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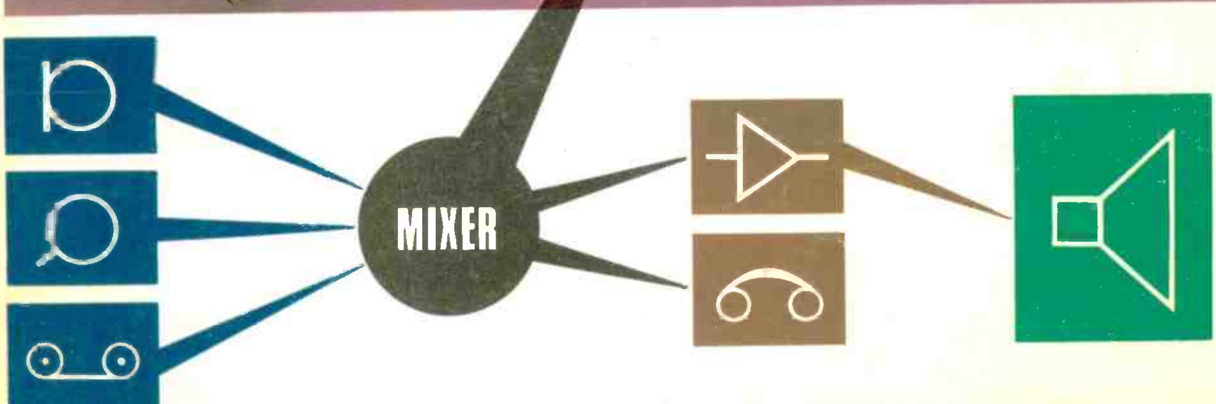

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Lasky's Radio

LASKY'S RADIO ESTABLISHED OVER 36 YEARS

THREE NEW TMK METERS

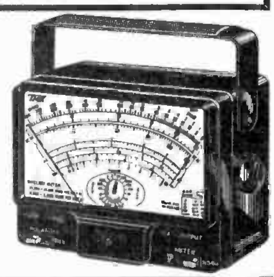
These meters by the famous TMK Co. of Japan incorporate the very latest developments in design and set a new standard in quality and accuracy. The new shape permits a more compact cabinet yet the meter size is actually increased! All have strong impact resistant cabinets with carrying handles and are complete with test leads, batteries and full instructions.

Model PL-436

20,000 O.P.V. Multitester for the amateur or professional. Features mirror scale and wood grain finish front panel. SPEC.: DC/V ranges: 0·6, 3, 12, 30, 120, 600V at 20K/O.P.V. AC/V ranges: 3, 30, 120, 600V at 8K/O.P.V. DC current: 50µA, 0·6, 60, 600mA. Resistance: 10K, 100K, 1M and 10M ohms end scale (65, 650, 6·5K and 65K ohms centre scale). Decibels: −20 to +57dB in four ranges. Operates on 2×1·5V U7 type batteries. Size: 5¾×4⅞×2⅜in.

LASKY'S PRICE £7.19.6 Post 5/-

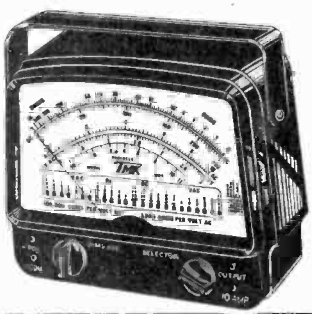
Model 5025



50,000 O.P.V. Multitester suitable for all professional and educational uses. Features a fantastic 57 measurement range cover (±2% accuracy on full scale DC). High speed range selection, polarity reversal switch and overload meter protection circuit. SPEC.: DC/V ranges: 0·125 to 1000V in 12 ranges (0·25 to 500V at 50K/O.P.V.). AC/V ranges 1·5V to 1000V in 10 ranges (1·5 to 500V at 5K/O.P.V.). DC current: 25µA to 10A. Ohms: 0 to 10M ohms. Decibels: −20 to +81·5dB in 10 ranges. Operates on 2×1·5V U7 type batteries. Size: 6¾×5½×2⅜in.

LASKY'S PRICE £13.10.0 Post 5/-

100,000 O.P.V. "LAB" Model



A highly accurate yet rugged Multitester using a 10µA meter hand calibrated to a DC accuracy of ±3% of full scale. Special features—ultra large meter scale 6¼×3⅛in. incorporating an entirely new type of range selection panel which gives instant range identification without taking your eyes from the meter. An audible buzzer is provided for easy short testing. SPEC.: DC/V ranges: 0·5, 2·5, 10, 50, 250, 500, 1000V at 100K/O.P.V. AC/V ranges: 3, 10, 50, 250, 500, 1000V at 5K/O.P.V. DC current: 0–10, 100µA, 0–10, 100mA, 0–2·5, 10A. Resistance: 0–1K, 10K, 100K, 10M, 100M/ohms. Decibels: −10 to +49·4dB. Continuity test: Audible buzzer. Operates on 1×1·5V U2 and 1×15V B.154 type batteries. Cabinet size 7¾×6⅞×3⅛in. Weight 4lb.

LASKY'S PRICE £19.10.0 Post 5/-

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SKYROVER Mk II

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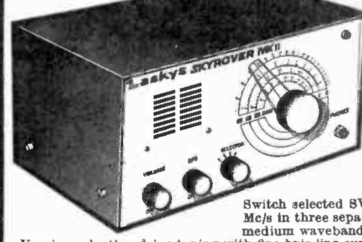


A completely new short wave receiver exclusive to Lasky's, at a real economy price. Four valve line up using one each 6BE6, 6BA6, 6AV6 and 6AR5 valves, gives highly sensitive reception and powerful gain. Switch selected SW frequency range cover: 1·5 to 30 Mc/s in three separate bandspread ranges and full AM medium waveband cover in one range 550-1,600 Kc/s. Vernier reduction drive tuning with fine hair line cursor. Controls include volume on/off, BFO, Band selector. Power on indicator lamp. External antenna connections and mains fuse at rear. 8 ohms internal speaker plus standard 5mm jack socket for phones on front. For 220/240V AC mains operation. Strong metal cabinet finished in grey crackle with anodised silver front panel. Size 9¾×5⅞×5¼ins. complete with mains lead and full instructions. **Previously listed at £17.15.0** (*A credit note for the difference in price will be given to customers who purchased this unit at the original price after Jan. 1st '69, on presentation of receipt*).

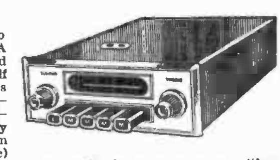
LASKY'S PRICE £13.13.0 Post 5/-

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 1605Kc/s, 88 to 108Mc/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 135Mc/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 panel and 18in. chrome telescopic antenna, size only 4×2⅞×2⅜in. (inc. knobs). Complete with battery and full instructions.

LASKY'S PRICE 79/6 Post 5/-

TWO BAND PUSH BUTTON TRANSISTOR CAR RADIO MODEL CR-62



A high quality all transistor superhet car radio that really breaks the quality/price barrier. A unique feature of this set are the four M/W band station preselection buttons which you yourself set to your own four favourite stations—this is in addition to full M/W band cover over 535–1605 Kc/s and full L/W band cover over 150–300 Kc/s (IF frequency 455 Kc/s.) Externally adjustable aerial trimmers ensure maximum output. Six transistor (including one drift type) and one diode circuit provides powerful 2W output. The set is adjustable for use on either positive or negative ground 12V systems (external line fuse fitted). Standard mounting size 6⅞×5⅞×2in.—front panel ⅛in. larger all round—finished in anodised aluminium with black push buttons. Complete with mounting brackets, full installation instructions and 2 baffle boards (for round or elliptical speaker). Fully guaranteed.

LASKY'S PRICE £10.19.6 Post 5/- 6×4in. dynamic speaker 17/6 extra—Post FREE

MANUAL TUNING MODEL OF CR-62 AVAILABLE. £7.19.6.
SPECIAL OFFER—LOCKING CAR AERIAL Model 83003 five section 42" extension heavy chrome telescopic wing mounting type with unique locking device to protect the antenna when closed. Complete with mounting bracket, lead and plug and two "keys". **LASKY'S SPECIAL PRICE 39/6** Post Free with the CR-62. Post Sep. 2/6.

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Type A. Industrial fire alarm. Emits loud warning note if air temp. exceeds 125°F, wall mounting. Operates on 2 x U2 type batteries. Size 6 x 2½ x 1½in. Grey enamel finish.

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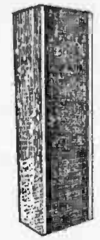
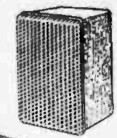
SPEAKER SYSTEMS

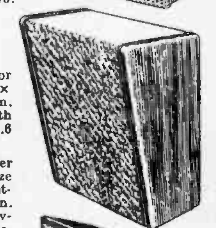
All cabinets are new and speakers are mounted on ½in. chipboard baffles. All speakers ex TV reconditioned hi flux magnet. All carefully tested before despatch.



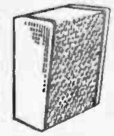
THE CAXTON COLUMN This is a column cabinet. 23¾ × 5½ × 5½in. wide, fitted with 3 speakers. This will handle 8 watts and will improve the quality of any tape recorder, or record player. Finished in wood grain cloth and sandstone Vynair. A real bargain at 59/6. P. & P. 10/6.



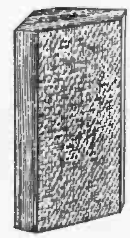
THE MILTON A. Hi-Fi Bookcase Cabinet. Size 9 × 5 × 6in., with 5in. speaker. Finished in Teak cloth with bold silk front 30/-. P. & P. 4/6.



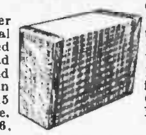
The Tennyson. Wedge shape for table or wall mounting 13½ × 16 × 8½in. Fitted EMI 13½ × 8in. Speaker. Finished in Grey cloth with matching Vynair. £4.7.6 P. & P. 7/6.



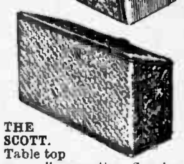
DUO. Wedge shaped Speaker Cabinet. Size 7½ × 7½in. fitted 7 × 4in. speaker. Covered in attractive two tone Vynair. Price 32/6. P. & P. 4/6.



The Cowdrey. Corner Cabinet in natural teak finish. Fitted 8 × 3in., 7 × 4in. and three 5in. round speakers wired in series to match 15 ohm impedance. £6.6.0. P. & P. 8/6.



THE IMP. Extension Speaker Cabinet. Wedge shaped, size 7½ × 6½in. fitted 7 × 4in. speaker. Covered with attractive walnut with fawn Vynairfront. Keyhole slot in back. Only 25/6. P. & P. 4/6.



THE SCOTT. Table top or wall mounting Speaker. Size 16½ × 10½ × 5½in., tapered as illustrated. Fitted 13½ × 8in. Speaker with volume control. Finished in black cloth with matching grey Vynair. (Please state 3 or 15 ohm imp.) £4.5.0. P. & P. 7/6.

SPEAKERS: Elac Heavy duty Ceramic Magnets 11,000 line, 10in. round, 10 x 6in. 3 ohm, or 15 ohm, 48/6, P. & P. 3/6. 8in. round 15 or 3 ohm, 42/6. P. & P. 3/6. E.M.I. 13½ x 8in. 3 ohm 45/-, 15 ohm 48/6, P. & P. 3/6. E.M.I. 3in. tweeter, 17/6. P. & P. 1/6. E.M.I. 13½ x 8in. fitted two 2½in. tweeters. 15 ohms, 77/6. P. & P. 4/6. E.M.I. 13½ x 8in. (15 ohm) Hi Fi Quality, £5.19.6. P. & P. 4/6. E.M.I. Woofers, 6½ x 6½in. square. 8 ohm, 59/6. P. & P. 4/6. E.M.I. Crossover, 16/6. P. & P. 1/-. EAGLE Crossover units, 3 or 16 ohms, 16/-. P. & P. 1/-. Bakers 12in., 25 watt, 15 ohm, £6.6.0. P. & P. 3/6.

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ROTARY SWITCHES: 2 Pole Mains Switch, 3/-; 1 pole 12 way, 2 pole 2 way, 3 pole 3 way, 3 pole 4 way, 4 pole 3 way, 3/6 each. P. & P. 1/-.

TRANSISTOR SPEAKERS 8 ohm 2in., 8/6. 3in., 10/6. 3½in., 12/6. P. & P. 1/-.

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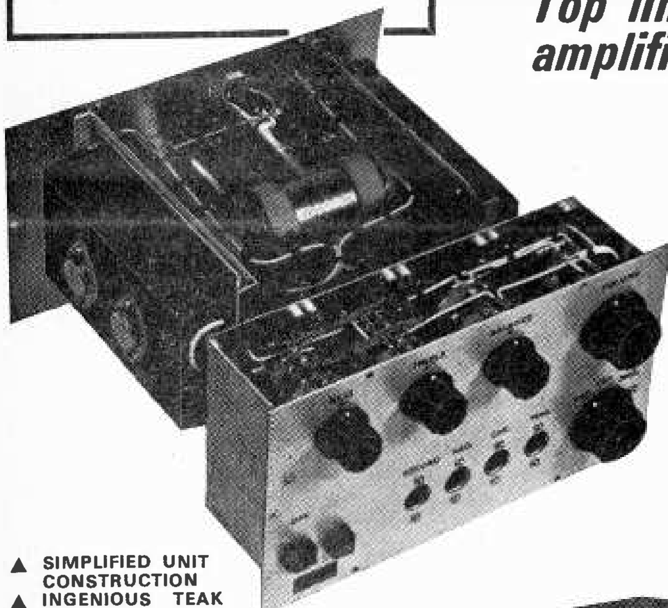
P.W. DOUBLE 12

As described in this month's Practical Wireless

Top line integrated hi-fi stereo amplifier featuring

PEAK SOUND "CIR-KIT"



Peak Sound are indeed proud to be associated with this superb P.W. design and that so much of it is made possible because of Peak Sound products and design techniques. Basically, the "P.W Double 12" demonstrates the value of using "Cir-Kit" in modern circuit board units either for single or prototype examples, but in this instance, Peak Sound have contributed much more to the success of this project. This includes the remarkable power amplifiers, the power pack and the ingeniously styled cabinet which almost assembles itself, it is so simple to build. Read about the "P.W Double 12" in this issue right now. Then when you build this exciting new design be sure you do it with authentic, exact-to-specification Peak Sound kits as described.

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"Cir-Kit" is at the heart of building this fine design. Made from almost 100% pure copper with unique adhesive backing, it is the superb circuit builder for all requirements. In 5' spools, 1/16" wide, 2/- each.

"CIR-KIT" makes it possible!

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2 Spools of "Cir-Kit" at 2/- each		4	0
2 Pre-amp and tone control kits	4	13	0
4 Pre-amp matrix boards		7	0
2 PA.12-15 Power Amplifier Kits	7	19	0
2 Heat Sink assemblies		12	0
2 P.A. matrix boards		8	0
1 PS.45K 45 volt power supply kit	4	10	0
1 Pack-flat afrormosia teak finished Cabinet kit	2	12	6
5 Controls as specified	2	0	0
TOTAL COST	£23	5	6

Metal work (make or buy), knobs, plugs and sockets, fuses etc. allow £3.0.0. From your local dealer.

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▲ Abridged specification

Formation—Two pre-amp panels, two tone control panels, two power amplifier modules, power supply unit on chassis, housed within teak finished cabinet.

Controls—Bass and treble cut and lift based on Baxandall circuitry/Volume/Balance/ Rotary selector.

Input Sensitivity—Magnetic P.U. (per channel) 2·5mV into 68kΩ. Ceramic P.U.—25mV into 27K. equalised for flat response. Radio/Aux. 60mV. HIGH OVERLOAD FACTOR ON ALL INPUTS.

Frequency Response—20Hz to 30KHz ± 1dB overall.

Output—12 watts per channel into 15Ω (8Ω speakers may be used).

Negative Feedback—43dB over each section.

Power required—45V D.C. (supplied by built-in power unit).

Cabinet—Afrormosia teak finish, pack-flat, easy to build kit. Size 9¼ x 5½in. high x 9½in. deep.

Transistors—Ultra low noise in pre-amp and tone control stages.

PERFORMANCE CHARACTERISTICS, PARTS REQUIRED, ETC., SEE OTHER PAGES IN THIS ISSUE

THESE PEAK SOUND PRODUCTS WILL HELP

PA.12-15 POWER AMPLIFIER

As specified for "P.W. Double 12" and available ready built complete with heat sink for mounting directly into position as described, but can also be used in other applications. Also available as a kit less heat sink and board.

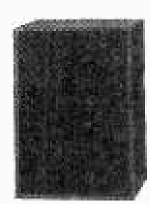
Built **£5.19.6**

Kit (less heat sink, board and "Cir-Kit") **79/6**

Heat sink and baseboard assembly **10/-**

Please add 2/6 p/p either model if ordered direct, or 5/- for two.

ES. 10-15 BAXANDALL SPEAKER



This easy to build loudspeaker provides genuine hi-fi standards by the use of unique equalising principles. Frequency response 60–14,000Hz (100–10kHz ± 3dB). Easy-to-build kit including 18 x 12 x 10in cabinet.

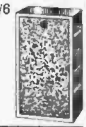
(Carr. 12/6). Leaflet available.

£10.2.3 + £1.2.9 P/Tax

PEAK SOUND (HARROW) LTD., 32 ST JUDES ROAD, ENGLEFIELD GREEN, EGHAM, SURREY, ***Phone EGHAM 5316***

THE 'YORK' HIGH FIDELITY 3 SPEAKER SYSTEM

★ **Moderate size, only 25 x 14 x 10in.** Complete Kit **19 Gns.**
★ **Response 30-20,000 c.p.s. Impedance 15 ohms.** Carr. 12/6
★ **Performance comparable with units costing considerably more.** Consists of (1) 12in. 15 watt Bass unit with cast chassis. Roll rubber cone surround for ultra low resonance, and ceramic magnet. (2) 3-way quarter section series cross-over system. (3) 8 x 5in. high flux middle range speaker. (4) High efficiency tweeter. (5) Measured weight of woollen acoustic damping material. (6) Teak veneered cabinet. (7) Circuit and full instructions.
DEMONSTRATIONS AT ALL BRANCHES.

