6, 5 and 4Mc/s; 1800-2000 9 and 7 Mc/s; 2000-2200 9Mc/s only; 2200-0600 circuit closed; 0600-0800 17Mc/s only.

West Coast South America (North of Chile): 1200-1800 25 and 21Mc/s; 1800-2000 21 and 17Mc/s; 2000-2200 17 and 15Mc/s; 2200-0600, up until 2400 15, 11, 9, 6, 5, 4 and 3Mc/s, after 2400 drop 15Mc/s; 0600-0800 11, 9 and 6Mc/s; 0800-1000 15, 11 and 9Mc/s; 1000-1200 21, 17 and 15Mc/s. Now here are this month's DX-tips:

AUSTRALASIA

Australia: During the winter season listen out for the new *R. Australia* transmitter station at Darwin. At the time of going to press no schedule details are available.

ASIA

Japan: *R. Japan*, Tokyo up until March 2 will transmit the morning service to Europe on 17,825 and 15,135 from 0700-0830. The evening service to Europe from 1930-2100 will be heard on 11,965 and 9,700.

EUROPE

Fed. Rep. Germany: *R. Deutsche Welle* is now on the following schedule for its English transmissions which are beamed to Africa, S. Asia, Far East and Pacific and North America, from transmitters at Juilich. 0600-0630 17,845, 15,275, 11,785; 0845-0940 21,650, 17,845, 15,275, 11,785; 1045-1055 11,965, 11,905, 9,605; 1045-1100 21,560, 17,875, 15,275; 1550-1620 17,875, 15,275; 1900-1910 15,405, 11,795, 9,605; 2110-2200 15,275, 9,765, 7,290; 2145-2205 11,925, 9,735; 0130-0250 9,735, 9,640, 6,025; 0300-0340 11,945, 9,640, 9,545 and from 0445-0545 9,650, 9,545 and 6,145.

Sweden: *R. Sweden*, Stockholm, is now operating the following schedule up until March 2. 0830-0900 11,880, 9,625; 0900-0930 9,625; 0930-1030 21,690, 9,625; 1030-1100 9,625; 1100-1210 11,705, 9,625; 1230-1330 21,690, 9,760; 1400-1530 21,675, 15,240; 1600-1700 17,770, 15,310; 1730-1800 15,240, 6,065; 1800-1830 15,240; 1830-1930 15,240 11,865; 1945-2015 6,065; 2015-2115 9,625, 6,065; 2130-2230 11,705, 6,065; 2245-2345 11,810, 11,705; 2400-0230 11,705, 5,990; 0300-0430 11,705; 0445-0615 21,675 and 0630-0715 6,065.

Switzerland: *Swiss Shortwave Service*, Berne, now has English programmes until March 2 at the following times. 0700-0800 on 11,775 and 9,590 daily, weekdays only also on 9,535 and 6,165; 0845-0945 15,135, 11,775; 1000-1100 21,520, 17,855, 15,305; 1130-1230 11,865, 9,665; 1315-1415 21,520, 17,845, 15,305; 1500-1600 17,830, 15,305; 1815-1915 15,305, 11,775; 1930-2030 9,665, 6,015; 0130-0230 11,715, 9,535, 6,120; 0445-0545 9,720, 6,120. So until next month a merry Christmas and good DX-ing in 1969.

THERE'S no doubt about it, the flavour of the month is 10 metres. Every other letter told me to stop moaning and start listening, and they sent a huge pile of DX scalps from 28Mc/s just to prove the point. Even little lads with BC receivers plugged into the television aerial have been hearing things so we can't say it's beginner's luck.

Talking about kicking a man when he's down. No sooner do I finish with the 10 metre logs than all the L.F. sleuths give me a right verbal bashing with choice callsigns logged on 40 and 80. Some very good openings have been in evidence all the way up the bands and it could be a FB Winter for aerial dangles everywhere.

Under the heading of News and Views comes a report that this week's callsign is OM, which could be a bit confusing. These tabs are worn by OK stations to commemorate the "formation" of Czechoslovakia.

Congratulations to two s.w.l's who have been reincarnated with an R.A.E. pass. **Robert Dinning** is one, and **Francis McVerry** has got the call GM3XUV and is loose on 40 metres with a rock-bound homebrew running 10 watts. He has already worked most of Europe with the rig.

Listen on 3804kc/s for W1FZJ/KP4 who listens for callers on 3800kc/s, but if you're transmitting remember that the frequency tolerance for band-edge working on 80 metres is 0.26 %.

FORTY AND DOWN

William Mantovani (Doncaster), heard 80 metres sigs from—ET3USA, VO1FX, VEØMD and W1FZJ/KP4. He says that he heard this last station last January but that the W is now four S-points up by comparison. Wish someone would say that about my signals. On 40, the log reads—PY7AUT, WB2WYZ/P/4X4, 8P6BH, 9N4KR, 9M2DQ. Gear in use, HAM-1 and an a.t.u. plus a 260ft. long wire.

A. Houghton has reached the ripe old age of twelve (congratulations Sir) and has a Bush AC71 domestic receiver. He reports that 160 is very busy and managed to grab an EI callsign too. On 40, his best is VQ3VAA. The antenna is a 110ft. double L. (Wonder what the double L that is?)

R. King (not at the key contacts I hope) is a 40 metre fan judging from the log. Located in Yorkshire with an HA500 and a 66ft. end fed he claims—CM2DC, CT1IJ, EA3QW, EA4JV, F6AFP, GC5ALO, GD3JIU, HC4WM, HP1NBR, IS1EP, IT1AVA, K1MBH, K2MRG/MM, KP4BRY/MM, LX1SL, OZ7NQ, PAØDX/M, PY1DAH, PY2ENX, PY6ABB, PY7LC, VK3OZ, VP1CP, WA1GNE, W2EQM, W4MPE, W8OO/M/4, ZS1JA, 4X4IX, 5N2ABG, 9M2DQ.

S. Krol (Lancs.), P.W. transistor superhet modified as per "April 1967", $\frac{1}{4}$ wave end fed advises—listen 3775kc/s just after midnight for AP2MR, for ZL's (ZL2BCG) at 0600 every morning, W1FZJ/KP4 and WØVXO/KV4 around 3804kc/s about 0430 onwards most mornings. Don't forget ON4UN's DX net on 80 on Friday and Monday nights.

TWENTY AND FIFTEEN

Jim strikes again, **Jim Baker** that is. He relates the hair-raising tale of LG5LG. Apparently this call was located at Morokuilen (I couldn't even find it in my atlas). This is a field on the LA/SM border and amateurs of any nationality are permitted to operate on that piece of "free territory". "Cor, now I've 'eard it orl", says he, packing the transistor rig and looking up the boat trains.

D. Redmond (Holyhead), ground plane plus an RA-1 had some FB s.s.b. sigs on 20 from—CE3NI, CE6EF, CE6EW, CP6GO, TI2DVH, PJ2AW, PYØARM, PY3HT, PY7AKL, VK3NO, VP1RD, YV3DA, YV5LOR. On 15—PY2EFF, VK2FA, VK2FU, VK2JM, VK5DE, 9V1OW.

P. Lovell (Kent), 4-valve s'het with a home-brew b.f.o. 30ft. vertical plans to take the R.A.E. in December. He heard I1BPW in QSO with guess who—JX3DH. (No comment.)

Robert Dinning (Ayrshire), HA350 plus PR30 plus RQ10 plus a pair of hi-fi headphones (I don't hear much but the quality of what I don't hear is marvellous!), went s.s.b'ing on 20 for—AP2KJ, CR7HY, HBØAG, HP4BIO, JX4EJ (never said a word), KA9NF, KC4USV, KG6IH, KR6SO, KX6DQ, LG5LG (funny Dud, funny), PYØARM, MP4BGU, OX5AP, TA1AV, VK3EU, VK5FU, VP8HZ, VQ8CS, VS5OJ, VS6DR, WA4WMA/AM (region 2), WB4IRT/AM, (region 1), YUØJ, ZL1APZ, ZS9Q, 3A2CP, 9J2MJ, 9K2AM, 9M2XX, 9V1NV, 9X5AA. On 15 the best were—CR6BA, CX2CN, DU1RZ, HK5AZA, HR1JMS, HS3MK, KG6AJQ, KR6RB, KV4FQ, MP4TCF, TG9RN, TU2AY, VK2AVT, VK9LR, VQ9OH, VR1L, VS6DR, VU2DKZ, XW8AX, YBØAB, YN1PS, ZD8CC, ZS3T, 3A2CX, 3V8AA, 9K2BV, 9N1MM.

TEN

Who heard VU2GGB, UF6HO, 6Y5NY, 8R1S, CX8DM, CO2BY, 4A1WS, KG4DH, 9J2RV, HI8XJP, ZE8JY, 9V1PB and VP8JT all on 10 metre phone? Confession of the above from **A4862** (Essex). He also has an SB300 and a 4 element beam at 60 feet. Crikey, you could almost see them as well from up there!

P. Baker (Wales), HE30, 150ft. long wire lassooed these on phone—CN8MI, CR4BC, CR6GU, CR7LI, ET3REL, HR3AC, MP4BGU, PY1AGP, SVØWO, VE1YO, VQ9DH, W6DRB, W6FMR, YV1DA, ZC4GM, 5Z4AA, 8P6CA, 9G1UQ, 9J2VX, 9K2BJ, 9Q51A, 9Y4BF.

RESOLUTIONS

How about checking the gear? The aerial and earth system needs an annual going over. Just think, a dodgy aerial or a bad connection could cost you a lot of 1969 DX. The station receiver too, when was it last lined up? The real experts check their receivers once a year at least.

If you have trouble finding the countries of origin of all those callsigns, then a ninepenny postal order to the R.S.G.B. will bring a countries list which will solve all your problems.

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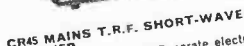
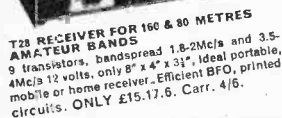
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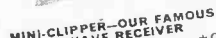
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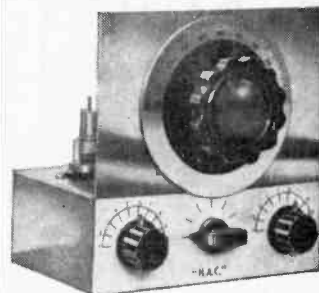
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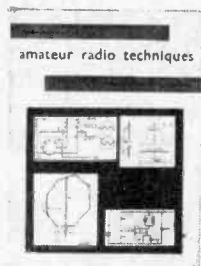
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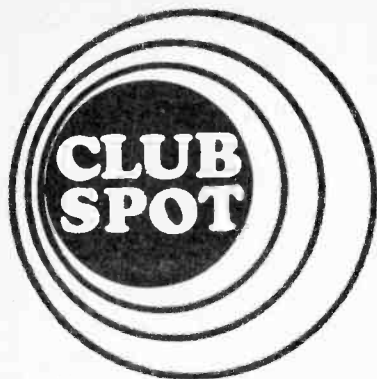


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No. 22

Leyton & Walthamstow AMATEUR RADIO SOCIETY

G
3
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Y

IMAGINE being interested in radio, yet living in a district where there was no radio club. No ensemble of happy smiling understanding faces who were enthusiastic about the hobby.

Of course, if you live in London E.10, or thereabouts, then you don't have a thing to worry about 'cos you've got the Leyton and Walthamstow Amateur Radio Club practically on your doorstep, and they are always very pleased to welcome a new face too.

The present membership has crept above twenty—why not drop in on the club and make it above thirty? Meetings are held at 7.30 p.m. on Tuesdays and at least ten members hold current call signs so there will be no lack of activity from the practical aspect. The club also boasts its own call sign—G3WHY, which is aired at every opportunity. The club station is frequently on the air on 160 metres and 2 metres although plans are being hatched to extend activity to the h.f. DX bands in the very near future.