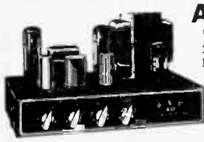


R.S.C. STEREO/20 HI-FI AMPLIFIER

PROVIDING **10/14 WATT ULTRA LINEAR PEAK PUSH-PULL OUTPUT ON EACH CHANNEL. SUITABLE FOR** "MIKE". GRAM, RADIO OR TAPE. (7) valves ECC83, (2 ECL86, (4) EZ81. **Frequency Response:** ±2dB 30-20,000 c.p.s. **Hum Level:** 65dB down. **Sensitivity:** 30 millivolts max. **Harmonic Distortion:** 0·2% ★**Four-position tone compensation and Input Selector Switch.** ★**Stereo/Mono switch.** ★**Neon panel indicator.** ★**Handsome Perspex Frontplate.** ★**Separate Bass and Treble controls.** Output transformers are high quality sectionally wound. Outputs for 3 and 15 ohms speakers. Complete set of parts, point-to-point wiring diagrams and instructions. Or factory assembled with our usual 12 mths' gntee 19gns. Or Dep. £4.10.0 and 9 monthly payments £2 (Total £22.10.0). *Send S.A.E. for leaflet.*

15 Gns. Carr. 12/6

R.S.C. A10 30 WATT ULTRA LINEAR HI-FI AMPLIFIER



Highly sensitive. Push-Pull high output, with Pre-amp./Tone Control Stages. Performance figures of factory built units: Hum level —70dB. Frequency response ±3dB 30-20,000c/s. Sectionally wound output transformer. All high grade components. Valves EF86, EF86, ECC83, 807, 807, GZ34. Separate Bass and Treble Controls. Sensitivity 36 mV. Suitable for **high** impedance microphones, Crystal or Ceramic P.U's. Designed for **Clubs, Schools, Theatres, Dance Halls** or **Outdoor Functions**, etc. For use with **Electronic Organ, Guitar, String Bass**, etc. Gram. Radio or Tape. Reserve L.T. and H.T. for **Radio Tuner.** Two inputs with associated volume controls so that two separate inputs such as Gram and "Mike" can be mixed. 200-250v. A.C. mains. For 3 and 15 ohm speakers. Complete kit of parts with point-to-point wiring diagrams and instructions. Carr. 12/6 **14 Gns.** Twin-handled perforated cover 27/6. Supplied factory built with EL34 output valves. 12 months' guarantee for **17 gns. TERMS: Deposit £5.14.0** and 9 monthly payments of 31/3 (Total £19.15.3). Send S.A.E. for leaflet.

R.S.C. A11 HIGH FIDELITY 12-14 WATT AMPLIFIER

PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP. Two input sockets with associated controls allowing mixing of "mike" and gram, etc. etc. High sensitivity. 5 valves—ECC83 (2), EL84 (2), EZ81. High quality sectionally wound output transformer. IND. BASS AND TREBLE CONTROLS. Frequency response ±3dB 30-20,000 c/s. Hum level —60dB. SENSITIVITY 40 millivolts. For Crystal or Ceramic PUs. High Impedance "mikes". For Musical Instruments such as String Bass, Electronic Guitars etc. Size approx. 12 x 9 x 7in. For AC mains 200-250v. 50 cps Output for 3 and 15 ohm spkrs. SAE for leaflet. Complete kit. **9 Gns.** Full instructions and point-to-point wiring diagrams. Carr 11/6 (or factory built **12 Gns.**) Twin handled metal cover 27/6. TERMS ON ASSEMBLED UNITS. Deposit **87/6** and 9 monthly payments of **22/-**, (Total **£14.5.6**).

RSC A11T TRANSISTORISED VERSION of above complete kit **9 Gns** (Assembled **13 Gns**)

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

An exceptionally powerful high quality all-purpose unit for lead, rhythm, bass guitar, vocalists, gram, radio, tape. Peak O/P rating.
★ Two extra heavy duty 12in. Loudspeakers.
★ Four Jack inputs and two Volume Controls for simultaneous use of up to four pick-ups or "mikes". Bass and Treble controls.
52 Gns. Carr. 30/- or dep. **£10.1.9** and 9 monthly payments of **£5.11.9.** (Total **57½ gns.**) Send S.A.E. for leaflet.
G100 100 watt peak output with pr. Columns and a Bass Unit. Inc. 8 speakers. Six 12", Two 15". 99½ gns.

R.S.C. BATTERY/MAINS CONVERSION UNITS

Type **BM1** An all-dry battery eliminator. Size 5½x4½x 2in. approx. Completely replaces batteries supplying 1·5v. and 90v. where A.C. mains 200/250v. 50c/s is available. Complete kit with diagram **49/11** or assembled **59/11**.

SELENIUM RECTIFIERS | **F.W. (Bridged)**
All 6/12v. D.C. output. Max. A.C. input 18v. 1a. **3/11.** 2a. **6/11.** 3a. **9/9.** 4a. **12/9.** 6a. **15/9.**

R.S.C. MAINS TRANSFORMERS

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

MIDGET CLAMPED TYPE 2½ × 2½ × 2¼in.

250v., 60mA, 6·3v. 2a.	15/11
250-0-250v., 60mA 6·3v. 2a.	16/11

FULLY SHROUDED UPRIGHT MOUNTING

250-0-250v. 60mA, 6·3v. 2a., 0-5-6·3v. 2a.	21/9
250-0-250v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	37/9
300-0-300v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	37/9
300-0-300v. 130mA, 6·3v. 4a., c.t., 6·3v. 1a. For Mullard 510 Amplifier	45/9
350-0-350v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	37/9
350-0-350v. 150mA, 6·3v. 4a., 0-5-6·3v. 3a.	47/9
425-0-425v. 200mA, 6·3v. 4a., c.t., 5v. 3a.	69/9
425-0-425v. 200mA, 6·3v. 4a., 6·3v. 3a., 5v. 3a.	75/-
450-0-450v. 250mA, 6·3v. 4a., c.t., 5v. 3a.	87/9

TOP SHROUDED DROP-THROUGH TYPE

250-0-250v. 70mA, 6·3v. 2a., 0-5-6·3v. 2a.	21/9
250-0-250v. 100mA, 6·3v. 3·5a.	25/9
250-0-250v. 100mA, 6·3v. 2a, 6·3v. 1a.	26/9
350-0-350v. 80mA, 6·3v. 2a., 0-5-6·3v. 2a.	27/9
250-0-250v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	37/9
300-0-300v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	37/9
300-0-300v. 130mA, 6·3v. 4a., 0-5-6·3v. 1a. Suitable for Mullard 510 Amplifier	44/9
350-0-350v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	37/9
350-0-350v. 150mA, 6·3v. 4a., 0-5-6·3v. 3a.	45/11

FILAMENT or TRANSISTOR POWER PACK Types 6·3v. 1·5a. 7/9; 6·3v. 2a. 8/9; 6·3v. 3a. 10/9; 6·3v. 6a. 21/9; 12v. 1a. 8/9; 12v. 3a. or 24v. 1·5a. 21/9; 0-9-18v. 1½a. 17/9; 0-12-25-42v. 2a. 29/9.

CHARGER TRANSFORMERS 0-9-15v. 1½a. 14/11; 2½a. 17/9; 3a. 19/11; 5a. 23/9; 6a. 27/9; 8a. 33/9.

AUTO (Step UP/step DOWN) TRANSFORMERS

0-110/120v. 200-230-250v. ......50-80 watts	15/9
150 watts, 29/11; 250 watts 49/9; 500 watts	99/9

OUTPUT TRANSFORMERS

Standard Pentode 5,000 Ω or 7,000 Ω to 3 Ω	8/9
Push-Pull 8 watts EL84 to 3 Ω or 15 Ω	12/9
Push-Pull 10 watts 6V6 ECL86 to 3, 5, 8 or 15 Ω	22/9
Push-Pull EL84 to 3 or 15 Ω 10-12 watts	21/9
Push-Pull Ultra Linear for Mullard 510, etc.	39/9
Push-Pull 15-18 watts, sectionally wound 6L6, KT66, etc., for 3 or 15 Ω	35/9
Push-Pull 20 watt high quality sectionally wound EL34, 6L6, KT66 etc. to 3 or 15 Ω	59/9

SMOOTHING CHOKES
150mA, 7-10H, 250 Ω 12/9; 100mA, 10H, 200 Ω 10/9; 80mA, 10H, 350 Ω 8/9; 60mA, 10H, 400 Ω 4/11.

BLACKPOOL

AGENT APPOINTED O. & C. ELECTRONICS 227 CHURCH ST.

R·S·C HI-FI CENTRES LTD.

R.S.C. COLUMN SPEAKERS

Covered in two-tone Rexine/Vynair. Ideal for vocalists and Public Address. 15 ohm matching. **C57 15 watts** inc. five 7 x 4in. speakers **£7.19.11.**
Type C48S, 30 watts. Fitted four 8in. high flux 8 watt speakers. Overall size approx. 42 x 10 x 5in. Or deposit 65/- and 9 mthly pmts 34/9 (Total £18.17.9) Carr. 10/-. **16 Gns.**
Type C412S, 50 watts. Fitted four 12in. 11,000 line 15 watt speakers. Overall size 56 x 14 x 9in. approx. Carr. 15/-. **24 Gns.** Or Deposit **£4.13.6** and 9 monthly payments of 52/6 (Total **£28.5.0**).

30 WATT HI-FI AMPLIFIER

for Guitar, Vocal or Instrumental Group
A 2 or 4 input, 2 vol. control Hi-Fi unit with Separate Bass and Treble controls. Current valves. Peak output rating. Strong Rexine covered cabinet with handles. Attractive black/gold perspex facia. Neon indicator. For 200-250v. A.C. mains. For 3 or 15 ohm speakers. Send S.A.E. for leaflet. Deposit 3 gns. and 9 mthly payments of 39/8 (Total £21). **18 Gns.** Carr. 12/6

12in. HIGH QUALITY LOUDSPEAKERS

In Teak or Afrormosia veneered Cabinets
15 Watt 11,000 lines 3 or 15 ohms. Carr 7/6 **£5.15.0** 20 Watt 10,000 lines 3 or 15 ohms. Carr 8/9 **£8.19.9**

LOUDSPEAKERS

Limited number of heavy duty units at well below list prices. Brand new, guaranteed. Terms available over £8. Carr. 10/- extra.

12in. 30 watt 6-8 ohms	12in. 30 watt 15 ohms impedance	15in. 40 watt 15 ohms
Normally approx. £12 **£6.19.9**	Normally £10.10.0. **£6.19.9**	Extra heavy duty **10 Gns.**

FANE 'POP' 100 LOUDSPEAKER

18" 100 Watt
Fantastic power handling. Guaranteed 2 years. POST FREE **19 Gns**

ARMSTRONG UNITS CLEARANCE

Stereo Amplifier 222 — **Our Price £25**
AM/FM Tuner-Amp 227M — **Our Price £35**

POWER PACK KIT

Consisting of Mains transformer, Metal Rectifier, Electrolytics, smoothing choke, chassis and circuit. 200/250v. A.C. mains. Output 250v. 60mA 6·3v. 2a. Supplied with case **24/11** in lieu of chassis 28/11. Or assembled 39/11.

CLEARANCE LINES

HIGH QUALITY 8" x 3" LOUDSPEAKERS 10000 Gauss 3 ohm only **11/9** Post 2/-

14 WATT HI-FI AMPLIFIERS

High sensitivity. Two separate inputs. Two vol. controls for mixing purposes. Separate Bass and Treble Controls. Valves ECC83, ECL86, ECL86, EZ80. Output for 15 ohm Loudspeaker. 200-250v 50 c.p.s. A.C. mains operation. Size approx. 8 x 8 x 6in. Factory built and fully guaranteed. Limited number to clear at **£7-19-11** Carr. 10/-

E.M.I. HIGH FIDELITY LOUDSPEAKERS

13" x 8" 15 ohms. Gauss 13,000 lines. Formed flexible P.V.C. cone surround for very low fundamental resonance. Range 30-15,000 c.p.s. Rating 10 watts. Limited number. **5½ Gns**

EXTENSION 'SPEAKERS 29/9

Cabinet size 12 x 8 x 5in. attractive grey lizard skin finish. Fitted high flux 5 watt 3 ohm speaker.

EMI PLAYER TURNTABLES

with P.U. 4 speed. Turnover cartridge. Limited number.
Mono **59/9** Stereo **69/9**

PHONE AMPLIFIERS

Speak and listen with both hands free. Standard dry battery operated. Attractive black moulded case. **59/9**

1 WATT TRANSISTOR AMPLIFIERS

for 3-5 ohm loudspeakers. Miniature size. Brand new boxed. Post free **37/9**

PRINTED CIRCUIT KITS

for making printed circuits. **12/9**
Complete with 72 square ins. laminated board and necessary fluids. Post 2/9

J.B. VHF/FM DIAL & DRIVE ASSEMBLIES

ONLY **9/9**
Complete with escutcheon. Size 7" × 4½". Escutcheon 7½" × 2½". Post 2/9

TAPE RECORD/PLAYBACK AMPLIFIERS

4 watts output. Magic Eye Recording level indicator. For 3 ohm L/S. All normal facilities. Less Facia plate. For 200/250 A.C. mains. Carr 8/6. **£8.15.0**

HEAVY DUTY 15in. 40 WATT LOUDSPEAKERS

in substantial Rexine/Vynair covered cabinet. Carr. 15/- ONLY **14 Gns.**

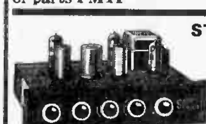
MINI-8 HI-FI LOUDSPEAKER UNITS

Teak or Afrormosia veneered cabinet, size approx. 10½ x 6½ x 7½in. Peak power handling 8 watts 3 ohms or 15 ohms. **Clearance Price 59/11**

JASON VHF/FM TUNER DESIGNS

Total cost of parts FMT1 **5 Gns.** FMT2 **£6.19.11.** JTV2 **9½ Gns.** Please state channel

STEREO/TEN HIGH QUALITY AMPLIFIER



5 watts high quality peak output on each channel. Sensitivity 50 millivolts. Suitable all crystal or ceramic stereo cartridges. Ganged Bass and Treble Controls. Valves ECC83 (2), EL84 (2), EZ81. For 2-3 ohm speakers. Assembled with 12 months' guarantee Carr. 7/9 **£11.19.6**

6/12V CAR BATTERY CHARGERS

Complete kit of parts with Ammeter and Circuit. Both models with variable charge rate selector.
4 amp 49/9 **6 amp 69/9**
All types 200-250v. A.C. Mains. Built 10/- extra.

R.S.C. SENSATIONAL HIGH FIDELITY STEREO PACKAGE OFFERS

"PACKAGE 3" 30 WATT OUTPUT
★ Goldring Transcription Turntable on Plinth
★ Shure Magnetic Pick-up Cartridge
★ Super 30 Amplifier **in veneered housing**
★ Pair of Stanton Loudspeaker Units
Special total price. Four fully wired units ready to "plug-in". Carr. 25/-. **85 Gns.** plus small P.T. surcharge
TERMS AVAILABLE ALL PACKAGE OFFERS

Matching as recommended for optimum performance. Send for coloured brochure showing other money saving offers.

Illustrated with TFMI Mk II Tuner fitted

"PACKAGE 2" 30 WATT OUTPUT
★ Garrard SP25 Mk II Turntable on Plinth
★ Goldring CS90 Ceramic P.U. Cartridge
★ Super 30 Amp. in veneered housing
★ Pair Stanton Speaker Units
Special total price. Four fully wired units ready to "plug-in" **75 Gns.** Carr. 25/- Plus small P.T. surcharge

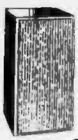
"PACKAGE 1" 13 WATT OUTPUT
★ Garrard SP25 Mk II 4 sp player unit on plinth
★ Goldring CS90 Ceramic P.U. Cartridge
★ TA12 Amplifier in cabinet
★ Pair of Dorchester L'speaker Units. Special total price. **49½ GNS.**
Plus small P.T. s'charge Or Dep. £10 and 9 monthly payments £5.4.0. (Total £56.16.0.) Perspex cover 3gns. extra.

AUDIOTRINE HIGH FIDELITY LOUDSPEAKERS

Heavy construction. Latest high efficiency ceramic magnets. Treated Cone surround giving low fundamental resonance. "D" indicates Tweeter Cone providing extended frequency range 40–15,000 c.p.s. Impedance 3 or 15 ohms. **Please state choice.** Exceptional performance at low cost. Prices include carriage.

HF510L	5"	10W	57/9	HF100D	10"	15W	£5.15.0
HF801D	8"	8W	57/9	HF120	12"	15W	69/9
HF811D	8"	10W	4 gns.	HF120D	12"	15W	79/9
HF102D	10"	8W	59/9	HF126	12"	15W	89/9
				HF126D	12"	15W	5 gns.

HIGH FIDELITY LOUDSPEAKER UNITS
Cabinets latest style Satin Teak or Afrormosia veneer. Acoustically lined or filled woollen damping. Ported where appropriate. Credit tms available.



DORCHESTER Size 16 x 11 x 9in. Appr. Range 45–15,000 c.p.s. Rating 8–10 watts. Fitted High flux 13 x 8in. Dual Cone spkr. Imp. 3 or 15 ohms **£8.19.9** Inc. Carr.

STANTON IIIS Size 18x11x10in. Rating 10 watts. Incorporating Fane 803b speaker with roll rubber cone surround and 15,000 line magnet. High flux tweeter. Handsome Scandinavian design cabinet. Range 30–20,000 c.p.s. Impedance 3 or 15 ohms. Gives smooth realistic sound output. **16 Gns.** Inc. carr.

GLOUCESTER Size 25 x 16 x 10in. 12in. High flux 12,000 line speaker. Cross-over unit and Tweeter. Rating 10 watts. Frequency range 40–20,000 c.p.s. Impedance 15 ohms. **12½ Gns.**

E2 EQUIPMENT CABINET

Size 17" wide 14½" deep 11½" high. Cut for **TA12**, Super 15, Super 30 and other amplifiers. 'Hinged' perspex cover. Satin Teak or Afrormosia veneer finish. Price inc. carr. **8 Gns.**

MOTOR BOARDS cut for Garrard Turntables and many other units. Price **12/9**

EXTREMELY ATTRACTIVE AND VERSATILE PLINTHS finished in Teak or Afrormosia veneer. Tinted Perspex "roll over" cover with satin chrome handle.

RECORD PLAYING UNITS

Money saving units. Ready to plug into Amplifier or Tape Recorder.
RP2 Consisting of Garrard SP25 Mk II (with heavy turntable) fitted Goldring CS90 high compliance ceramic Stereo/Mono cartridge with diamond stylus. Mounted on Plinth. Inc. Perspex cover. Carr. 15/-. Plus 8/7 P.T. surcharge. **22 Gns.**
RP3 As above but with Goldring Lenco GL68 Transcription unit and CS90 Cartridge. Supplied with Perspex Cover. Inc.P.T.s'charge **£28** Carr. 21/-

R.S.C. PLINTHS

for Record Playing units. Teak finish cut for Garrard 1000. 2000. 3000, AT6, AT60, SP25 or Goldring GL68. Available with clear Perspex cover as ill. Inc. Carr. **59/9** **6 Gns.** Perspex cover sold separately at 3 Gns. Limited number of covers slightly damaged but repaired by makers. 39/9

10 W HIGH FIDELITY AMPLIFIERS

LINEAR L10 Separate Pre-amp and Main Amp. Matched to Magnetic P.U. **To clear** **10 GNS.**

R·S·C·TA12 13 WATT STEREO AMPLIFIER

FULLY TRANSISTORISED, SOLID STATE CONSTRUCTION HIGH FIDELITY OUTPUT OF 6·5 WATTS PER CHANNEL

Designed for optimum performance with any crystal or ceramic Gram P.U. cartridge, Radio tuner, Tape recorder, 'Mike' etc. ★ 3 separate switched input sockets on each channel ★ Separate Bass and Treble controls ★ Slide Switch for mono use ★ Speaker Output 3–15 ohms ★ For 200–250v A.C. mains ★ Frequency Response 30–20,000 c.p.s. —2dB ★ Harmonic Distortion 0·3% at 1000 c.p.s. Hum and Noise —70dB ★ Sensitivities (1) 300mV (2) 50mV (3) 100mV (4) 2mV Output rating I.H.F.M. ★ Handsome brushed silver finish Facia and Knobs. Complete kit of parts with full wiring diagrams & instructions. **12½ GNS.** Carr. 7/9 Factory built with 12 mth gntee **16 GNS** or Deposit **£4.16.0** and 9 mthly pymts 31/6 (Total £18.19.6) Or in Teak or Afrormosia veneer housing **19 Gns.** Dep. £4.19.0 and 9 mthly pymts 39/-. (Total £22.10.0).

AUDIOTRINE HI-FI SPEAKER SYSTEMS

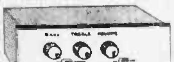
Consisting of matched 12in. 12,000 line 10 watt 15 ohm high quality speaker, cross-over unit and tweeter. Smooth response and extended frequency range ensure surprisingly realistic reproduction. **5 Gns.** Carr. 5/9
Or Senior 15 watt inc. HF 126 15,000 line Speaker 6 Gns. Carr. 6/6

HI-FI SPEAKER ENCLOSURES

Teak or Afrormosia veneer finish. Modern design. Acoustically lined and ported. Inc. carr.
JE8 Size 16 x 11 x 9in. Pressurised. Gives pleasing results with any 8in. Hi-Fi 'speaker. **4 Gns.**
SE8 For optimum performance with any 8in. Hi-Fi 'speaker. Size 22 x 15 x 9in. **5 Gns.**
SE10 For outstanding results with 10in Hi-Fi 'spkr Size 24 x 15x10in. **£5.10.0**
SE12 For exclnt prfmnce with 12in Hi-Fi speaker and Tweeter. Size 25 x 16 x 10½in. **6 Gns.**

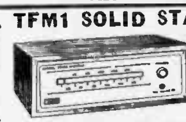
INTEREST CHARGES REFUNDED on Credit Sales settled in 3 months.

R.S.C. TA6 6 Watt HIGH FIDELITY SOLID STATE AMPLIFIER



200-250v. AC mains operated Frequency Response 30–20,000 c.p.s. —2dB. Harmonic Distortion 0·3% at 1,000 c.p.s. Separate Bass and Treble 'lift' and 'cut' controls. 3 input sockets for Mike, Gram, Radio or Tape. Input selector switch. Output for 3–15 ohm spkrs. Max. sensitivity 5mV. Output rating I.H.F.M. Fully enclosed enamelled case, 9½ x 2½ x 5½in. Attractive brushed silver finish facia plate 10½ x 3½in. and matching knobs. Complete kit of parts with full wiring diagrams and instructions. Carr. 7/6 **£6.19.9**
Or factory built with 12 months guarantee. £8.19.9

R.S.C. TFM1 SOLID STATE VHF/FM RADIO TUNER



Total cost of parts with detailed wiring diagrams & instructions. Inc. Carr. **14 Gns.**
Or factory built 16½ gns. Or in Teak finished cabinet as illustrated 19½ gns. Terms: Deposit £5 and 9 monthly payments £2. Total £23.

★ High-sensitivity ★ 200-250v. A.C. Mains operation. ★ Sharp A.M. Rejection. ★ Drift-free reception. ★ Output ample for any amplifier (approx. 500 m.v.). ★ Simple alignment instructions. ★ Output available for feeding tuning meter. ★ Output for feeding Stereo Multiplexer. ★ Tuner head using silicon Planar Transistors. ★ Designed for standard 80 ohm co-axial input. Visually matching our Super 15 and 30 amplifiers and of the same high standard of performance and reliability. The pre-wired tuning head facilitates speed and simplicity of construction. Printed circuitry. Only high grade transistors and components used. A quality product at considerably less than the cost of comparable units. Stereo version, all parts 20 gns. Inc. carr. Assembled 22½ gns. inc. carr.

R.S.C. SUPER 15 HI-FI AMPLIFIER

SOLID STATE CONSTRUCTION
SPECIFICATIONS COMPARABLE WITH UNITS COSTING CONSIDERABLY MORE

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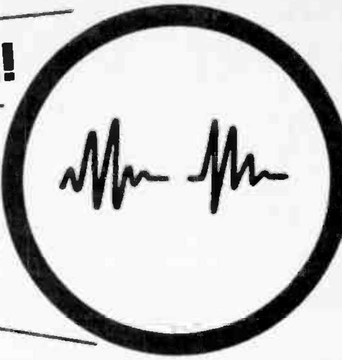

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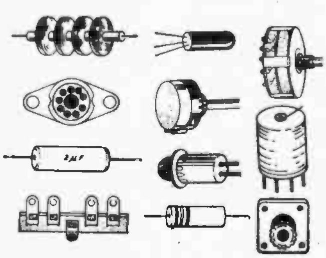

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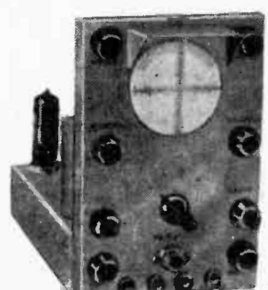

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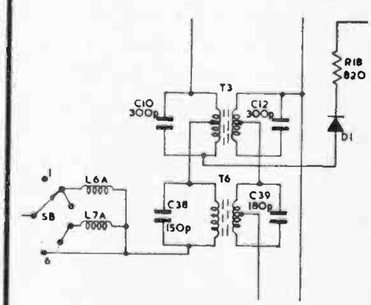

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PRACTICAL WIRELESS

VOL 45 No 2

Issue 748

JUNE 1969

TOPIC OF THE MONTH

Standardisation

OBSERVANT readers will have noticed that P.W. is changing over from c/s to Hz. Much of industry has already made the change and most technical journals have followed suit, some of these decisions having been made, as was P.W.'s, not for choice but for conformity.

The idea was to honour the pioneer Hertz, celebrated for his work on radio waves. Thus changing 15kc/s for 15kHz makes some kind of sense, but 50c/s to 50Hz does not, for these are audio frequencies. Blumlein or another audio pioneer would have been a better choice!

But this is only one small item in the move towards Continentalisation (what an ugly word!), the abandoning of a perfectly understandable and descriptive term for one that is not. Already we are taking our medicine, if not our beer, in millilitres, our currency is being decimalised, temperature is given in both C and F and we are being generally geared to the Common Market, even if we never join that confederation.

This movement has led to outbreaks of midsummer madness and perhaps the choicest example was in a recent issue of a contemporary radio trade journal. In big bold headlines it was proclaimed that a certain maker's TV sets were now "metric ready". Reading on, it was discovered that this awe-inspiring term meant no more than that the cabinet dimensions were specified in centimetres instead of inches! So help us, it's true.

At least one other journal has abandoned inches per second for tape speeds in favour of metric figures. Here we find, for instance, that the fairly roundish 7½i.p.s. becomes 19·1cm, although the actual figure is 19·05cm. Some standard! Advertisements in the same journal show that the actual makers are still, however, specifying in i.p.s.

We *are*, though, all for standardisation in practical matters. For instance, the sooner everyone goes over to the DIN specifications for plugs and sockets the better. Then there will be no need for a caseful of odd leads carrying phono, coaxial, DIN, banana and "special" plugs and sockets. There are many fields in which acceptance of standard interchangeable components would be a blessing for everyone concerned. We'd like to see more of it. W. N. STEVENS—*Editor*

NEWS AND COMMENT

CONSTRUCTIONAL

OTHER FEATURES

JULY ISSUE WILL BE PUBLISHED ON JUNE 6th

All correspondence intended for the Editor should be addressed to: The Editor, "Practical Wireless", IPC Magazines Ltd., Tower House, Southampton Street, London, W.C.2. Phone: 01 836 4363. Advertisement Department: Fleetway House, Farringdon Street, London, E.C.4. Subscription rates, including postage: 42s. per year to any part of the world.

NEWS AND COMMENT...

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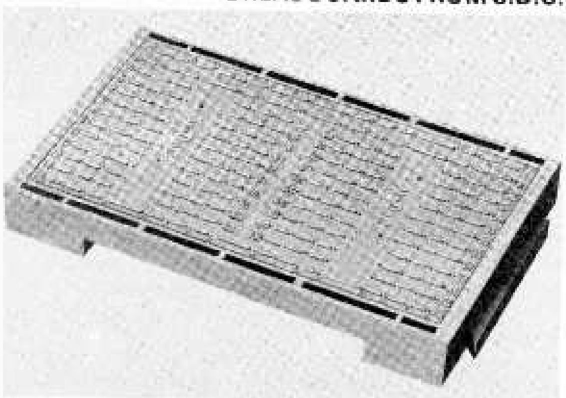


S.D.C. Products (Electronics) Limited, have extended their range of modular, solderless breadboarding systems to include two new DeCs specifically designed to accommodate integrated circuits as well as discrete components and to have an increased contact capacity—208 contact points per DeC—as compared to the original S-DeC.

The layout of the contacts consists of two panels of parallel rows of electrically linked contacts spaced 5mm. apart. This spacing enables short lead devices to be inserted directly into the boards. The new DeCs may be interlocked to give a stable area of breadboard of any desired size and each DeC has slots to accommodate two control panels.

The DeCs are formed from glass-filled nylon enabling temperature cycling tests to be carried out and contacts are of heavy gauge phosphor bronze in natural finish, in either silver plated or gold over nickel plated finish.

DeCs are supplied in two packs. The single pack contains one DeC, one control panel (with bushes for reducing the diameter of drilled holes in the panel) and a jig (for pre-forming components). The 6-DeC pack contains six DeCs, six control panels, sets of bushes and jigs, 50 x 1mm. plugs and eight links for joining power rails in neighbouring DeCs.

WHITBY TELEVISION AND VHF RADIO RELAY STATION

The BBC has placed an order for the construction of the building for the television and v.h.f. radio relay station which is being built to serve Whitby, Yorkshire.

This new relay station is being built near Abbey Lane, Whitby. It will transmit BBC 1 television on channel 4, with vertical polarisation, and v.h.f. radio on the following frequencies: Radio 2 89·6MHz, Radio 3 91·8MHz, Radio 4 94·0MHz.

PRESTON MOBILE RALLY

We of the Preston Amateur Radio Society are again basing our mobile rally on Kimberley Barracks, Deepdale Road, Preston, and this year's rally will be held on Sunday, 31st August, 1969.

For further details send s.a.e. to Press and Contest Sec.: Mr. G. Wright, 56 Queensway, Bamber Bridge, near Preston, Lancs.

BORDER AMATEUR RADIO SOCIETY

This new radio society has been formed to serve the Southern Borders and North Northumberland. The Secretary, J. Nairn, asks all who are interested to contact him at 5 Murrayfield, Gordon, Berwickshire or the Chairman, G. Shankie, GM3WIG. Meetings are held in the Cross Keys Hotel, Greenlaw.

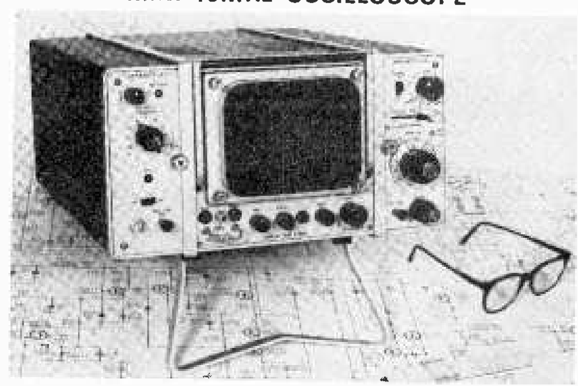
TRISTAN CALLING

Mr. Roy Folgate whose callsign G3KDY is well known on the bands, will now have a new callsign—ZD9RF, for he is now resident on Tristan da Cunha, the volcanic island in the South Atlantic where he has taken up the post of Superintendent of Posts and Telegraphs.

"HEMEL HEMPSTEAD RADIO-NEWSLETTER"

This is the bi-monthly newsletter of the Pathfinder Radio Group. They also publish and circulate from time to time *Pathfinder DXer*. Since forming in 1964, the subscription has been free, but as from April 1969, the group are charging 10s. to new members. The *Hemel Hempstead Radio-Newsletter* is circulated in 9 European countries. For further details, s.a.e. to Alexander Lex-Arnold, c/o 13 Little Road, Hemel Hempstead, Herts.

MINI 15MHz OSCILLOSCOPE



What is thought to be the smallest portable solid state oscilloscope of its sort with 15MHz bandwidth, has been announced by Dynamco and is available at £355.

It consists of a 7100 display unit, with a new 1Y7 single channel amplifier measuring only 2¾in. and a new 1X6 timebase module, also of a similar width.

The 1Y7 is a general purpose single channel amplifier having a basic deflection factor of 50mV/division at full bandwidth and a maximum deflection factor of 5mV/division with a switched X10 a.c. coupled preamplifier. When the 1Y7 is used for horizontal deflection, the deflection factor remains the same and the frequency response is nominally d.c. to 4MHz–3dB.

The 1X6 timebase module is intended to provide, in a minimal width, most of the facilities required for general purpose applications. The calibrated sweep rates are 0·5μS/div. to 0·2 secs/div. in 19 calibrated steps of 1, 2 and 5 sequence and a fine control provides continuous uncalibrated variation between steps and extends the range to 0·5 secs/div.

A switched X10 magnifier gives a maximum sweep speed of 50nS/div.

NEWS AND COMMENT...

NEW FOR TWO-METRE FANS

Now joining the Hallicrafter CRX101 pocket-size solid-state aviation frequency receiver already available from Electroniques is the companion model CRX102.

Hallicrafters' CRX102 ranges from 144 to 174MHz (the high-band), tuning to the two-metre Amateur band.

Like the CRX101, it features a superhet circuit with three i.f. stages and five tuned circuits. It receives both a.m. and f.m. An r.f. stage boosts sensitivity and push-pull class B amplification combines high efficiency and power with long battery life (standard 9V battery).

Other features are: automatic gain control, telescopic aerial, provision for external aerial and earphones.

Price of the CRX102, like the 101, is £17 9s. 6d., plus 7s. 6d. postage. From Electroniques, Edinburgh Way, Harlow, Essex. (Harlow 26777.)

THE GOSCUT PISTOL-GRIP SHEAR

The Goscut single-handed shear, only six inches long from tip to tip, is adjustable to cut almost all sheet materials from paper to steel. It has three interchangeable blades. The blade bears down through a slot in a flat surface, so that the tool provides its own anvil or workbench. Close support at the point of cut prevents distortion or fracture of the material and leaves a clean-cut edge.

Adjustment of the slot width enables materials of varying thicknesses below $\frac{1}{8}$in. to be cut. Cutting speed is about 30 seconds a foot run or a little longer for the heavier gauges of metal.

VHF MOBILE TX TRANSISTORS

Two new high-gain, n-p-n silicon planar transistors announced by Mullard have been specially developed for use in v.h.f. mobile transmitters. Types BLY83 and BLY84, they are electrically equivalent to the TO-60 types BLY35 and BLY36 respectively.

Emitters in the new transistors are composed of several interdigitated structures, each with its own current-sharing resistor. Consequently, they are so robust electrically that they can be used in circuits containing no protection against aerial mismatch or variations in the supply voltage.

The transistors are enclosed in capstan type encapsulations that minimise lead inductance and lend themselves to efficient r.f. circuit design. They are designed primarily for use with a nominal supply voltage of 13·8V, and are intended for output stages—the BLY83 in a.m. and the BLY84 in f.m. transmitters.

12 VOLTS FROM 6

Philips new EN5013 transistor converter unit (suggested selling price £4 10s) enables a 12 volt car radio, when switched to negative earth, to be used in vehicles with a 6-volt electrical system.

The new converter unit has a power rating of 12 watts and can be inserted in the supply lead of the radio and operated with a separate on/off switch or, alternatively, wired to the radio switch so that it can be switched on/off with the radio.

W. Norman Stevens, the Editor of PRACTICAL WIRELESS and *Practical Television* magazines opened the proceedings by welcoming readers to Caxton Hall and introducing Ian Nicholson of the Mullard Films and Lectures Division, and A. T. Collins, Managing Editor of the "Practical" group of magazines.

Ian Nicholson then introduced the film entitled, *It's the Tube that Makes the Colour* which described the manufacture and operation of the Mullard Colour Screen colour tubes and also described how the pictures are received. It is being used in the BBC Trade Test Transmissions.

After the film, Mr. Nicholson delivered a lecture entitled "Purity, Convergence and All That". He explained that deviation from ideal picture reproduction occurs for one main reason—the fact that the three guns cannot all be mounted on the axis of the tube itself. It is because of this that geometrical errors between the three rasters that are produced and some means of correction must therefore be provided.

"It is with these means of correction that we are primarily concerned tonight", he said. "We find moreover that the prime components required to effect these corrections are all mounted externally around the tube itself. There is the magnetic shield, the deflection coil assembly, radial convergence magnets, the purity magnets and the blue horizontal or lateral shift magnets. The adjustment of static and dynamic convergence may at first seem rather complex but it is not nearly as difficult as it may appear. After all, purity adjustment consists merely of setting a couple of ring magnets for purity of colour near the screen centre. The position of the scanning coils should then be adjusted along the neck of the tube to give pure colours away from the centre. Static convergence is achieved simply by adjusting five permanent magnets on the tube neck to bring the red, blue and green beams together to give a white crosshatch pattern at the centre of the screen. Finally, dynamic convergence is the manipulation of a dozen or so controls for the two line standards in a generally established sequence in order to bring the separate red, green and blue crosshatch line patterns together to give single white lines at the top, bottom and sides of the picture."

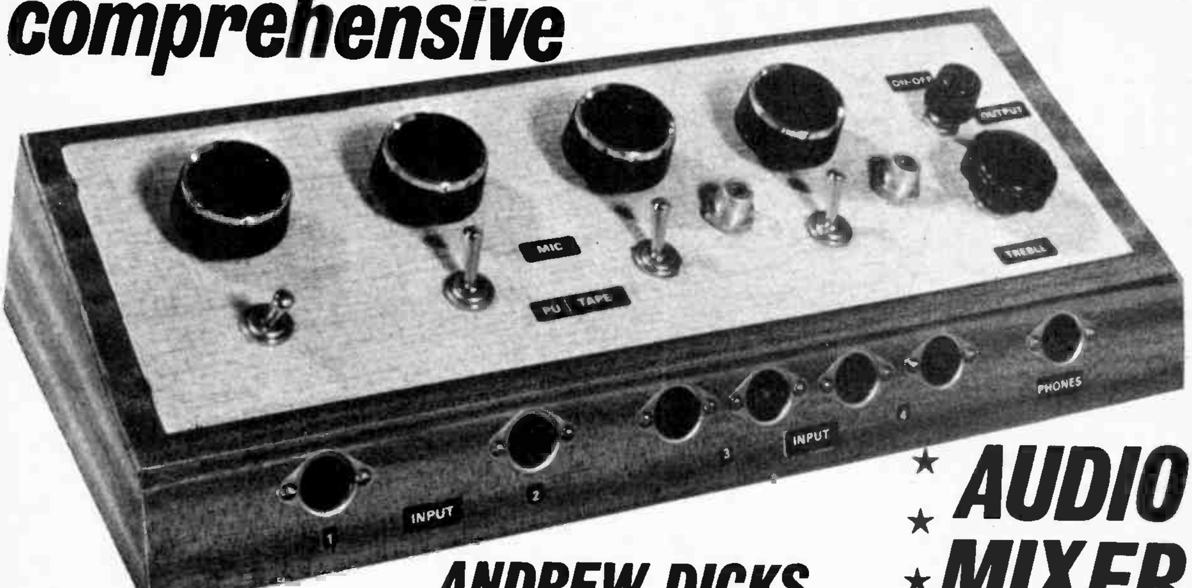
As yet there is no standardised terminology for the controls involved and each manufacturer has his own ideas about how and in what sequence these operations should be tackled—dependent usually on his own particular circuitry. Mr. Nicholson presented a broad picture of the principles involved in colour television receivers so as to make it easier to understand the individual service procedures.