Help is always to hand for those needing any assistance whether practical or theoretical. Regular classes are held for those wanting to learn Morse and advice is on tap for anyone with problems regarding the R.A.E.

At least two members have braved the u.h.f. region and have taken the precaution of arming themselves with a /T licence. Several demonstrations both /T and /A have been given in local clubs and at various events.

The club has a keenness for contests and although no pots have been won this doesn't deter them from having a go and having a good time in the process. Not only does the club enter both h.f. and v.h.f. field days but also runs its own mini-field-days during the long Leyton summers. Although not professing to be on a par with the national events, these are a great success and perhaps more important, everyone who attends seems to have a great deal of fun.

The club has a variety of interests and thus the meetings vary in content. Junk sales, lectures, natter-nights, etc. all form part of the club menu.

The Hon. Sec. assures that the members are a "... fairly normal bunch of blokes with all the usual vices". Almost worth while going along just to see isn't it?

Place for the weekly meetings is the Leyton Senior Evening Institute, Essex Road, London, E.10. If you'd like to check first, then why not give "Charlie" a buzz? You can find him at 114 Farmillo Road, Leyton, London, E.17, and the phone book says you can reach him on LEY 4673.



Above: Some of the gang caught hovering near a few of the entries for the annual construction contest which took place last June.

Right: Will it work and what's that bit doing? Two critical pairs of eyes examine one of the entries in the constructors contest.

Below: CQ two—CQ—two, here G3WHY. The club station in action on 144Mc/s from the Senior Evening Institute on a typical Tuesday evening.



THE MEDIUM WAVE COLUMN

WITH the season well established and a fall predicted for the sunspot count, DXers will be looking forward to a good winter on the medium waves. Conditions to North America were very good during the summer—KMOX (1120) St. Louis was logged several times during August. In the autumn however, this path became rather unstable, conditions varying rapidly from day to day. No reports yet of the west coast of the United States though the writer did log a weak station on 1000 on 22nd October at 0624 hours GMT which was heard, during a peak, to mention the Seattle Police Force (KOMO?). Recent loggings from North America include CBN (640), CBH (860), WCB (880), CJCH (920), CJON (930), WINZ (940), CHNS (960), ZFBI (960), WINS (1010), KDKA (1020), WBZ (1030), CBA (1070), WBAL (1090), WNEW (1130), and *Radio St. Pierre* (1375). The latter is in the French islands of St. Pierre et Miquelon located near Newfoundland. This is a "medium wave only" country as St. Pierre is the sole broadcasting station.

Further south, XEOY (1000) in Mexico City has been heard a number of times with the call "Es Radio Mil". A new one in the Caribbean is WBMJ (1190), San Juan, Puerto Rico, with programming in English. It was fair at 0130 GMT on 25th October. CMBQ (1060) in Havana, Cuba, is the only other station heard recently from this area. *Radio Americas* (1165) has now gone off the air for good.

Brazil has been coming in well at about 0200 hours GMT with PRA3 (860), PRE8 (880), PRF4 (940), PRG2 (1040), PRE3 (1180), all in Rio de Janeiro. From Argentina, LR3 (950) *Radio Belgrano*, LR1 (1070) *Radio el Mundo* and LS10 (1030) *Radio Libertad*, all in Buenos Aires, together with LU6 (1150) *Radio Atlantica La Plata*, have been logged. From the northern part of the Continent

PJB2 (800) Bonaire, Netherlands West Indies, with programming in English, is an easy station for the newcomer to the band. ZFY (760), the *Voice of Guyana* has been heard at midnight GMT with a weakish signal. From nearby Surinam, SRS (725) in Paramaribo, broadcasting rather attractive local music, occasionally has announcements in English, and can often be heard. A loop aerial is a great help here in reducing splash from the all-night German station on 728. The letters SRS incidentally, although used as a call sign, are actually the initials of the organisation running the station. An interesting logging from the west coast of South America is OAX4U (1010) Lima Peru. This station is now 50kW and it has been heard frequently in England and the United States since midsummer, sometimes with a strong and steady signal. The call is *Radio America*, followed by a trumpet fanfare.

A number of African stations are audible in the late evening. Dakar (764) in Senegal is usually strong, with programming in French, also Conakry (1403) in Guinea, again in French. There are two regulars from the Canary Islands, R.N.E. (620) in Las Palmas and CES4 (1097) in Tenerife. The latter is invariably mixed with EFE14 Madrid but it is worth the effort to get material for a report to this station as it issues a rather pretty, coloured, embossed QSL card. CSB91 (1529) in Funchal, Madeira, closes down at midnight GMT with a rather weak signal. The language used is Portuguese.

From the Near East, Baghdad (760) is often strong at 0300 hours GMT when signing on. The two BBC relay stations in Cyprus on 638 and 719 are also audible, in English, at this time, the latter being much the weaker of the two. Finally, Kuwait (1345) has been heard at 0335 with a good signal.

CHARLES MOLLOY

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coils. They have become an integral part of the printed circuit and never need adjustment—another step in increasing reliability and reducing the final price.

Almost all other tuners use the Foster-Seeley discriminator or the ratio detector. The System 2000 tuner uses a pulse counting discriminator. This is free from drift and possesses a lower level of distortion than any other system. Inter-station noise suppression, mains tuning and stereo indicators together with a sensitivity for full limiting of an incredible 3 microvolts are all incorporated. An additional attractive feature is