After his talk, Mr. Nicholson opened the meeting to questions from the audience.

On the question of the kind of developments we can expect to see in the future of colour TV, Mr. Nicholson said the main developments would be in the use of integrated circuits which would give greater reliability and improved performance. Integrated circuits would be the subject of Filmshow '70 and Mullard Ltd are at present working on the production of the film.

A. T. Collins, W. N. Stevens and Ian Nicholson.

comprehensive AUDIO MIXER



ANDREW DICKS

MOST of the small audio mixers that are available to amateur audio enthusiasts have very limited applications. Many people who own these will have realised their incapability of accommodating all the various input sources that the amateur may use. One usually resorts to "hooking up" arrangements of attenuators, transformers and other devices to match sources to inputs.

The purpose of this mixer is to provide such comprehensive facilities that almost anything can be plugged into it without alteration. It is the wide range of available inputs that make this unit such a comprehensive piece of equipment. If good quality components are used the results will be no less than hi-fi and the price and appearance of finished unit will compare favourably with any commercially obtainable instrument.

General Principles

Broadly speaking, audio mixers may be classified into "active" or "passive" types. High quality devices are usually "active", that is, they incorporate some form of amplification. A block diagram of an "active" type of mixer is shown in Fig. 1, and the mixer to be described is based on this system. The inputs are fed to four emitter-followers which incorporate faders to control the level of each channel. The four sound channels are mixed by an adding circuit and the level of the composite signal is controlled by one master fader. The composite signal is then fed through a further stage of amplification to compensate for losses due to the adding circuits and attenuators.

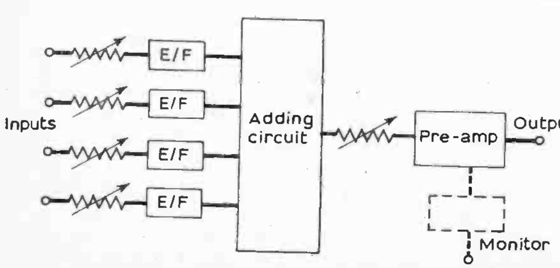


Fig. 1: Block diagram of an active mixer.

The most difficult problem in designing audio circuits of this sort is the matching of input impedances and voltages. Fortunately, the matching of impedances is not too critical and values that are reasonably close will do, provided the voltage ratings match fairly well. The classes of impedances that are met with in practice are as follows:

High (up to 2MΩ):	crystal microphones, ceramic and crystal pick-ups.
Medium (50kΩ):	some magnetic and crystal microphones, tuner units, tape recorder outlets, magnetic pick-ups.
Line (500Ω):	magnetic microphones.
Low (3—30Ω):	magnetic microphones, loudspeakers.

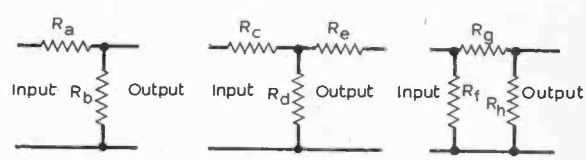


Fig. 2: Three types of resistive attenuator—L, T and π.

The easiest way of matching levels is to use attenuators. These can be purely resistive, the simplest of which are the L, T and π networks illustrated in Fig. 2. It is not proposed to discuss these circuits in detail as they can be found in standard textbooks, but suffice it to say that the L and T types of attenuator are used in this mixer.

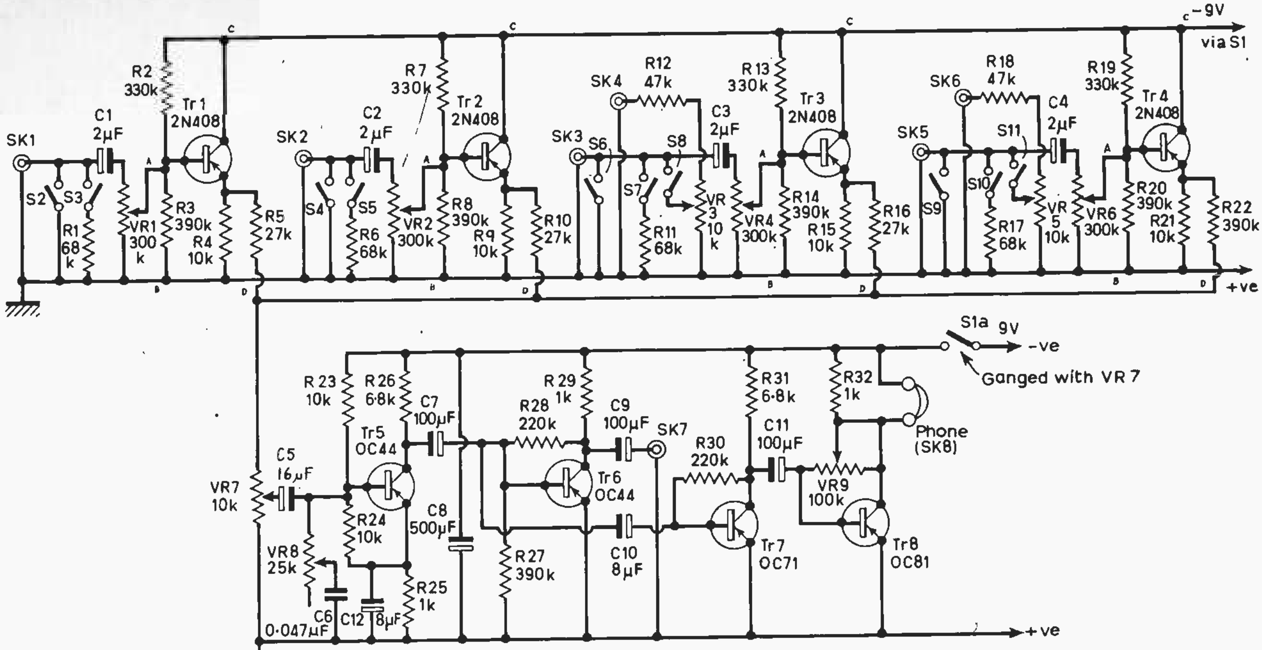


Fig. 3: Circuit diagram of the complete mixer unit.

Description and Specifications

The mixer is based on the idea outlined in Fig. 1; an additional facility has been incorporated (dotted lines) to enable the composite signal to be monitored using phones. The complete circuit of the unit is given in Fig. 3. A few points should be made regarding the input circuits—these are most prone to noise and for this reason only good quality components should be used for resistive attenuators. This also applies to the switches and electrolytic capacitors. The transistors used for the emitter follower stages are AC128 low noise a.f. types; these were found to be the most suitable low-priced transistors available.

The channels are mixed by a simple adding circuit and are given further amplification by Tr5 and Tr6, producing an output of up to 300mV at Sk7. The treble-cut control VR8 is perhaps a luxury item included primarily so that surface-noise on old records could be removed by cutting the upper frequencies. It will also be found useful when recording from a.m. radio.

The input sensitivities of the mixer are tabulated below:

Channels	*Inputs*	*Sensitivity*	*Impedance*
1, 2, 3, 4	Microphone	0·5mV	300kΩ
1, 2, 3, 4	Mic. or Mag. P.U.	5mV	50kΩ
3, 4	Crystal P.U.	100mV	50kΩ
3, 4	Radio, Tuner, etc.	200mV	100kΩ

Comparison of these impedances with the list of impedances given before shows that the mixer will accommodate a wide variety of inputs.

Plugs and Sockets

Before describing the actual construction of the mixer, it is worth while discussing plugs and sockets. Both professional bodies and amateurs are beginning to acknowledge the use of the German DIN system (Deutscher Industrie Normenausschus) for radio and electronics. The commonly used plugs are the 3-pin, 5-pin, and loudspeaker 2-pin. The convention as agreed by DIN for wiring these is shown in Fig. 4,

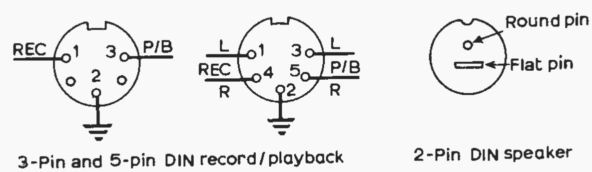


Fig. 4: Pin connections for 2, 3 and 5-pin DIN plugs.

and these should be followed although in particular cases it is advisable to check with the maker's instructions in case the pin order is non-DIN. The diagrams show the plugs as viewed from the free end or the sockets from the solder tags end. It should be noted that in each case, pin 2 is connected to earth. The 3-pin plug will fit the 5-pin socket and also the plugs are lugged so they are irreversible. The 5-pin sockets are used on the mixer so that inputs with 3-pin or 5-pin plugs may be used.

Construction

The complete mixer is housed in a compact wooden cabinet and to simplify construction this should be made first. The drilling of the various pieces is shown in Fig. 5. The base is made of ½in. plywood and the side panels are of ¼in. plywood. The side and front panels are fixed to the base with glue and screws, the other panels being fixed by suitable lengths of ½ x ½in. wooden strips; the top is made so that it can be screwed onto the side panels. The photograph shows how the cabinet looks when assembled. A sheet of Formica is glued to the top panel, which not only improves the appearance of the finished unit but also enables markings to be made in pencil which can easily be erased; this is useful for noting down volume levels etc.

In a design of this sort attention has to be paid to screening so as to reduce noise, hum, and cross-talk. Screens made of 18 s.w.g. aluminium cover each of the emitter-follower stages, the details of which are also given in Fig. 5.

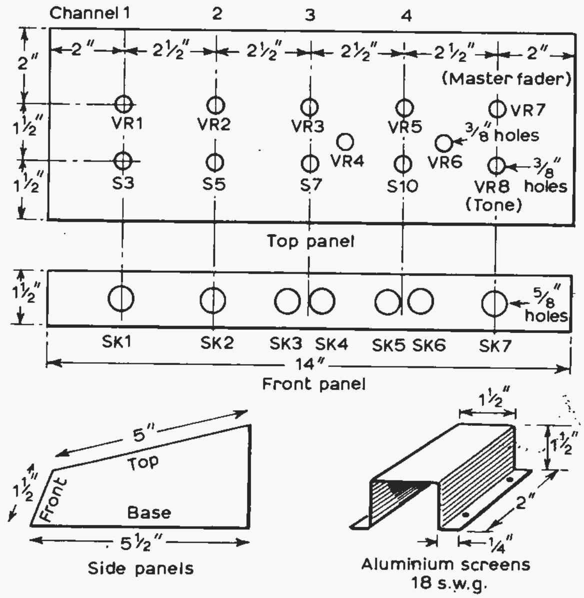


Fig. 5: Dimensions of cabinet, side panels and screens.

Most of the hardware is mounted on the top panel and so the switches and faders should be mounted first (see Fig. 7). The emitter-follower stages should be constructed next. These are most easily made on Veroboard, four of them being required and the wiring details are given in Fig. 6. It is perhaps a good idea to use different coloured wires for the connections A, B, C and D. Having made these stages, they can be secured to the top panel using screws and insulated washers. These are positioned as outlined in Fig. 7, when the main panel can then be wired up. Screened leads should be used to all of the sockets and to the input on the pre-amp. Fairly long leads should be used to connect the sockets on the front panel to the top panel to enable the top panel to be easily removed should this become necessary. Once the top panel has been wired up the screens can be fitted over the emitter-follower circuits.

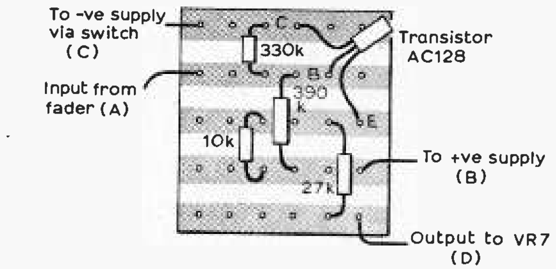


Fig. 6: Wiring of the emitter follower stages. Note the necessity for screened input and output leads.

The 5-pin sockets on the front panel are wired so that a 5-pin stereo source may be used and also to allow 3-pin plugs to be used. To do this, on each socket the tags 3 and 4 are connected together; tags 2 should be connected to the outer braid of the leads connecting to the top panel, and it is also advisable to connect the number 2 tags on each socket together and to take the positive battery supply to these tags. The output socket Sk7 is mounted on the rear of the cabinet.

The remainder of the circuit which consists of the pre-amplifier and the monitoring amplifier is assembled on a single piece of Veroboard which is then mounted on the base of the cabinet. The details of this board are given in Fig. 7 and the construction should present no problems.

The potentiometer VR9 can be mounted in a suitable position on the base of the cabinet; it is of the pre-set type and will vary the output to the phones. The output provided by this two-stage amplifier should be ample for most purposes.

When the amplifier has been made it can be screwed to the base of the cabinet and any remaining wiring completed.

Finally, the cabinet can be finished—the top

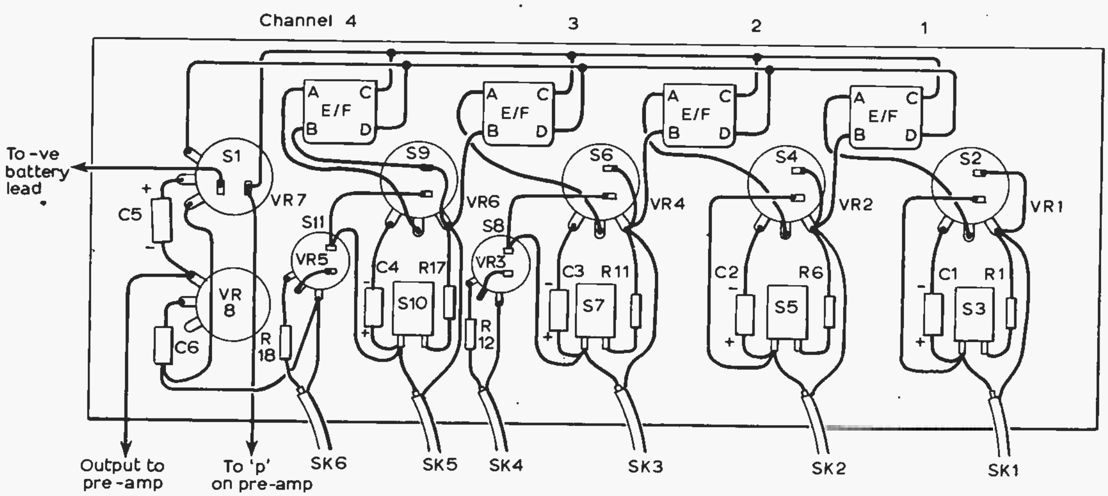


Fig. 7: Wiring of the main panel.

★ components list

Resistors:

R1	68kΩ	R17	68kΩ
R2	330kΩ	R18	47kΩ
R3	390kΩ	R19	330kΩ
R4	10kΩ	R20	390kΩ
R5	27kΩ	R21	10kΩ
R6	68kΩ	R22	27kΩ
R7	330kΩ	R23	10kΩ
R8	390kΩ	R24	10kΩ
R9	10kΩ	R25	1kΩ
R10	27kΩ	R26	6·8kΩ
R11	68kΩ	R27	390kΩ
R12	47kΩ	R28	220kΩ
R13	330kΩ	R29	1kΩ
R14	390kΩ	R30	220kΩ
R15	10kΩ	R31	6·8kΩ
R16	27kΩ	R32	1kΩ

All $\frac{1}{8}$ or $\frac{1}{4}$W, 10%

Capacitors:

C1, C2, C3, C4	2μF, 15V electrolytic
C5	16μF, 15V electrolytic
C6	0·047μF disc ceramic, 20V
C7	100μF, 15V electrolytic
C8	500μF, 15V electrolytic
C9	100μF, 15V electrolytic
C10	8μF, 15V electrolytic
C11	100μF, 15V electrolytic
C12	8μF, 15V electrolytic

Potentiometers:

VR1, VR2, VR4, VR6	300kΩ log., with switch
VR3, VR5, VR7	10kΩ lin., with switch
VR8	25kΩ log.
VR9	100kΩ lin.

Transistors:

TR1–4	AC128
TR5, TR6	OC44
TR7	OC71
TR8	OC81

Miscellaneous

Seven 5-pin DIN sockets; four s.p.s.t. toggle switches; Veroboard; 18s.w.g. aluminium; PP7 battery or equiv.; clips for battery; screened wire; plywood; Formica for cabinet; knobs etc.

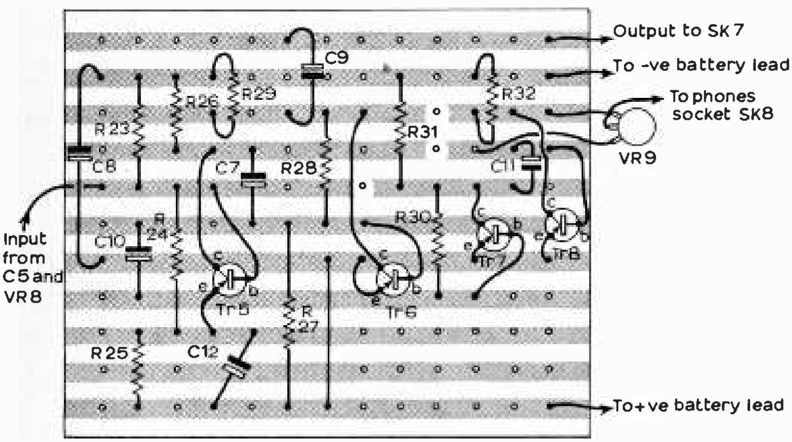


Fig. 8: Layout of the amplifier panel.

panel being fastened and the back panel screwed in place.

A 9V power supply is required and a PP7 power-pack will fit into the cabinet. Alternatively a simple power-supply can be made to run off the mains, details being provided in Fig. 9. This should preferably be mounted in a separate case to prevent any mains hum being picked up by the circuits.

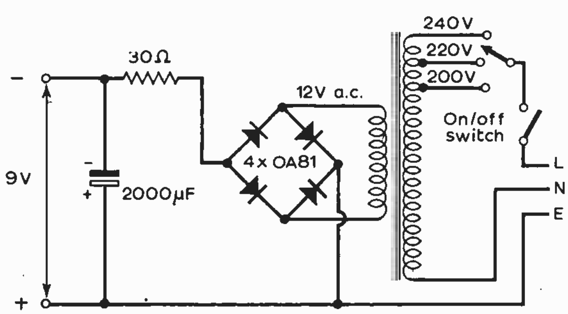


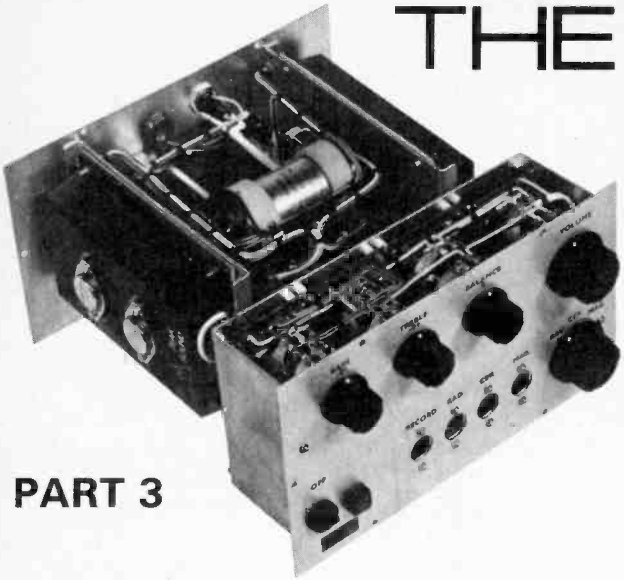
Fig. 9: A suitable power supply.

Testing

To test each of the channels a number of suitable sources are required. Plug a pair of head-phones into the phones socket and switch the mixer on by turning the master fader VR7 clockwise. Plug a microphone into socket Sk1, Sk2, Sk3 or Sk5 and turn on the appropriate channel. For high impedance microphones (crystal) the appropriate toggle switch (S3, S5, S7 or S10) should be off and conversely on for lower impedances, the actual sensitivities having been previously given in the table. Adjust the faders to full volume then adjust the pre-set control VR9 so that a reasonable listening level is obtained without undue distortion. The attenuators VR4 and VR6 should be off when using microphones.

To use crystal pick-up, radio, tuner etc. channels 3 and 4 are used: plug a suitable source into Sk4 or Sk6 and turn on the attenuators VR4 and VR5; these can be adjusted to give a suitable volume level with the faders turned fully clockwise.

Obviously the number of possible combinations of devices that can be used with this instrument is quite large and it would be pointless enumerating them all; the specifications given before will give the user a good idea of the range of applications for which this could be used. ■



THE P.W. DOUBLE·12 HI-FI AMPLIFIER

PART 3

HAL MOORSHEAD

IN THE PREVIOUS ARTICLES DETAILS WERE GIVEN ON THE CONSTRUCTION OF THE PREAMPLIFIER AND THE METALWORK FOR THE COMPLETE UNIT. THIS FINAL PART WILL DESCRIBE THE BUILDING OF THE MAIN AMPLIFIERS AND POWER SUPPLY AND A DESCRIPTION OF THE CABINET USED FOR THE PROTOTYPE.

AS the P.W. Double-12 is a stereo unit obviously two main amplifiers are needed. As mentioned in the previous articles a wide range of ready built amplifiers are available at very small cost, in fact the cost of ready built units is so low that some readers may be suspicious of the claims made for them, but the author has tried several and found them excellent. For the reader who only requires a Hi-Fi amplifier and finds construction laborious ready built modules may be used. However, many constructors, like the author, prefer to build projects completely.

After considering several designs the one chosen finally was based on the Peak Sound P.A. 12-15 module, available either as a kit or as a ready built unit; this gives very high quality at a cost below buying the individual components. However a complete parts list and building details are given for anybody wishing to start from scratch.

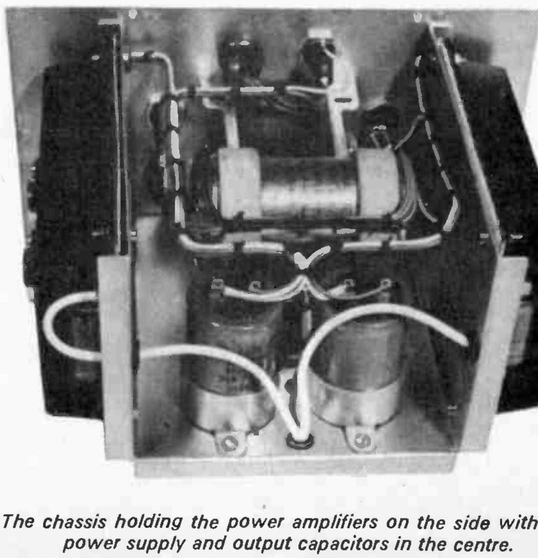
The performance of the P.A. 12-15 easily exceeds the new European DIN standard for Hi-Fi amplifiers; specially selected high gain output transistors are used in closely matched pairs which, together with the high degree of negative feedback (43dB), contribute to the excellent performance figures which were given in some detail in the first part. In addition to having very good characteristics the module is easily built into a neat and compact unit.

The circuit

The theoretical circuit of one channel of the main amplifier is shown in Fig. 1. The circuit is a fairly common configuration for Hi-Fi amplifiers and the method of working has been described before in Practical Wireless but for those unfamiliar with the basic operation a brief description will be given.

The signal from the preamplifier is fed to Tr1 (2N4289) which is arranged as a common emitter amplifier, the output is d.c. coupled to Tr2 which further amplifies the signal (again arranged as a common emitter amplifier) to drive the complementary pair of driver transistors Tr3 and Tr4. C5, which is connected from the collector to the base of Tr2, applies a.c. negative feedback and allows the top frequencies (above 50kc/s) to fall away. R10, TH1 and VR2 provide the correct base biasing for the complementary pair. The thermistor (TH1) alters the biasing to compensate for temperature changes.

The complementary pair act as phase splitters, each driving one of the power transistors Tr5 and Tr6 with half the signal, the two outputs appear together at the junction of R15 and the collector of



The chassis holding the power amplifiers on the side with the power supply and output capacitors in the centre.

Tr6. This combined signal is applied via C7, a 1,000μF capacitor to the loudspeaker.

Since the entire amplifier is directly coupled d.c. feedback is applied to stabilise the circuit from the output to the base of Tr1 via R2 and R11. Negative feedback is applied through C6 enhancing the performance and making the output more linear than it would be otherwise.

Construction

Like the preamplifier and tone control panels, the main amplifiers are built on a matrix board, 5 × 3¾in., the interconnections being made using Cir-Kit self adhesive copper strip. First lay the strip following the layout in Fig. 2 observing the rules given in the first article. Insert the components and carefully solder. The output transistors are mounted on a heatsink which covers the entire matrix board. It is necessary to insulate the bodies of these transistors (these are connected to the collector) from the heatsink using mica washers, first having spread both sides with a little silicon grease (provided in the kit) to ensure good heat conductivity.

The connections to the output transistors are taken by means of wires to the matrixed board; this is shown clearly in the photograph.

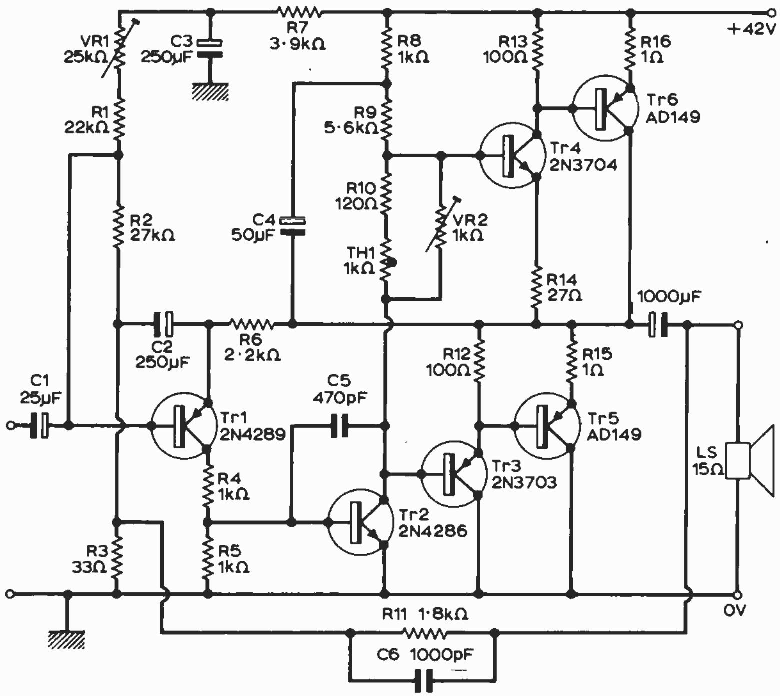
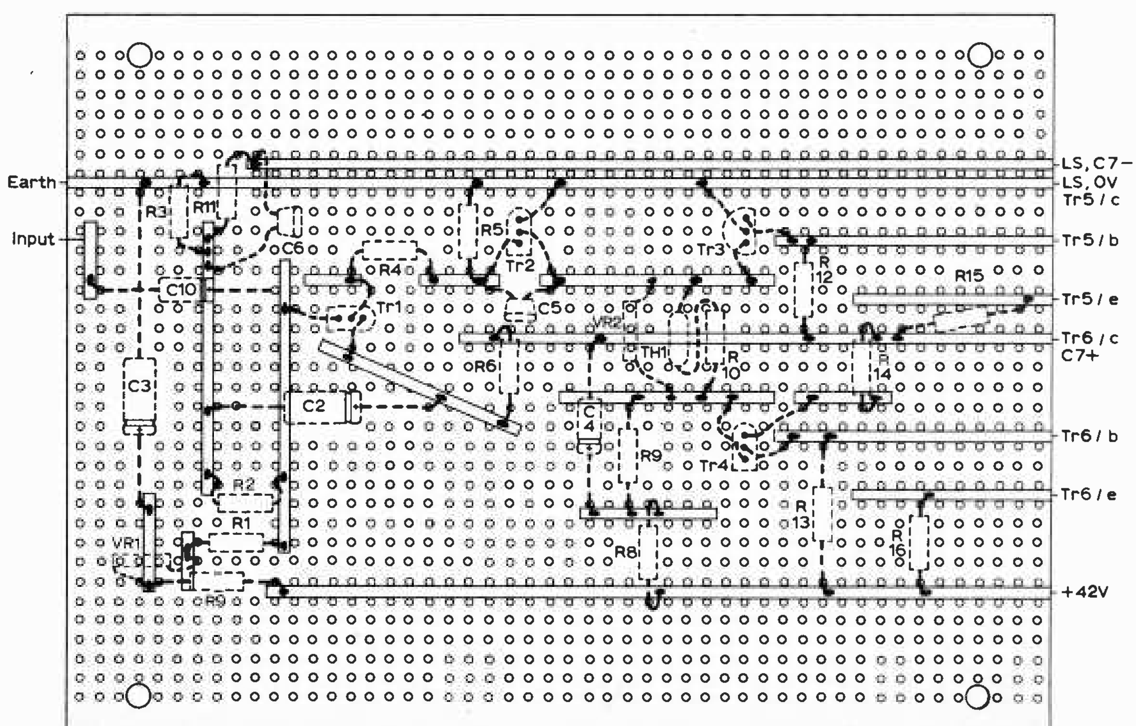


Fig. 1: The circuit of the power amplifier.

Fig. 2: The component layout of the power supply board. Like the preamp. panels they are mounted on matrix board and use Cir-Kit for interconnection.



The power supply

The power supply shown in Fig. 3 is very simple and any mains transformer with a secondary of 33 volts at 2 amp. could be used. The bridge rectifier is composed of a single unit which is wired directly on to tags of the transformer. The mounting of the transformer, bridge rectifier and smoothing capacitor are clearly shown in the photographs of the unit; their layout is uncritical and self explanatory.

The 20V supply to the preamplifier section is taken from the output of the power supply (45V), the voltage being dropped by inserting a 5·6kΩ resistor in the supply line.

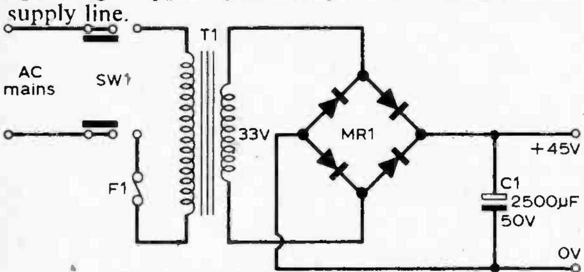


Fig. 3: The circuit of the power supply.

Interconnection

The outputs from the preamplifiers are wired directly to the power amplifier boards. The output from the amplifiers are taken to C7, the 1,000μF output capacitor and the other side of this is fed firstly back to the board providing negative feedback and secondly to the loudspeaker output socket through a fuse. It is important that a 1 amp. fuse is fitted into the loudspeaker circuit as shorting the output will damage the output transistors. The reader should refer to the metalwork (in the last issue) for the location of the fuse holders and the loudspeaker output sockets.

Setting up the power amplifiers

It will be noted that there are two preset potentiometers in the main amplifier circuits and it is important that these are correctly set. Before switching on set VR1 to the mid-position and VR2 to minimum resistance. Switch on and measure the voltage applied (this should be between 38 and 50V) to the amplifiers. Set VR1 so that the voltage between chassis and the amplifier side of C7 (1,000μF) is half the applied voltage plus half a volt. Thus, if the applied voltage is 42V VR1 should be set to read 21·5V. VR2 should be set to provide an emitter current in Tr5 of 50mA in quiescent conditions, that is with no signal applied.

★ components list

(POWER SUPPLY, MISCELLANEOUS AND EXTRA CIRCUITS)

Power Supply: Mains transformer, 250V primary 33V secondary, 2 amp; Silicon bridge rectifier (four BY100 rectifiers may be used if difficult to obtain); 1,000μF smoothing capacitor, 50V working; 1 amp. fuse holder.

Filter Networks: Top cut: 1kΩ, 15kΩ (both ¼ watt, 10%); 6,800pF; 2,200pF; double pole slider switch. Rumble filter: 0·47μF (or 1μF—see text); double pole slider switch.

Miscellaneous: Two 1 amp. fuses with fuse holders (for loudspeaker circuit), mains cable, wire etc.

Additional features

MONO/STEREO SWITCH. Previously it was mentioned that a mono/stereo switch should not be necessary, but if one is required it is only necessary to fit a small slider switch to couple together the outputs from the preamplifier panels. There is plenty of room to fit the switch on to the front panel.

SCRATCH FILTER. Some constructors may want a scratch filter, especially when old records are played. The circuit shown in Fig. 4 provides a cut-off at 9kc/s at the rate of 8dB per octave and is switched in and out by means of a double pole slider switch (one section being used for each channel) which again may be fitted to the front panel.

RUMBLE FILTER. Although a cut-off at the lower frequencies is incorporated in the design, it is possible to fit a rumble filter giving a sharp cut-off at the lower frequencies. All that is necessary is to incorporate a slider switch which switches out C6 in the tone control panel and substitutes a 0·47μF capacitor in its place. This will begin to cut at 50c/s and cuts sharply below 30c/s. If a lower cut-off frequency is required a 1μF paper or polystyrene capacitor should be used, this will cut sharply below about 20c/s.

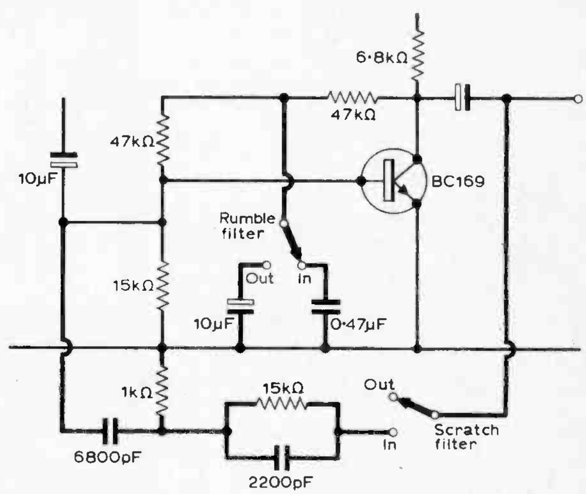
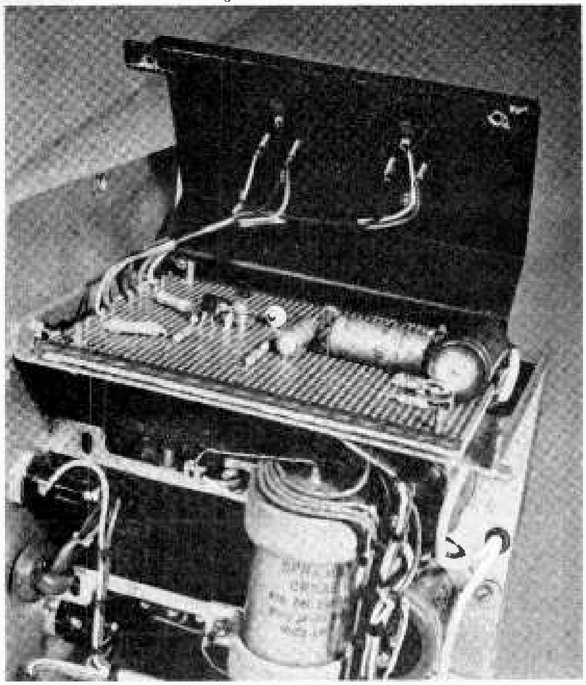


Fig.4: Additional circuitry for the scratch and rumble filters.

CORRIGENDA

In part one components list, the value of R4 in the preamplifier was given as 82kΩ: this should read 68kΩ as in the circuit diagram. Also all resistors in the preamp. and tone control circuits are ¼ watt, 10% miniature types. Alternatives to the BC169C were given and among these was the BC154; this is not suitable

In the second part the wiring of the input plugs was shown incorrectly. Numbering the pins 1-5 clockwise, on both the magnetic and ceramic inputs pins 1 and 2 should be joined together and pins 4 and 5 joined. In Part 2, Fig. 2, the spacing of the back panel from the bottom of the front panel is shown as ⅝in. This should read 1¼ in.



One of the power amplifiers with the heatsink raised.

★ components list

(MAIN AMPLIFIERS)

Resistors:

R1	22kΩ	R10	120Ω
R2	27kΩ	R11	1·8kΩ
R3	33Ω	R12	100Ω
R4	1kΩ	R13	100Ω
R5	1kΩ	R14	27Ω
R6	2·2kΩ	R15	1Ω 1 watt
R7	3·9kΩ	R16	1Ω 1 watt
R8	1kΩ	VR1	25kΩ preset skeleton pot
R9	5·6kΩ	VR2	1kΩ preset skeleton pot

All resistors except R15 and R16 ¼ watt miniature, 10% tolerance.