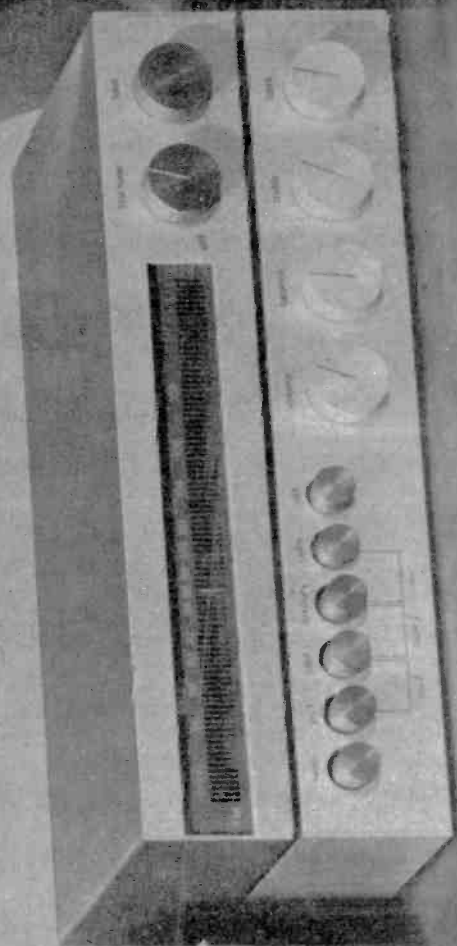
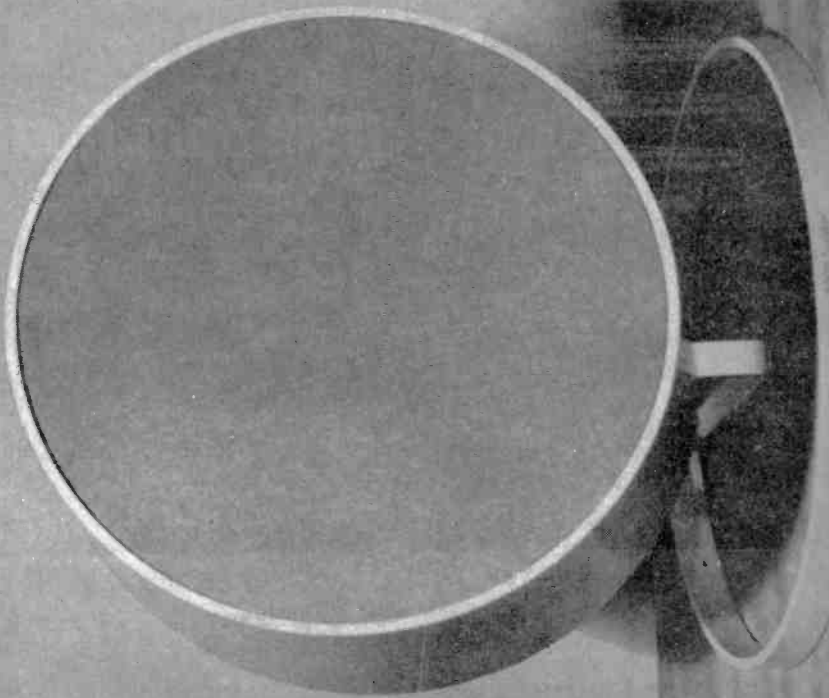
provision for plug-in remote and switched tuning units (available separately). The amplifier and loudspeaker are equally outstanding and well worth comparing for yourself. Ask your dealer for a demonstration or write or ring us for a leaflet.

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| System 2000 35 watt Integrated Stereo Amplifier | 29 gns |
| System 2000 F.M. Tuner | 25 gns |
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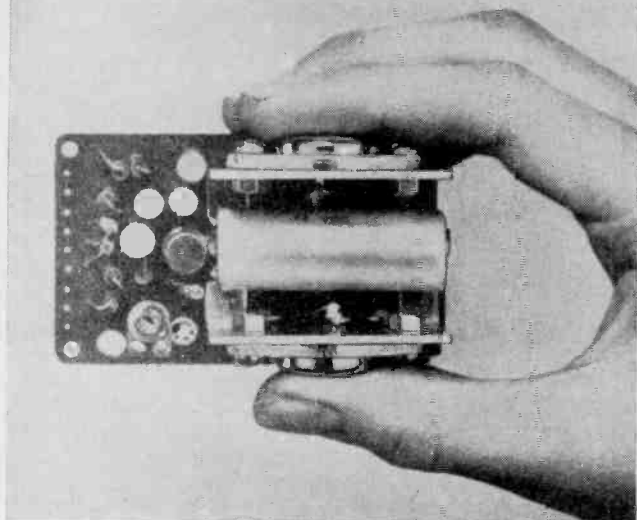
Sinclair launch their System 2000 range with the amplifier, tuner and speaker shown here. The tuner and amplifier are separate units which may be mounted together for convenience. Each is complete in itself and may be used with existing high fidelity equipment. The System 2000 uses new components and ingenious construction in ways which reduce costs, increase performance and improve reliability.

For example, look at the circuits of most F.M. tuners and you will find that they vary very little. Look at the System 2000 tuner. You will notice the absence of conventional



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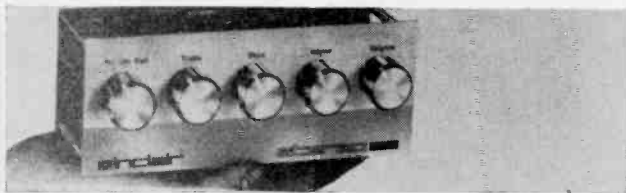


12 watts R.M.S. continuous sine wave output.

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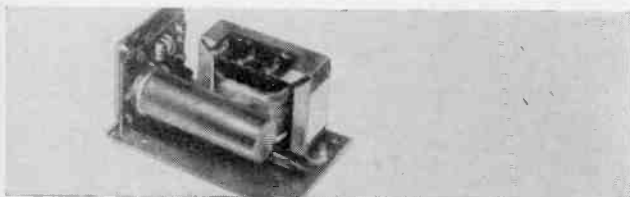
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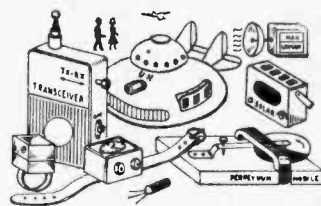
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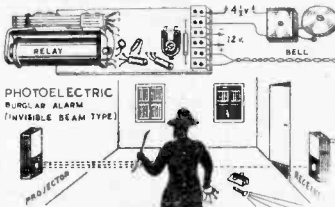
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CONTENTS: 2 P.C. Chassis Boards, Chemicals, Etching Manual, Infra-Red Photo-transistor, Latching Relay, 2 Transistors, Condensers, Resistors, Gain Control, Terminal Block, Elegant Case, Screws, etc. In fact everything you need to build a Steady-Light Photo-Switch/Counter/Burglar Alarm, etc. (Project No. 1) which can be modified for modulated-light operation.



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Everything needed (except plywood) for building: 1 Invisible-Beam Projector and 1 Photocell Receiver (as illustrated). Suitable for all Photoelectric Burglar Alarms, Counters, Door Openers, etc.
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Versatile Invisible-beam, Relay-less, Steady-Light Photo-Switch, Burglar Alarm, Door Opener, Counter, etc., for the Experimenter.
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4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole, 6 way—1 pole, 12 way. All at 8/6 each. 36/- dozen, your assortment.

WATERPROOF HEATING ELEMENT

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BLANKET SWITCH

Double pole with neon light into side so luminous in dark, ideal for dark room light or for use with waterproof element—new plastic case. 5/6 each. 3 heat meter 7/6.

PHOTO-ELECTRIC KIT

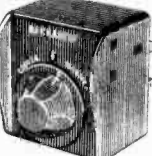
All parts to make light operated switch/burglar alarm/counter, etc. Kit comprises printed circuit. Laminated Boards and chemicals. Latching relay. Infra-red sensitive Photocells and Hook. 2 transistors, cond., terminal block. Plastic case. Essential data, circuit and P.C. checks plus of 10 photo-electric devices including auto. car parking light, modulated light alarm. Simple invisible ray switch—counter—stray light alarm—warning tone electronic alarm—project lamp stabiliser, etc., etc. Only 39/6, plus 2/- post and insurance.



PP3 ELIMINATOR. Play your pocket radio from the mains save 2s. Complete component kit comprises 4 rectifiers—mains dropper resistances, smoothing condenser and instructions, only 6/8 plus 1/- post.

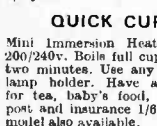
BECKASTAT

This is an instant thermostat, simply plug your appliance into it and its lead into wall plug. Adjustable setting for normal air temperatures. 13A loading. Will save its cost in a season 19/6. Post and ins. 2/9.



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230/240V 1500 watt. Made by Best for kettles with 9 1/2 in. dia. hole including Best, Besco, Chalfont, Davidson, Dimplex, Grafton, Hawkins, Frymaid, Morrow, Monogram, Pifco, Revco, Town, Swan. Normally 32/6. Our price 15/- plus 2/6 post.



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Mini Immersion Heater, 350w. 200/240V. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. 19/6, post and insurance 1/6. 12v. car model also available.



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Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only 18/6, plus 3/6 postage.

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12V BLOWER

Heavy duty motor with centrifugal blower coupled to one end. Ideal for car heater. 12/6, plus 4/6 post.

VARYLITE

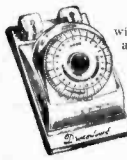
Will dim fluorescent or incandescent lighting up to 500 watts from full brilliance to out. Fitted on M.K. flush plate, same size and fixing as standard wall switch so may be fitted in place of this, or mount on surface. Price complete in heavy plastic box with control knob 23.19.6.



THIS MONTH'S SNIP

Electric Clock

with 3 amp switch made by Smiths for Dreamland. These are mains driven and frequency controlled so are extremely accurate. The dial enables "switch-on" time to be accurately set. Switch off is 3 hours later or by manual control. Intended for switching electric blankets this needs only one setting for the season. Suitable also to control tape recorder, radio and lamp etc. up to 600W. In neat plastic case with mains lead and two outlet plugs. New and unused. 39/6, post and insurance 3/6.



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Transistors, rectifiers, transistors, etc., which use heat-sinks can easily be protected; simply make the contact thermostat part of the heat-sink. Motors and equipment generally, can also be adequately protected by having thermostats in strategic spots on the casing. Our contact thermostat has a calibrated dial for setting between 90 deg.-190 deg. F. or with the dial removed range setting is between 80 to 600 deg. F. Price 10/-.



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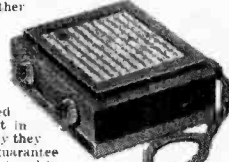


A Fluorescent lighting unit made by the famous Atlas company, with super silent polyester filled choke and radio suppressed starter. The tube springs in and out and the whole unit is beautifully made and finished white enamel. Amazingly economical. If left on all the time costs only one penny per day (uses 1 watt). Measures 2ft. long. Is ideal in Kitchen, Bedroom, Hallway, Porch, Loft, etc. Don't miss this amazing offer, 39/6 with tube. Assembled ready to install. Postage and Insurance 6/6 extra.

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7 transistor Key chain Radio in very pretty case, size 2 1/2 x 2 1/2 x 1 1/2 in.—complete with soft leather zippered bag. Specification:—Circuit: 7 transistor superheterodyne. Frequency range: 530 to 1600 Kc/s. Sensitivity: 5 mv/m. Intermediate frequency: 455 Kc/s. or 455 Kc/s. Power output: 40mW. Antenna: ferrite rod. Loudspeaker: Permanent magnet type.

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DRILL CONTROLLER

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. 19/6 plus 2/6 post and insurance. Or available made up 25/-, plus 2/6 post.



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Panel mounting, consists of neon lamp in red plastic lens with resistor in leads for mains operation 2/6 each, 24/- doz.

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As fitted to telephones, 4 core 2/6 each, 3 core 2/- each.