Capacitors:

C1	25μF 25V	C5	470pF
C2	250μF 25V	C6	1,000pF
C3	250μF 50V	C7	1,000μF 50V
C4	50μF 25V		

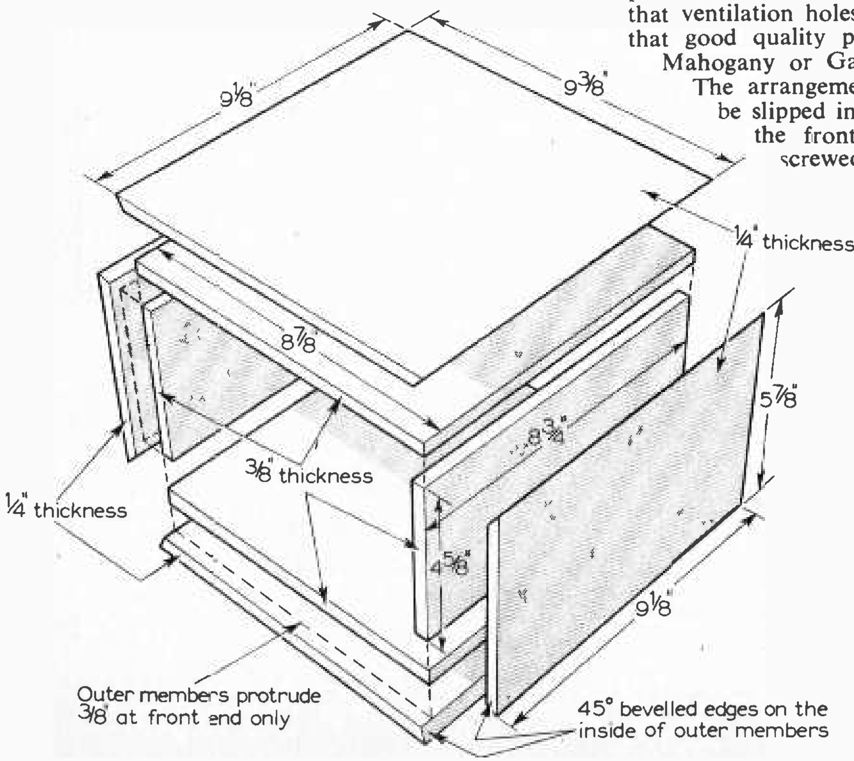
Semiconductors:

Tr1	2N4289	Tr4	2N3704
Tr2	2N4286	Tr5 and Tr6	AD149
Tr3	2N3703	(All available from Peak Sound)	

Miscellaneous:

Matrix board 5 x 3¾in., Cir-Kit strip, TH1 (Thermistor) Siemens K151; Heatsink (Peak Sound), mica washers.

Fig. 5: A suggested design for the cabinet made from plywood.



The cabinet

The cabinet for the Double-12 is extremely simple and can be made in an hour or two. The heat output from the unit, even at full output, is so small that ventilation holes are unecessary. It is suggested that good quality plywood is used and if desired Mahogany or Gaboon-faced ply could be used. The arrangement of the chassis enables it to be slipped into the cabinet, slightly recessing the front panel and allowing it to be screwed in. Details are shown in Fig. 5.

Conclusion

The P.W. Double-12, when completed, should be an excellent amplifier capable of faithfully reproducing the input. If used with good speakers, many of which are now available at reasonable prices, the builder will have an excellent Hi-Fi set-up at a very low cost. Any queries will be answered by the author if accompanied by a current query coupon and a stamped, self addressed envelope. ■

Due to pressure on space the second part of the PULSE CIRCUITS series has been held over till next month.

P.W. GUIDE TO COMPONENTS

PART 6

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

IN Part 5 last month basic transistor operation was outlined and the simple alloy-junction transistor described. This month we shall look at the more refined types of transistor giving improved performance.

Mesa Transistors

Drift transistors differ from alloy transistors in that the impurity concentration varies across the base region. This is achieved by *diffusing* the base region on to the main collector region and thus obtaining a greater concentration of impurity at the emitter, which is subsequently alloyed to the base region. The base thickness is carefully controlled and the varying concentration has the effect of a drift field which reduces the transit time of electrons or holes in the base region. The frequency response is considerably increased and operation up to 1,000Mc/s has been achieved.

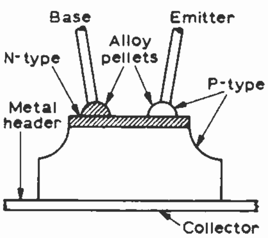


Fig. 1: Mesa transistor construction.

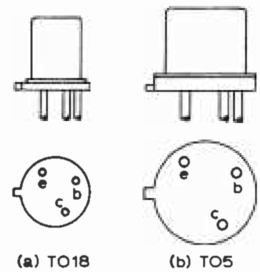


Fig. 2: Typical low-power transistor encapsulations.

Figure 1 shows a drift transistor construction which derives its name from its shape. This resembles a flat-topped mountain or mesa. In this construction a slice of p-type material is heated and placed in an atmosphere of n-type impurity such as aluminium until the aluminium has diffused into the slice to form an n-type base region. The base connection is made by alloying an n-type pellet whilst the emitter junction and connection is made by alloying a p-type pellet. The resulting p-n-p transistor is then bonded to a metal header which often forms part of the encapsulation to give good heat dissipation. The whole unit is hermetically sealed in a metal encapsulation of the familiar TO-5 or TO-18 style shown in Fig. 2 or for power transistors the TO-3 or TO-66 encapsulations shown in Fig. 3. Other encapsulations are used but these are almost regarded as the standard casings except for special purpose applications.

Mesa construction is used for both germanium and silicon transistors but as the diffusion of p-type impurities into n-type germanium is long and impractical germanium n-p-n transistors are not formed by diffusion techniques. Both p- and n-type diffusions are possible with silicon and hence silicon transistors of either type are available. Also the double-diffused mesa construction shown in Fig. 4 is used extensively in order to control the emitter junction thickness and impurity level. And as the reverse leakage current is considerably lower and the maximum operating temperature considerably higher for silicon transistors they are rapidly superseding germanium transistors as general purpose devices.

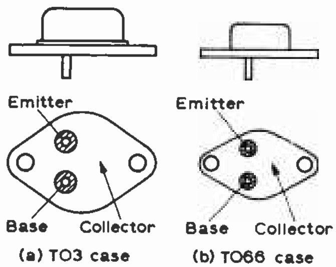


Fig. 3: Power transistor encapsulations.

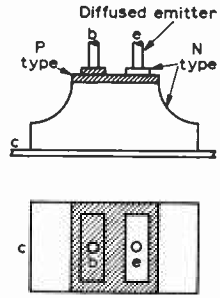


Fig. 4: Double diffused silicon n-p-n transistor.

For power transistors the drift transistor construction brings difficulties due to secondary breakdown. This phenomenon is due to currents which flow in the transistor during switch-off. The current on rapid switch-off is localised at the circumference of the junction and in power devices the high currents cause the junction to break down. This effect is minimised if a drift field is not used and hence a homogeneous, rather than drift, epitaxial or surface layer is diffused. These homotaxial transistors using the mesa construction are used for power devices.

With the popularity of silicon mesa transistors a further step in construction was to produce transistors by diffusion techniques alone—using the production of silicon dioxide, which resists diffusion and is also a good insulator, to form the basis of a photographic and etching method of construction. This resulted in the planar epitaxial form of construction.

Planar Transistors

Planar transistors are formed by the epitaxial planar construction shown in Fig. 5. The name derives from planar, meaning in planes; and epitaxial, for surface. The technique starts with n-type material which forms the collector region. A silicon dioxide layer is then formed by passing superheated steam over the slice which ultimately will produce several hundred transistors. The silicon dioxide is selectively etched away and the base

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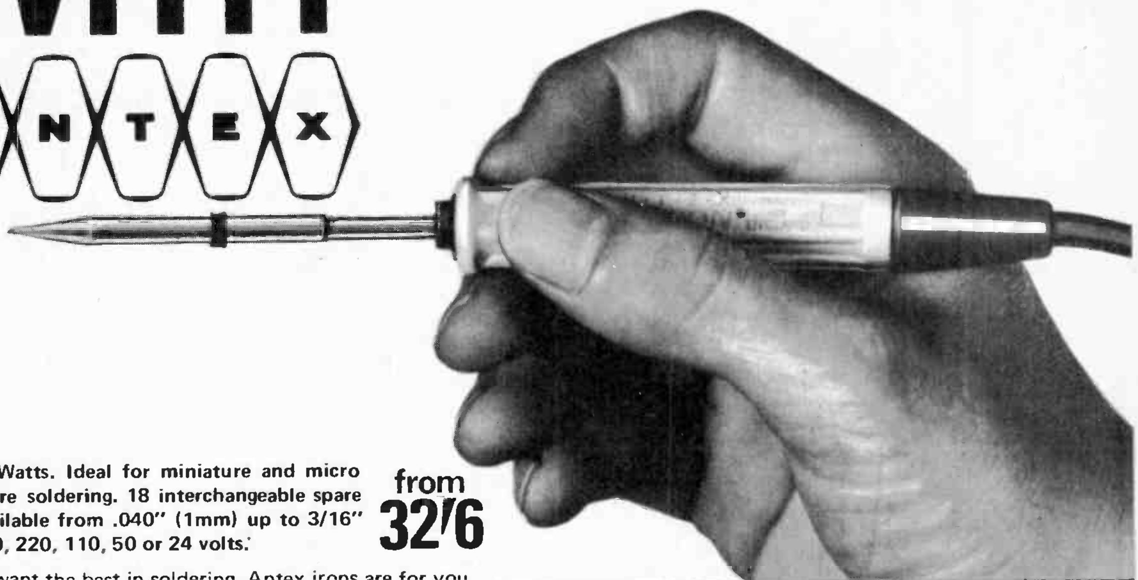

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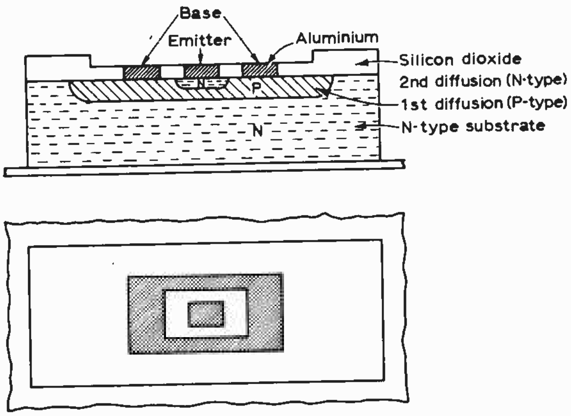

Fig. 5: Epitaxial planar transistor construction.

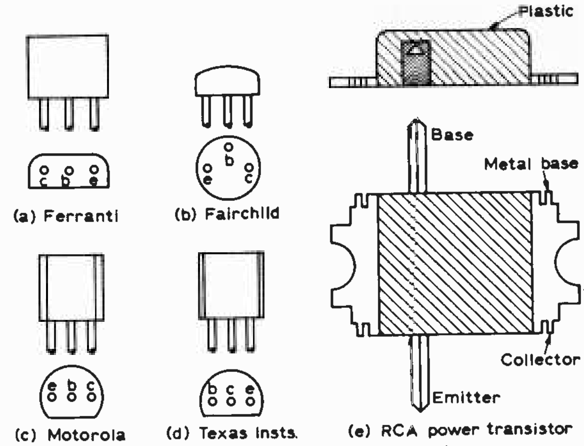

Fig. 6: Common epoxy resin encapsulations.

region formed by using a p-type impurity which diffuses where the silicon dioxide was removed. The slice is then re-oxidised to renew the dioxide layer and the emitter region etched away, an n-type diffusion then forming the emitter region. The slice is next diced into the separate transistor chips and the chips bonded to a metal header to which the lead-out wires are connected. The connections are joined to the lead-out wires by fine wires ultrasonic or heat bonded to the separate regions on the chip.

The whole device is encapsulated in a metal case of the TO-5 or power TO-3 type. Alternatively the chip is encapsulated in the new plastic encapsulations some of which are shown in Fig. 6. These plastic encapsulations are of very recent origin and have considerably lowered the price of industrial and commercial transistors but are at present not acceptable for military ratings.

The advantage of the planar construction is reliable control of physical parameters and hence better yields of the desired types of transistor. They have good high frequency characteristics, and by using a technique of producing multi-emitter regions to reduce the effects of secondary breakdown high power operation can be obtained.

The construction shown in Fig. 5 is a low frequency device: for higher frequencies a more complex geometry is used.

Table 1: Standard Semiconductor Designations

First Letter	
A	Germanium
B	Silicon
C	Group III-V material
R	Photoconductive cells and Hall effect devices or materials
Second Letter	
A	Diode
C	A.F. transistor
D	Power transistor, a.f.
E	Tunnel diode
F	H.F. transistor
H	Field probe
K	Hall generator
L	H.F. power transistor
M	Hall generator (modulator or multiplier)
P	Control and switching device, low power
S	Switching transistor
T	Power control and switching device
U	Switching power transistor
Z	Zener diode

Designation

With all transistors the device number is printed on the case. Initially, numbering was individual to each manufacturer as was the order and spacing of the lead-out wires. Now however some standardisation of casing in the TO-3, TO-5 etc. style has been achieved and lead-out wire connections are as shown in Figs. 2 and 4. Plastic cases have yet to be standardised.

Designations have standardised around the JEDEC system in the USA., such as the 2N1132 or 2N series, and in Europe the standard ACY, BFY etc. series. It is hoped that the European standard will prevail since the 2N series carries no meaning in the number whilst the European standard contains worthwhile information in the first two letters. The first letter indicates the material used in the construction and the second the general device type. The convention is detailed in Table 1.

Parameters and Cost

Thousands of different types of transistor are produced and this profusion is bewildering to say the least. If however we examine the main circuit parameters we find that in all but the most specialised applications a great many are interchangeable. The fundamental parameters to be considered in connection with interchangeability are: (1) construction and material (n-p-n, p-n-p —Si, Ge); (2) maximum voltage (V_{CEO} max); (3) maximum current (I_C max); (4) power rating (P_T); (5) frequency response (f_T); (6) current gain (h_{FE}, h_{fe}, α').

The construction and material are important since n-p-n and p-n-p transistors are not interchangeable unless all the transistors are reversed—together with polarised components and the supply voltage. Although silicon transistors can be used in place of germanium ones, often the bias supplies require alteration as the base emitter volt drop is 0·2-0·3V for germanium and 0·6-0·7V for silicon.

Provided the maximum voltage and current are not exceeded any transistor may be used and the frequency characteristics should match. Power rating is important and in general for the same case size silicon transistors can replace germanium types. Providing these requirements are met current gain matching can be determined by simple substitution.

In specialist applications, such as switching, the saturation volt drop $V_{CE\,sat}$ is important but again substitution is usually a sufficient test.

Many transistors are interchangeable and the experimenter should never be deterred from trial and error as a means of determining whether an available type can be used.

Why there are so many different types is a question which is highly relevant. This is due to the large number of manufacturers and the yield of several types from each basic production unit. From this it can be seen that the cost of a transistor depends largely on the production yield, parameters and market requirement for a given type. Specialist devices are expensive but general purpose widely used transistors are cheap. Transistors with specialist parameters are often expensive simply because the demand is small. Therefore only popular devices should be used in circuit design.

General purpose low frequency transistors are available at 2s. 6d. to 5s. but £5 can be the price of similar devices. Power transistors range from 7s. to £2 for low frequency types but from £5 to £37 for high frequency working. Low power high frequency types are available at from 10s. to £10 for 1,000Mc/s. High voltage devices at low power are available from 4s. 6d. to £3. For silicon transistors generally n-p-n types are cheaper than p-n-p and plastic encapsulated devices are often half the price of their metal-cased counterparts.

The Future

As techniques improve and demand increases transistor prices will fall. Plastic encapsulation will find widespread application whilst the demand for germanium devices, exept in specialist applications, will fall.

It is entirely probable that improved manufacture of f.e.t.s will considerably affect transistor usage whilst further inventions are likely to render obsolete the construction and application of transistors as we know them today.

TO BE CONTINUED

THE MW COLUMN

ALTHOUGH when we are talking about MW DX we are generally referring to signals from North or South America, Africa or Asia, there are some interesting and rare catches to be had within continental Europe. There are 34 distinct countries in Europe with MW broadcasting stations (two countries, San Marino and Liechtenstein have none) and of course many of these are easily heard even during daylight. During the evening the band is crammed with over a thousand stations and to pick out the unusual ones takes perhaps even more skill and patience than waiting until conditions are favourable for transatlantic signals.

Listen out for the Azores, Portuguese islands in the Atlantic with four stations, CSA97(836); CSB81 (1570); CSB80(1394) and the US Forces Station (1500). The Faroes, Danish islands north of the Shetlands, can sometimes be heard before close down at 2000 hrs. on 548. Iceland can be heard fairly easily over its LW stations but for the purist there are several MW stations, most of these are of flea-power but the stations on 665 and 737 are occasionally heard.

Gibraltar has been heard, but very rarely, on 1484, the International Common Frequency, broadcasting in English and Spanish. Although *Manx Radio* using only 50W is heard fairly well in Lancashire and North Wales on good equipment it can be heard during daylight throughout the country on 1295 when the BBC European Service on the same frequency is not on the air.

The only other countries that could possibly be classed as DX areas are Greece, Malta and Turkey, Greece broadcasting on 665, 728, 791 and 1007. There are several other low-powered stations but these are rarely heard. The *VOA* station on Rhodes can easily be heard on 1259 in a variety of languages. Turkey has two stations in Europe, a high power one on 701 and a 2kW one on 963. Malta can be heard occasionally through the BBC Relay on 1178 in Arabic but there are two other stations, *BFBS* on 1425 and *Radio Malta* on 1214; due to BBC *Radio 1* using 1214 *Radio Malta* would indeed be a prize catch.

Searching for these Europeans should be ideal for the enthusiast who doesn't fancy the idea of waiting till after midnight before even starting.

Radio Andorra on 701 is reported to be testing with English programmes after midnight and if this ever gets off the ground they may try to become a second *Radio Luxembourg*. Several of the European stations have English programmes in the late evening as a limited sort of overseas service, and all these will readily confirm and will send schedules. In the case of the Eastern European stations they will often send literature for years. The author is still receiving programme schedules, free records and competition forms from *Radio Budapest* even though only one report was sent—eight years ago!

European stations can also often provide a guide to the general conditions. If stations in Portugal and Spain are heard clearly the reception path across the Atlantic will usually be good. ■

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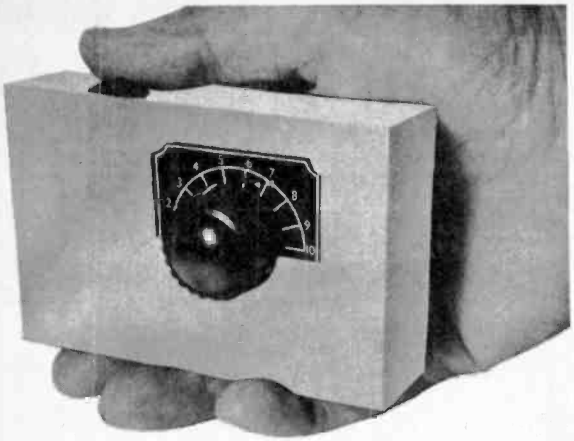


A SLIMLINE SUPERHET

F. G. RAYER

★★★

POCKET receivers often use reflexed t.r.f. circuits, and although these can give good results, some constructors may prefer a superhet. The one described here is built with standard and readily available transistor type components, and is approximately $4\frac{3}{8} \times 2\frac{7}{8} \times 1$in. external dimensions, including battery. It is a 4-transistor superhet circuit giving excellent headphone results.