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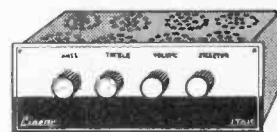
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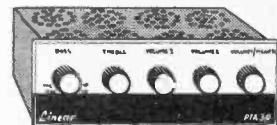
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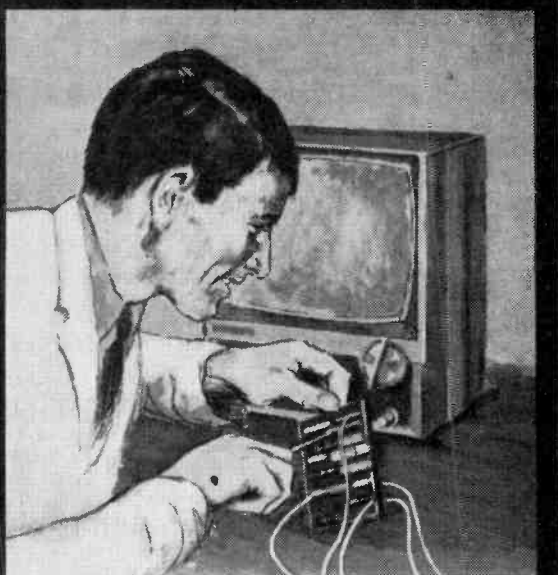
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1C5 7/9	6F17 12/6	12B2K 7/8	306 13/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC120 4/9	0A221 9/8
1C8 10/6	6F18 7/8	12B2L 7/8	307 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC121 3/8	0A222 9/8
1D5 6/9	6F19 12/6	12B2M 7/8	308 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC122 3/8	0A223 9/8
1D6 9/6	6F20 11/7	12B2N 7/8	309 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC123 3/8	0A224 9/8
1F1D1 3/9	6F21 11/9	12B2O 7/8	310 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC124 3/8	0A225 9/8
1F1D9 3/9	6F22 10/6	12B2P 7/8	311 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC125 3/8	0A226 9/8
1G6 8/-	6F23 3/-	12B2Q 7/8	312 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC126 3/8	0A227 9/8
1H5GT 7/8	6F24 3/5	12B2R 7/8	313 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC127 3/8	0A228 9/8
1L4 2/6	6F25 3/5	12B2S 7/8	314 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC128 3/8	0A229 9/8
1L5 5/6	6F26 3/5	12B2T 7/8	315 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC129 3/8	0A230 9/8
1L6 5/6	6F27 3/5	12B2U 7/8	316 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC130 3/8	0A231 9/8
1L7 5/6	6F28 3/5	12B2V 7/8	317 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC131 3/8	0A232 9/8
1L8 5/6	6F29 3/5	12B2W 7/8	318 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC132 3/8	0A233 9/8
1L9 5/6	6F30 3/5	12B2X 7/8	319 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC133 3/8	0A234 9/8
1L10 5/6	6F31 3/5	12B2Y 7/8	320 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC134 3/8	0A235 9/8
1L11 5/6	6F32 3/5	12B2Z 7/8	321 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC135 3/8	0A236 9/8
1L12 5/6	6F33 3/5	12B2A 7/8	322 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC136 3/8	0A237 9/8
1L13 5/6	6F34 3/5	12B2B 7/8	323 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC137 3/8	0A238 9/8
1L14 5/6	6F35 3/5	12B2C 7/8	324 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC138 3/8	0A239 9/8
1L15 5/6	6F36 3/5	12B2D 7/8	325 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC139 3/8	0A240 9/8
1L16 5/6	6F37 3/5	12B2E 7/8	326 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC140 3/8	0A241 9/8
1L17 5/6	6F38 3/5	12B2F 7/8	327 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC141 3/8	0A242 9/8
1L18 5/6	6F39 3/5	12B2G 7/8	328 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC142 3/8	0A243 9/8
1L19 5/6	6F40 3/5	12B2H 7/8	329 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC143 3/8	0A244 9/8
1L20 5/6	6F41 3/5	12B2I 7/8	330 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC144 3/8	0A245 9/8
1L21 5/6	6F42 3/5	12B2J 7/8	331 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC145 3/8	0A246 9/8
1L22 5/6	6F43 3/5	12B2K 7/8	332 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC146 3/8	0A247 9/8
1L23 5/6	6F44 3/5	12B2L 7/8	333 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC147 3/8	0A248 9/8
1L24 5/6	6F45 3/5	12B2M 7/8	334 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC148 3/8	0A249 9/8
1L25 5/6	6F46 3/5	12B2N 7/8	335 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC149 3/8	0A250 9/8
1L26 5/6	6F47 3/5	12B2O 7/8	336 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC150 3/8	0A251 9/8
1L27 5/6	6F48 3/5	12B2P 7/8	337 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC151 3/8	0A252 9/8
1L28 5/6	6F49 3/5	12B2Q 7/8	338 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC152 3/8	0A253 9/8
1L29 5/6	6F50 3/5	12B2R 7/8	339 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC153 3/8	0A254 9/8
1L30 5/6	6F51 3/5	12B2S 7/8	340 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC154 3/8	0A255 9/8
1L31 5/6	6F52 3/5	12B2T 7/8	341 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC155 3/8	0A256 9/8
1L32 5/6	6F53 3/5	12B2U 7/8	342 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC156 3/8	0A257 9/8
1L33 5/6	6F54 3/5	12B2V 7/8	343 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC157 3/8	0A258 9/8
1L34 5/6	6F55 3/5	12B2W 7/8	344 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC158 3/8	0A259 9/8
1L35 5/6	6F56 3/5	12B2X 7/8	345 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC159 3/8	0A260 9/8
1L36 5/6	6F57 3/5	12B2Y 7/8	346 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC160 3/8	0A261 9/8
1L37 5/6	6F58 3/5	12B2Z 7/8	347 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC161 3/8	0A262 9/8
1L38 5/6	6F59 3/5	12B2A 7/8	348 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC162 3/8	0A263 9/8
1L39 5/6	6F60 3/5	12B2B 7/8	349 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC163 3/8	0A264 9/8
1L40 5/6	6F61 3/5	12B2C 7/8	350 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC164 3/8	0A265 9/8
1L41 5/6	6F62 3/5	12B2D 7/8	351 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC165 3/8	0A266 9/8
1L42 5/6	6F63 3/5	12B2E 7/8	352 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC166 3/8	0A267 9/8
1L43 5/6	6F64 3/5	12B2F 7/8	353 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC167 3/8	0A268 9/8
1L44 5/6	6F65 3/5	12B2G 7/8	354 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC168 3/8	0A269 9/8
1L45 5/6	6F66 3/5	12B2H 7/8	355 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC169 3/8	0A270 9/8
1L46 5/6	6F67 3/5	12B2I 7/8	356 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC170 3/8	0A271 9/8
1L47 5/6	6F68 3/5	12B2J 7/8	357 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC171 3/8	0A272 9/8
1L48 5/6	6F69 3/5	12B2K 7/8	358 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC172 3/8	0A273 9/8
1L49 5/6	6F70 3/5	12B2L 7/8	359 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC173 3/8	0A274 9/8
1L50 5/6	6F71 3/5	12B2M 7/8	360 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC174 3/8	0A275 9/8
1L51 5/6	6F72 3/5	12B2N 7/8	361 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC175 3/8	0A276 9/8
1L52 5/6	6F73 3/5	12B2O 7/8	362 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC176 3/8	0A277 9/8
1L53 5/6	6F74 3/5	12B2P 7/8	363 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC177 3/8	0A278 9/8
1L54 5/6	6F75 3/5	12B2Q 7/8	364 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC178 3/8	0A279 9/8
1L55 5/6	6F76 3/5	12B2R 7/8	365 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC179 3/8	0A280 9/8
1L56 5/6	6F77 3/5	12B2S 7/8	366 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC180 3/8	0A281 9/8
1L57 5/6	6F78 3/5	12B2T 7/8	367 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC181 3/8	0A282 9/8
1L58 5/6	6F79 3/5	12B2U 7/8	368 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC182 3/8	0A283 9/8
1L59 5/6	6F80 3/5	12B2V 7/8	369 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC183 3/8	0A284 9/8
1L60 5/6	6F81 3/5	12B2W 7/8	370 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC184 3/8	0A285 9/8
1L61 5/6	6F82 3/5	12B2X 7/8	371 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC185 3/8	0A286 9/8
1L62 5/6	6F83 3/5	12B2Y 7/8	372 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC186 3/8	0A287 9/8
1L63 5/6	6F84 3/5	12B2Z 7/8	373 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC187 3/8	0A288 9/8
1L64 5/6	6F85 3/5	12B2A 7/8	374 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC188 3/8	0A289 9/8
1L65 5/6	6F86 3/5	12B2B 7/8	375 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC189 3/8	0A290 9/8
1L66 5/6	6F87 3/5	12B2C 7/8	376 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC190 3/8	0A291 9/8
1L67 5/6	6F88 3/5	12B2D 7/8	377 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC191 3/8	0A292 9/8
1L68 5/6	6F89 3/5	12B2E 7/8	378 11/8	E307 24/-	PABCS0 7/3	TV36P 12/2	X105 5/9	X105 5/9	BC192 3/8	0A293 9/8