Figure 1 is the circuit, the aerial L1 and oscillator coil L2 being tuned by a midget 192/78pF ganged capacitor, fitted with 15pF trimmers. AF117 transistors are used in mixer and i.f. stage, and IFT1 is double-tuned. IFT2 is single-tuned, and works into the emitter detector/amplifier Tr3. Automatic gain control bias to Tr2 is through R6. This type of circuit performs very well, and Tr4 is an audio amplifier, giving adequate output for phones or a personal earpiece.

The receiver is wired in three sections, and fitted together afterwards.

(1) $4\frac{3}{8} \times 2\frac{7}{8}$in. front panel, carrying ferrite rod, volume control with switch, and ganged capacitor.

(2) Mixer and intermediate frequency amplifier, assembled on an insulated board $3\frac{1}{16} \times \frac{7}{8}$in.

(3) Detector/audio amplifier, on a $1\frac{1}{2} \times 1$in. board.

If alternative components are used, it would be wise to see that these will fit, as there is only a little free space.

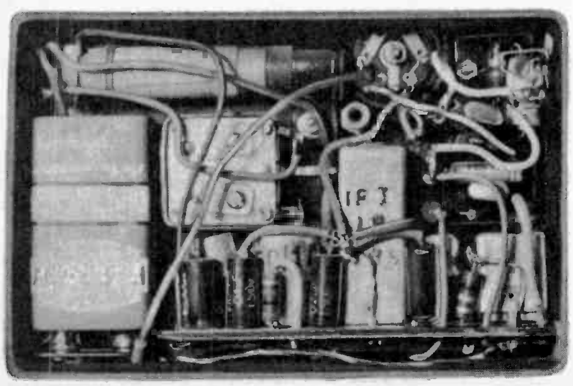
Front Panel

The panel is wired as in Fig. 2, the mixer, i.f. and audio sections being omitted. VR1 is mounted with a small bolt so that it will project through a slot in the case side. VC1/2 is attached with two bolts.

The aerial listed is for a longer rod, and the ferrite rod actually needed here is $2\frac{3}{8}$ to $2\frac{1}{2}$in. long, and $\frac{3}{8}$in. in diameter. A piece this size was broken from a longer rod by gripping the rod quite tightly $2\frac{3}{8}$in. from one end in a vice, and snapping it off. The rod is fixed by a band of insulating material, which passes round it at one end, and is secured with a bolt.

The aerial and oscillator coil L2 are of a type intended for 208pF aerial tuning, and 176pF with a series padder in the oscillator section. The ganged capacitor used here has an aerial section tag A, rotor tag E, and oscillator section tag O, Fig. 2, and alignment was found satisfactory. No series padder is used with L2. For the AF117 mixer transistor, the base coupling winding requires four turns. Aerials made for other transistors may have more turns here. If so, turns should be removed.

Leads to L1 can be solid wire, arranged to permit a little movement of L1 on the ferrite rod, if required later.



The Mixer/IF Section

A piece of $\frac{1}{16}$in. paxolin sheet is cut and drilled to take the components as in Fig. 3. With the oscillator coil L2, a coloured dot is between pins 1 and 6. Pins on the i.f.t.s have closer spacing between 1 and 2, and 5 and 6. These components need to be fitted over holes so that the cores can be reached. Tags from the metal cans of L2, IFT1 and IFT2 are wired together and to the positive or "earth" line of the receiver.

Insulated sleeving should be placed on all leads. The transistors are fitted last, passing their leads down through the correct holes. Put on suitable pieces of sleeving, bend the leads over, and solder them to the other circuit points, afterwards snipping off unwanted wire. Be sure that transistor leads on top of the board cannot touch each other, or bare parts. Pieces of sleeving about $\frac{1}{4}$ to $\frac{3}{8}$in. long can be put on these leads in advance.

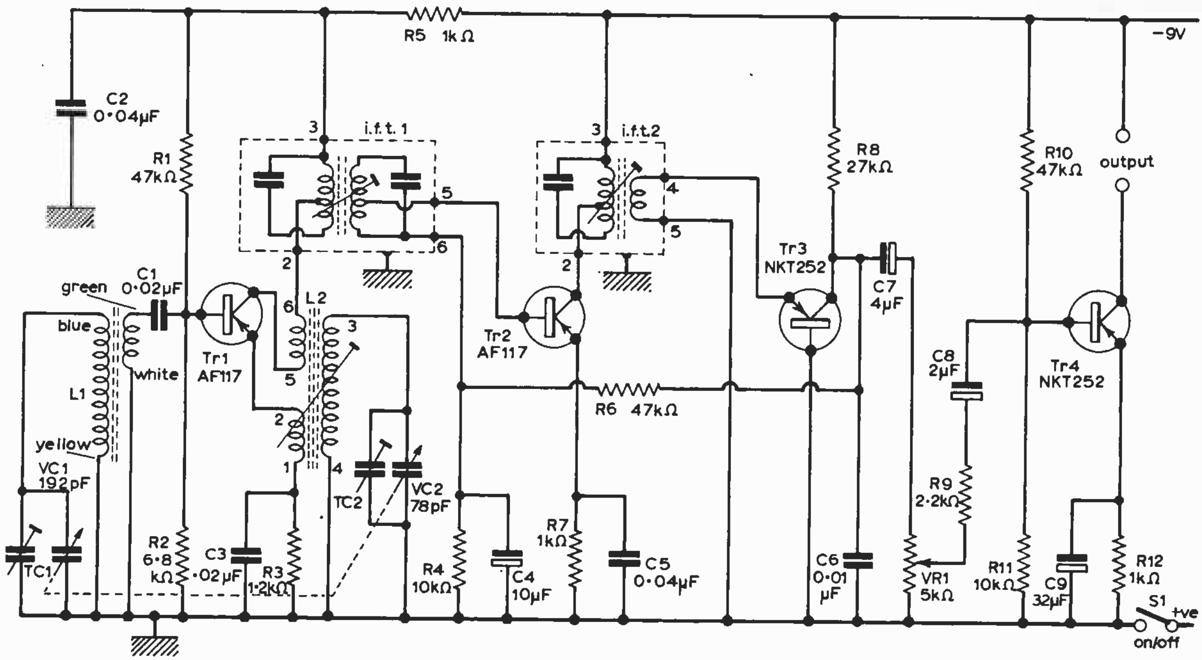


Fig. 1: Circuit of the Slimline Superhet, suitable for driving headphones or a personal earpiece.

The finished mixer/i.f. section is later attached to the panel by two small, countersunk 8BA bolts, which pass through the brackets in Fig. 3. These brackets are cut from thin metal, drilled, and soldered in place. One is soldered to the can tag of IFT1, while the second bracket is soldered to a can tag and pin 5 of IFT2.

C2, C3, C5, R3, R7, VC1/2 (E) and VR1/S1 are all joined near IFT1 (Fig. 3), and a lead passes down through the board to the earth (positive) line, Fig. 2.

When the mixer/i.f. section is fixed to the panel, the four adjustable cores can be reached with a suitable insulated tool.

C1 is wired to L1 green tag, and the earth circuits made to VC1/2 and VR1/S1, as mentioned (Fig. 2). A wire is prepared to run from pin 6 of IFT1 to R6. Other leads will run to the negative line at R8 and R10, and from the positive line of the i.f. section to positive on the audio circuit board.

Detector and Amplifier

Tr3 and Tr4 are on the audio amplifier board, Fig. 4. This is cut away to clear the milled rim of VR1. When this section is completed, it is mounted with a small bolt and spacer.

A lead passes from Tr3 emitter to pin 4 of IFT2. R6 is connected to pin 6 of IFT1. Leads run from C7 to VR1, and from C8 to R9, which is soldered directly to VR1 as in Fig. 2.

Battery negative goes to R8/R10, and also the mixer/i.f. section at pin 3 of IFT2. Battery positive is connected to S1, as in Fig. 2. The insulated strip, with snap fasteners, from an old battery can be used as battery connector. Remember to observe the polarity shown on the *battery*.

Two leads run from R10 (negative line) and the collector of Tr4. These connect to a miniature jack, for the headphones or a personal earpiece.

When the two small circuit boards have been fixed to the panel, the receiver should be tested, and i.f., aerial and oscillator circuits adjusted.

★ components list

Resistors:

R1	47kΩ	R7	1kΩ
R2	6·8kΩ	R8	27kΩ
R3	1·2kΩ	R9	2·2kΩ
R4	10kΩ	R10	47kΩ
R5	1kΩ	R11	10kΩ
R6	47kΩ	R12	1kΩ

VR1 5kΩ miniature log. pot. with switch
All resistors ¼ watt 10%

Capacitors:

C1 0·02μF 150V Hunts miniature
C2 0·04μF 150V Hunts miniature
C3 0·02μF 150V Hunts miniature
C4 10μF 6V electrolytic
C5 0·04μF 150V Hunts miniature
C6 0·01μF 150V Hunts miniature
C7 4μF 6V electrolytic
C8 2μF 6V electrolytic
C9 32μF 6V electrolytic
VC1/VC2/TC1/TC2 Jackson Delemin 192/78pF with 15pF trimmers

Coils and Transformers:

L1 Weyrad RA2W (medium wave only)
L2 Weyrad P50/1AC
IFT1 Denco IFT 18/465
IFT2 Denco IFT 14/465

Transistors:

Tr1	AF117	Tr3	NKT252
Tr2	AF117	Tr4	NKT252

Miscellaneous:

1/16in. sheet paxolin. Miniature jack and plug. PP3 battery. Knob, 1mm sleeving, etc.

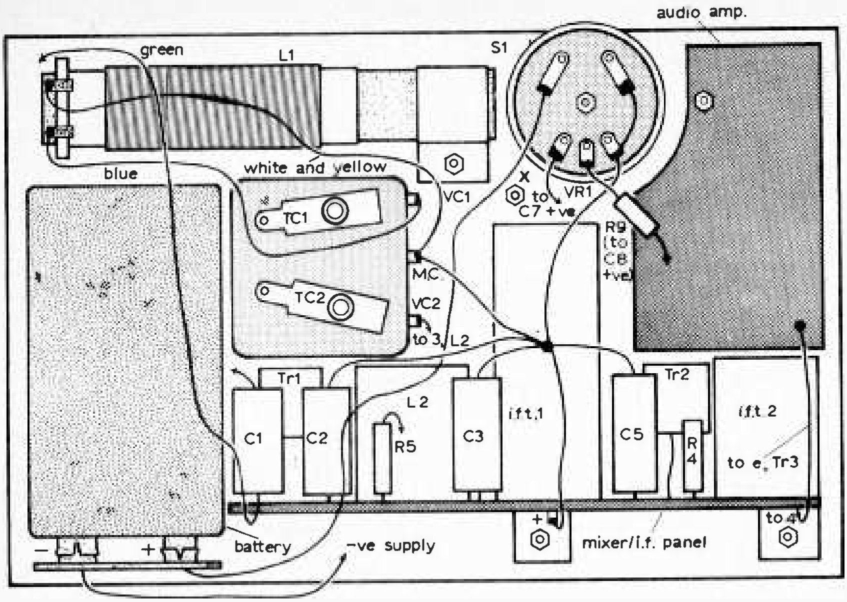


Fig. 2: General layout and inter-module wiring.

Alignment

A modulated 465kHz signal may be injected at the base of Tr1, and the cores of IFT1 and IFT2 rotated for best volume. If alignment is so far in error that no signals are obtained by this means, inject at 5 on IFT1 and adjust the core of IFT2. Then inject at 2 on IFT1 and adjust the second core. Afterwards inject at Tr1 base or collector, and adjust the first core of IFT1, and check adjustment of all cores.

To make these adjustments without a signal generator, tune in a transmission and rotate the cores for best volume. This is afterwards checked with a weak signal.

To align L1 and L2, first unscrew TC1 and TC2 about half-way. Set VC1/2 at maximum capacitance, and rotate the core of L2 to set the low-frequency band edge to about 600kHz (or so that Radio 3 is tuned with VC1/2 nearly closed). At the same time move L1 on the rod for best results.

Open VC1/2 to near minimum capacity, and adjust TC1 and TC2 for best results with a 1,500kHz signal from the generator, or for reception of Radio Luxembourg.

Adjustments should be repeated, and checked over the band, for best results.

Case

Using $\frac{1}{16}$in. thick paxolin throughout, the top and bottom of the case are cut to $4\frac{3}{8} \times \frac{7}{8}$in., one piece being cut to clear VR1. The sides are $2\frac{3}{4}$in. long by $\frac{7}{8}$in. wide, and are cemented to the panel.

The terminal head X, Fig. 2, is fixed to the panel by means of a very short countersunk bolt. A screw is run into this terminal head from behind, to hold the back of the case.

Patterned material as used for covering boxes, etc., was cut to cover the front panel and sides, and to fold over about $\frac{1}{4}$in. or so inside the case.

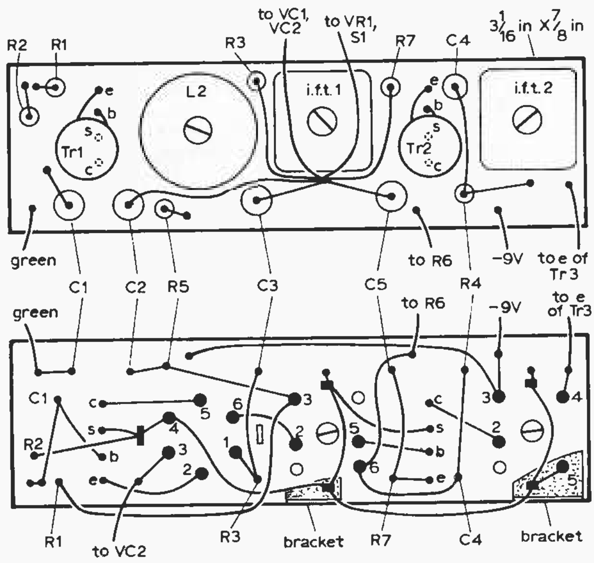


Fig. 3: The r.f. and i.f. amplifier component board.

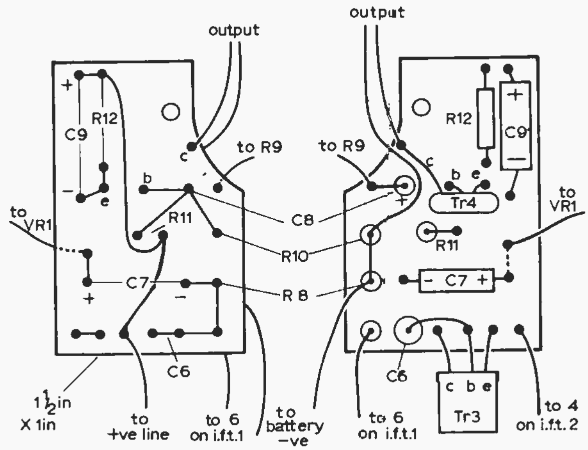


Fig. 4: The detector and audio stages.

Tuning Dial

The dial had white markings on a black background, from Set 6 (Dials) "Radio Constructor" panel transfers.

The tuning knob is a $1\frac{1}{8}$in diameter knob, with a white spot placed near the edge, to read against the tuning scale. A very small knob makes tuning rather critical.

The back of the receiver is $2\frac{7}{8} \times 4\frac{3}{8}$in., with a hole drilled opposite terminal head X. Some small pieces of paxolin are cemented to the inside of the back, and rest inside the case when the back is in place. It is then held correctly in position by the single bolt. ■

TRANSISTOR

MANY engineers who could build a valve amplifier without the need to refer to a circuit diagram feel totally lost when tackling transistor power output stages. Part of the trouble is due to the nature of the transistor, so easily damaged by excessive current and requiring heatsinks to avoid excessive temperature rise, and part to the confusing stream of different transistor characteristics which have been used in the past. This article attempts to clear up some of those difficulties.

The Need for Power Output

When an amplifier is used to drive the deflection plates of a cathode ray tube, the amplifier has to raise and lower the voltage on the plates, but, because the plates have no other connections, the amplifier does not have to supply any current. If the same amplifier had to raise and lower the voltage across a resistor, it would also have to raise and lower the current through the resistor, because the voltage across any resistor is its resistance times the current through it (V=IR), which is Ohm's law.

When an amplifier has to supply *both* voltage and current signals, and the maximum voltage signal occurs at the same time as the maximum current signal (as it must with a resistor) or nearly at the same time (with loudspeakers), then the amplifier is supplying power. This power can be measured in a variety of ways. If the amplifier supplies its power to a resistor, the resistor will be heated by the power and the temperature rise can be used to measure the amount of power used or *dissipated,* provided we know what amount of power causes a given temperature rise. This method is often used for microwave amplifiers when other readings are difficult. Alternatively we may measure the voltage across the resistor and current through it with a meter which reads r.m.s. units and multiply the two together to give power. When volts d.c. are multiplied by amps d.c., the result is power in watts. R.M.S. meters are a.c. meters which are scaled so that the same multiplication gives the correct result in watts for a sine wave, but other waveforms, and other meters or cathode ray oscilloscopes, will give readings for voltage and current which cannot be multiplied so readily, and a conversion table is given.

Table I

When using a meter which measures in peak volts and is scaled in R.M.S. volts (for example, any moving coil and rectifier type of meter).

Waveform	To find power
Sine	V × A as read on meter
Sawtooth	2/3 × V × A
Square	2 × V × A

The need to supply both voltage and current restricts the sort of amplifier which we can use. Suppose, for example, we have a valve with an anode load of $100k\Omega$ and a line voltage of 1,000V. Then with no current through the valve, the anode voltage is 1,000V, and with 10mA flowing the anode voltage is 0V. This stage can give a voltage signal of 1,000V but a current signal of only 10mA, since these are the ranges of voltage and current available, so that it would be totally unsuitable for delivering large amounts of power to a load of 3 ohms (for example).

Matching Loads

Any amplifying device, valve or transistor, has an *internal impedance,* which measures its resistance to current flowing through it and in some cases restricts the amount of signal current flowing. When triode valves are used, the maximum power output is obtained when the load resistance R_l equals the internal resistance R_a. This piece of advice was so thoroughly drilled into the heads of designers in the valve era that it still persists even now that the use of triodes for output stages is practically obsolete. Pentode valves deliver a signal current that is almost constant despite changes in anode voltage, which is another way of saying that they have a high internal impedance.

On the maximum power theory, they would require a very high load impedance for maximum power. This is true, but a *slightly* smaller power can be delivered at much less distortion into a smaller load, and this is the value of load recommended for such valves. Transistors are a separate case again; the signal current is almost independent of collector voltage (high impedance) *but* very high currents can pass at quite low voltages.