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ORGAN BUILDERS! SILICON N.P.N. TRANSISTORS, ALL INDIVIDUALLY TESTED IN PUBLISHED DIVIDER CIRCUIT! GOLD-PLATED LEADS FOR EASY SOLDERING! Unbeatable value at 1/6 each or £5.0.0 per 100.

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TRANSISTORS

OC200, OC203, OC204 all at 2/- each.
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LIGHT SENSITIVE TRANSISTORS (similar OCP71) 2/- each.
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DIODES. Very low leakage. Make excellent detectors, also suitable for keying electronic organs. 1/- each. 20 for 10/-.

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MULLARD POLYESTER CAPACITORS. FAR BELOW COST PRICE!

0-001µF 400 volts	3d.	0-02µF 200 volts	3d.
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RECORD PLAYER CARTRIDGES

ACOS GP67/2 Mono 15/- complete with needles.
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2 1/2in. x 1in.	0-15in. matrix	1/1	17in. x 2 1/2in.	0-15in. matrix	11/-
3 1/2in. x 2 1/2in.	0-15in. matrix	3/3	17in. x 3 1/2in.	0-15in. matrix	14/8
3 1/2in. x 2 1/2in.	0-15in. matrix	3/11	3 1/2in. x 2 1/2in.	0-1in. matrix	3/9
3 1/2in. x 2 1/2in.	0-15in. matrix	3/11	3 1/2in. x 3 1/2in.	0-1in. matrix	3/11
5in. x 3 1/2in.	0-15in. matrix	5/6	5in. x 2 1/2in.	0-1in. matrix	3/11
			5in. x 3 1/2in.	0-1in. matrix	5/6

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MULTIMETERS. 20,000 ohms per Volt.

Ranges: A.C.: 1,000V, 500V, 100V, 50V, 10V.
D.C.: 250mA, 2-5mA, 50µA.
D.C.: 2,500V, 500V, 250V, 50V, 25V, 5V.
Resistance: 0/50KΩ and 0/5MΩ.

Special price £4.0.0 only.

ELECTROLYTIC CONDENSERS

0-20µF	3 volt	4µF	25 volt	25µF	25 volt
1µF	6 volt	5µF	30 volt	30µF	10 volt
1µF	20 volt	6µF	6 volt	80µF	6 volt
1-25µF	16 volt	8µF	3 volt	50µF	6 volt
2µF	3 volt	8µF	12 volt	64µF	2-5 volt
2µF	350 volt	8µF	50 volt	64µF	9 volt
2-5µF	16 volt	10µF	6 volt	100µF	9 volt
3µF	25 volt	10µF	25 volt	320µF	4 volt
2-2µF	64 volt	20µF	6 volt	320µF	10 volt
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All at 1/- each. 20 assorted (our selection) 10/-.

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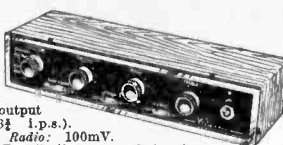
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THE CLASSIC

Controls: Selector switch Tape speed equalisation switch (3½ and 7½ i.p.s.). Volume. Treble. Bass. 2 position scratch filter and 2 position rumble filter.

Specification: Sensitivities for 10 watt output at 1KHz. Tape head: 3mV (at 3½ i.p.s.). Mag. P.U.: 2mV. Cr. P.U.: 80mV. Radio: 100mV. Aux.: 100mV. Tape/Rec. output: 100mV. Equalisation for each input is correct to within ± 2dB (R.I.A.A.) from 20Hz to 20KHz. Tone control range: Bass ± 13dB at 60 Hz. Treble ± 14dB at 15KHz. Total distortion: (for 10 watt output) <1.5%. Signal noise: <60dB. A.C. mains 200-250V. Size 12½in. long, 4½in. deep, 2½in. high. Teak finished case. Price 8 gns. + 7/6 p. & p.



THE DORSET (600mW output)



7-transistor fully tunable M.W.-L.W. superhet portable —with baby alarm facility. Set of parts. The latest modulated and pre-alignment techniques makes this simple to build. Sizes: 12 x 8 x 3in.

MAINS POWER PACK KIT: 9/6 extra.

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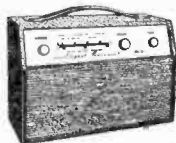
THE ELEGANT SEVEN MK. III (350mW output)

7-transistor fully tunable M.W.-L.W. portable. Set of parts. Complete with all components, including ready etched and drilled printed circuit board—back printed for foolproof construction.

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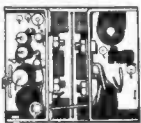
Circuit 2/6 FREE WITH PARTS.



X101 10W SOLID-STATE HI-FI AMP WITH INTEGRAL PRE-AMP

Specifications: RMS Power Output (into 3 ohms speaker): 10 watts continuous (sine wave), 13 watts music power. Sensitivity (for rated output): 1mV into 3K ohms (0.33 micro-amp). Total Distortion at 1KHz: at 3 watts 0.35%, at rated output 1.5%. Frequency Response: Minus 3dB points 20Hz and 40KHz. Speaker: 3-4 ohms (3-15 ohms may be used). Supply voltage: 24V d.c. at 800mA (6-24V may be used). Control assembly: including resistors and capacitors.

1. Volume: PRICE 5/-.
2. Treble: PRICE 5/-.
3. Comprehensive bass and treble: PRICE 10/-.
The above 3 items can be purchased for use with the X101. Power Supplies for the X101:
P101 M (for mono) 35/- plus 4/6 p. & p.
P101 S (for stereo) 42/6 plus 4/6 p. & p.



Price 49/6 plus 2/6 p. & p.



THE RELIANT 10W SOLID-STATE HIGH QUALITY AMPLIFIER

Output—10 watts RMS sine-wave
13 watts RMS music-power
Inputs—1. xtal mic 10mV
2. gram/radio 250mV
Tone Controls—Treble control range ± 12dB at 10KHz
Bass control range ± 13dB at 100Hz
Frequency Response—(with tone controls central) Minus 3dB points are 20Hz and 40KHz
Signal to Noise Ratio—better than -60dB
Transistors—4 silicon Planar type and 3 Germanium type
Mains input—220-250V. A.C. Size of chassis—10" x 5½" x 2"
A.C. Mains, 200-250V. For use with Std. or L.P. records, musical instruments, all makes of pick-ups and mikes. Separate bass and treble lift control. Two inputs with control for gram. and mike. Built and tested. 8" x 5" speaker to suit price 14/6 plus 1/6 P. & P. Crystal mike to suit 12/8 plus 1/6 P. & P.
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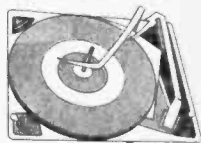


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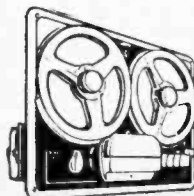
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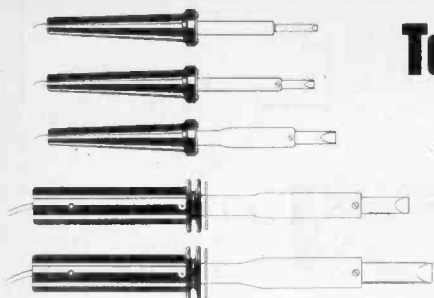
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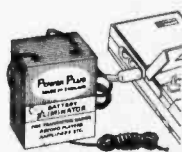
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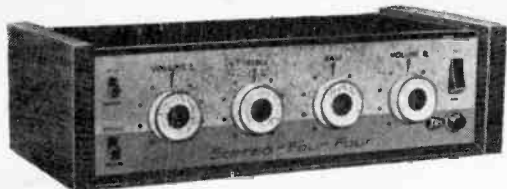
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- Noise Limiter
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Add-on Stereo Unit (p.p. 2/6) 10 gns.

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Decca Deram with diamond 92/6; MONO Acos GP91-1 21/-; Goldring MX2M 28/6.

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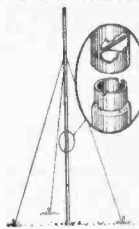
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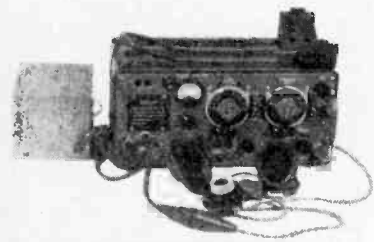
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EY88	8/-	EY88	8/-	PCF898/-	PCF801	15/-
EY88	8/-	EY88	8/-	PCF908/-	PCF802	15/-
EY88	8/-	EY88	8/-	PCF918/-	PCF803	15/-
EY88	8/-	EY88	8/-	PCF928/-	PCF804	15/-
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EY88	8/-	EY88	8/-	PCF1848/-	PCF896	15/-
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EY88	8/-	EY88	8/-	PCF2068/-	PCF918	15/-
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EY88	8/-	EY88	8/-	PCF2128/-	PCF924	15/-
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EY88	8/-	EY88	8/-	PCF2428/-	PCF954	15/-
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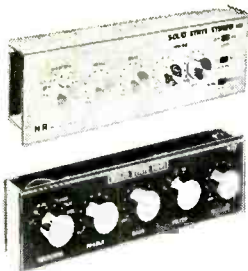
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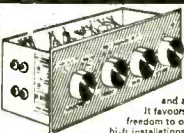
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