This point often causes confusion; the "high impendance" transistor passes high currents at low voltages, which *seems* to indicate low impedance, but we are talking of two different things. The impedance is represented by the change of current with collector voltage *for a fixed bias;* impedance$=\frac{\text{voltage change}}{\text{current change.}}$ When we bias the transistor full on and measure the voltage across it and the current through it and do the same sum of $\frac{\text{volts}}{\text{current}}$ we are simply measuring the resistance of the transistor to d.c., not to signals. This quantity should be called *Perveance*. It is well known to the user of transmitting valves used with positive grid voltages because it indicates the current which the valve can supply at low anode voltages.

All this means that our matching of transistors must be for best undistorted output and that it is unwise to bias a transistor hard on while the full line voltage is on the collectors, since a very high current will flow.

Single-ended Stages

When a single valve or transistor or a group wired in parallel is used to deliver power to a load, this is termed a *single-ended* stage. We bias such a stage so that the bias current is about half the maximum current we wish to take from the output, and we load so that the voltage at anode or collector is minimum (about 30V for a valve, 1V for a transistor) at maximum current. If the load we wish to use differs from the calculated ideal load, we use a transformer for matching, with a turns ratio N:1 equal to $\frac{\text{Primary load}}{\text{Secondary load}}$ where N is the ratio of primary turns to secondary turns. With valves, this procedure is quick and straightforward; with transistors, almost always impossible. To start with, when a valve is biased, and no signal is being amplified, there is power dissipated in the valve equal to anode voltage times anode current. This power appears when the current in the valve strikes the anode and heats it up; this heat must be lost by radiation, but does not affect the working of the valve, since electrons move through the vacuum unaffected by the temperature of their surroundings. When a transistor is biased in this way, the heat is generated inside the semiconductor crystal and spreads throughout it. The effect of this is to make the crystal more conducting so that more heat is generated, and the situation can end up with the whole crystal melting, a catastrophe called *Thermal Runaway*.

A fair degree of protection can be obtained if the bias can also change with temperature, or can be regulated to keep the current fairly constant. This may involve a thermistor to reduce bias (Fig. 1) as temperature increases (the thermistor being attached to the transistor to short its temperature) or biasing with a network which holds the base at a constant voltage and using an emitter resistor so that any increase of emitter current automatically reduces bias (Fig. 2). The second method is better, since the emitter resistor can be chosen to prevent excessive current ever flowing, but the emitter resistor dissipates some power so that less can be used in the load.

Another method which has been used is to rectify some of the output signal and use it to increase the bias current when large signals are being amplified. In this way a low bias can be set for normal use without excessive distortion on large signals. This method, called *sliding bias*, is seldom seen due to the difficulties of setting the time constants of the rectifying circuit so that the response is quick enough to avoid undue distortion at the start of a loud passage and yet slow enough to avoid oscillation due to feedback of signal. A typical sliding bias circuit is shown in Fig. 3.

Single-ended output stages are wasteful in the sense

I. R. SINCLAIR

OUTPUT STAGES

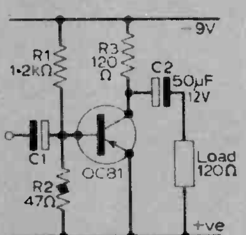


Fig. 1: A single-ended stage using thermistor compensation. If the voltage at A is less than half the line voltage, thermal runaway cannot cause damage. R3 may be used as the load if bias current can be passed through the load (not suitable for use with a loudspeaker)

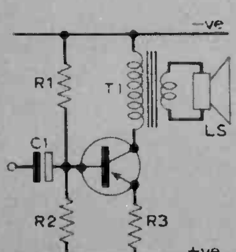


Fig. 2: A transformer coupled output stage. R3 is usually small, 1-10Ω, depending on the bias current so that about 0·5 volt is dropped across it. R1 and R2 are low value resistors, and R2 may be a thermistor for greater protection. R3 could be a torch bulb.

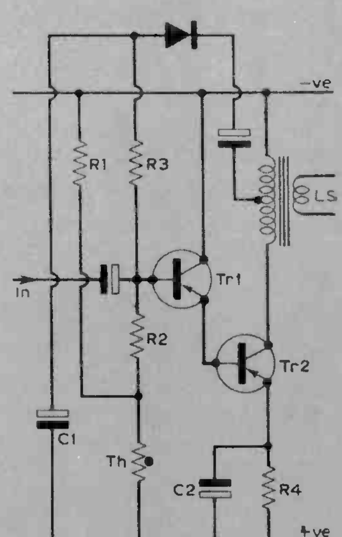


Fig. 3: A sliding bias amplifier. The current fed back by the rectifier must exceed the input signal current, and C1 must be chosen so that there is not too much time-lag between the signal and bias. Too small a value of C will cause severe distortion of low frequencies.

that the bias causes most of the wattage to be dissipated in the transistor and very little in the load, though they are fairly cheap in terms of component costs. Their main application is in car radios, where the bias current is only a small load on the power supply. When power is supplied by rectifying a.c., single-ended stages are seldom used because the large steady current demand makes it very difficult to obtain a supply free from mains hum.

Push-Pull Transformer—coupled

The basic circuit is shown in Fig. 4. The transistor may be biased in Class A, meaning a bias current of about half of the maximum signal current required, in

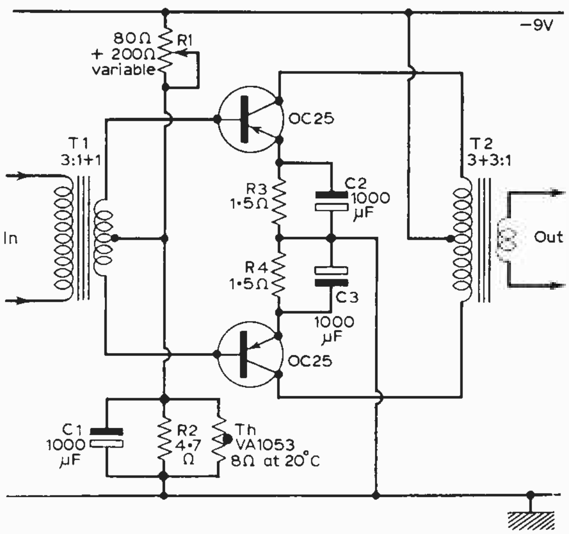


Fig. 4: A push-pull transformer coupled amplifier.

which case the disadvantages are the same as for the single-ended stage, excessive heat, danger of thermal runaway and large standing current drawn from the power supply. The use of push-pull does, however, avoid the hum from the power supply appearing in the output signal (provided it is not present in the input signal).

The bias can be reduced, so that the transistors work

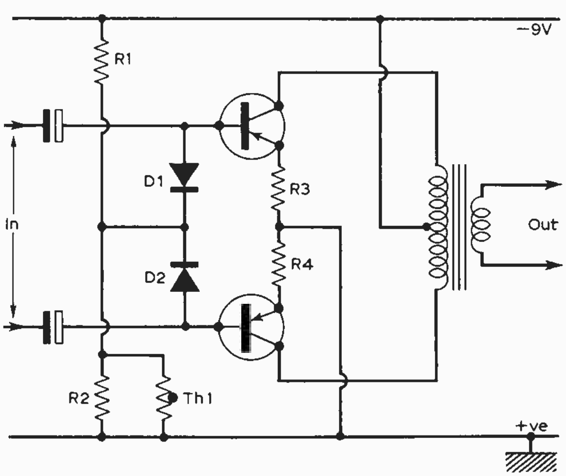


Fig. 5: A re-arrangement of Fig. 4 which is useful where a low supply voltage has to be used. The voltage at each collector becomes double the supply.

in Class AB, with both conducting but not passing as much as half of maximum signal current or in Class B where the bias current is almost zero, and each transistor conducts only when the signal input is in the forward direction of bias. The class AB circuit of Fig. 5 is capable of good results, and the transformer is easily made, yet this circuit does not seem to have been widely used, despite its very close resemblance to the equivalent valve circuit. Perhaps this has been due to the wide publicity given to circuits (dealt with later) which use no transformers, but which do not necessarily benefit thereby. The circuit of Fig. 5 is extremely useful where supply voltage is limited, as the effect of the transformer is to make the maximum voltage at each collector double the supply voltage.

Class B circuits can be used, but distort badly at low signal levels. They are useful in devices such as loud hailers or guitar amplifiers but not when close resemblance to the original sound is required.

The Totem-pole Circuit

Officially this circuit is known in this country as the "single-ended Push Pull", but the American name is much more descriptive. In outline, the circuit is as in Fig. 6. Two transistors are connected in series and driven so that they conduct alternately. Such an arrangement could be used in Class A, but is usually used in Class AB or B, and is the output stage used in the majority of transistor amplifiers. No output transformer is required, though, in some American designs, an autotransformer output is used so that loads of different impedances can be used. When the load is coupled directly, one transistor connects the load to line voltage when conducting and the other connects the load to earth. In most designs, the load is the greatest impedance in the circuit, and very large currents can flow through the output transistors if a signal is applied to them with a low impedance load connected or the load shorted. For this reason, output circuits of this type need protection against excessive current, usually in the form of low ohmage resistors, fuses or lamps in the emitter of the output transistors.

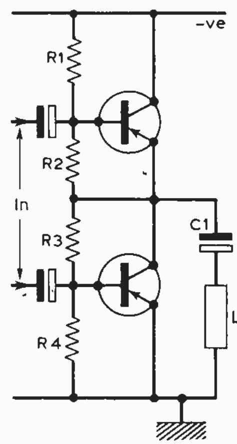


Fig. 6: A single-ended push-pull or totem-pole amplifier.

Summing up the output power and transistor dissipation for transistors used in this circuit:

$$\text{Power Out} = \frac{V_c^2}{R_l} \qquad \text{Power Dissipated} = A \times \frac{V_c^2}{R_l}$$

	Sine wave	*"Music"*	*Square wave*
A is	1/40	1/50	1/30

The Totem-pole circuit can be seen in three distinct forms, depending mainly on the way in which the input is applied: by a transformer, by driving transistors, or as a single phase input to a complementary pair output.

NEXT MONTH: TRANSFORMERLESS AMPLIFIERS AND THERMAL CALCULATIONS

LETTERS...

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

Turning a deaf ear!

At the risk of making a complicated situation even more incomprehensible I would like to call attention to certain aspects of Mr. Iain Smith's letter published in February.

He states that, apart from certain cheap amplifiers which include a "loudness" control as a gimmick, many manufacturers provide this facility on their equipment under the *misconceived* notion that some compensation should exist to boost bass frequencies when the volume is reduced. In practice he suggests that this is not required because, for example, during a live concert if one moved from the front towards the back of the auditorium the sound would normally appear to fall with more noticeable loss in the lower frequency range. This, of course, is quite true. But then it presupposes that the situation is always of this form and that the intention is to make the sound seem a long way off whenever an amplifier has its gain reduced. It further suggests that it should be normal to shift the apparent sound source every time we adjust the volume control! And perhaps, even more ludicrously, that whenever an orchestra decides to play quietly it suddenly moves *en masse* to perform in some remote position outside the hall!

Fundamentally (provided we remain seated) none of these "loudness" distortions seem to occur during a live performance—why? We are all aware that an orchestra can deliberately create the illusion of playing a long distance away, but it can equally well play *quietly* and not give this impression. This, I suggest, is brought about by the effect of normal audition among the members of the orchestra; i.e. they are only able to create these effects by consciously monitoring (in conjunction with the conductor) the sounds they make and adjusting the amplitude accordingly. All these amplitude adjustments are necessarily made with reference to what the conductor's concept is of the sound produced by his orchestra playing at "full voice".

However, "we in our living rooms" cannot use the "full voice" reference without blowing several windows out, so naturally we keep the volume level much lower. By doing this, though, we automatically change the reference point, but forget that our hearing response remains substantially the same. Therefore if, for example, we are listening to a recording of some music which up till now has remained at a satisfactory level, and then suddenly drops to a low intensity during a quiet passage, it will now sound far off and quite unrealistic. The only way in which this can be countered is by judicious use of a loudness control. It then matters little *where* the initial reference is.

Incidentally, Mr. Smith does not seem to mention that to a slightly less extent the ears' response *also* falls off with reduction in the intensity of treble. Most manufacturers take care of this in their design of loudness correction circuits.—**G. C. Brown** (*Hampshire*).

A lady replies

While leafing through my husband's copy of PRACTICAL WIRELESS, the contents of which are invariably beyond the comprehension of my housewife's brain, I noticed among the letters one concerning loudness control.

I would point out to any reader who considers that the further away one sits from an orchestra at a live performance, the less bass one hears, that this is not entirely true. Casting my mind back to my school days, when I was a regular concert-goer, it seems to me that one's distance from the orchestra is compensated for by the acoustics of the concert-hall. I am thinking in particular of the Free Trade Hall in Manchester, where our pocket money limited us to the cheapest seats, either the very back of the "Gods" or the front eight rows of the stalls. I can't honestly remember noticing any difference in the amount of bass that came over nor did it seem to me that the sound heard at the very back was murky or obscure, as Mr. Iain Smith suggests. This may, of course, be due to the fact that I am a music-lover, not an electronics enthusiast.

Having made this admission I would like to state my reasons for writing. My husband is at the moment, constructing a hi-fi unit, and since he asked my opinion as to whether the loudness control was an improvement, I gave the matter a little consideration and now feel that I am as well qualified as most electronics experts and amateurs to state my views on what is, after all, a matter of individual taste.—**Susan Jebb** (*Warwickshire*).

The (w)hole truth?

That you should publish an article and a letter (B. R. Meredith, March P.W.) stating that hole theory is fiction shows editorial irresponsibility, I believe. To compare thermionic valve action to transistor action is as irrelevant as to compare the working of steam and diesel engines. It is a fact (unfortunately?) that the action of semiconductor devices cannot be explained *quantitatively* without holes. Current flow in semiconductors *does* take place by two distinct mechanisms. I can just believe that Mr. Meredith may be able to describe *qualitatively* transistor action without direct reference to holes. I defy him to produce a plausible explanation of the Hall Effect without introducing the concept of holes. Simple experiments based on this effect prove that there are in deed two different conduction processes in semiconductor materials.

It is certainly beyond the scope of your magazine to consider the band theory of solids in sufficient quantitative detail to demonstrate the existence of the hole. But you should not lead your readers astray by printing such dogmatic letters as Mr. Meredith's without comment.

I do not class myself as an "acknowledged expert": I am a third year undergraduate studying for the "Electrical Sciences Tripos".

I have read PRACTICAL WIRELESS regularly for about seven years. As a result, my interest in electronics has steadily increased. **R. F. Pannett** (*Trinity College, Cambridge*)

Anybody heard of these?

I recently acquired some TK3IC JY and TK3IC NB transistors and can find no reference to them in any of the books I have.

I wonder if any fellow readers could possibly supply me with simple circuits which use such devices?—**J. Boot** (38 *Gowing Road, Hellesdon, Norwich, NOR 4OM*).

TAKE 20

JULIAN ANDERSON

A SERIES OF TRANSISTOR PROJECTS, EACH USING LESS THAN TWENTY COMPONENTS AND COSTING LESS THAN TWENTY SHILLINGS TO BUILD.

No. 2 an audio oscillator

WHEN building or testing equipment a source of sound is always useful. This can be supplied by all sorts of equipment, best of all a full range constant level audio oscillator, but a very simple source and one of the most useful is a transistor phase shift oscillator. Unlike the other commoner sine wave generators this uses only one transistor.

THE CIRCUIT

From the circuit diagram in Fig. 1 it will be seen that the output of Tr1 is taken from the collector and fed back to the base via a RC network comprising R1, R2 and R4 and C1, C2 and C3. The values of these components determines the output frequency. The network itself changes the phase at one particular frequency by 360° resulting in positive feedback and consequently oscillation. The losses in the network are quite high and a gain of 29 times must be obtained from the transistor for it to work. The transistor used in the prototype was an OC170, but almost any transistor giving enough gain could be used. The output impedance of the unit is high and if it is being used to feed into a transistor amplifier (where the impedances are generally fairly low) a 100kΩ resistor should be fitted in the lead to the equipment; with this the unit will still oscillate even if the ends are shorted.

The actual frequency can be calculated by the formula $f=\frac{\sqrt{6}}{CR}$ but it will be found that the internal resistances and capacities of the actual transistor used will alter this.

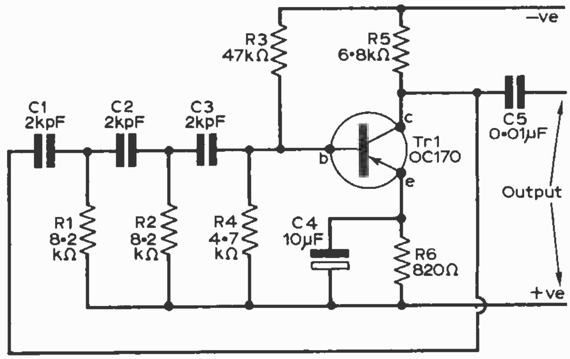


Fig. 1: The circuit of the phase shift oscillator. The voltage is 9v, supplied by any battery.

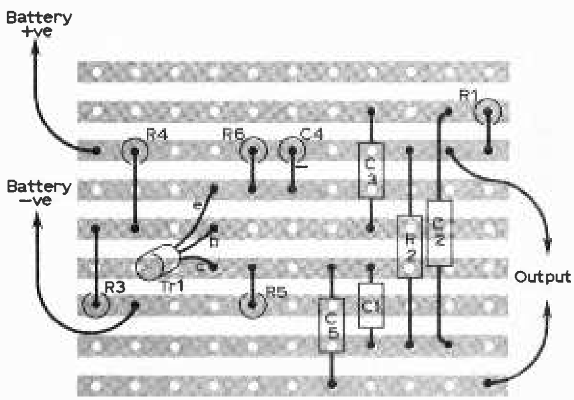


Fig. 2: The component layout; there are no breaks in the Veroboard copper strip.

★ components list

Resistors:

R1 8·2kΩ	R4 4·7kΩ
R2 8·2kΩ	R5 6·8kΩ
R3 47kΩ	R6 820Ω

All resistors ¼ watt miniature types.

Capacitors:

C1 2,000pF	C4 10μF 9V
C2 2,000pF	C5 0·01μF
C3 2,000pF	

Transistor OC170—see text.

9v Battery, Veroboard 1¾ x 1⅜in., on/off switch.

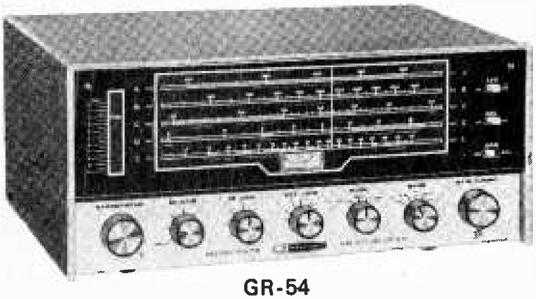
If one is lucky enough to have an oscilloscope the unit may be used very successfully for tracing the waveform through an amplifier. In addition it may be used to feed a Schmitt trigger for producing square waves.

The actual building of the phase shift oscillator presents no problems, all the components can be mounted on a piece of Veroboard 1¾ x 1⅜in.; no breaks are necessary in the copper strip.

If the unit is built into a copper tube about 1in. diameter, a small push button can be mounted at one end and a probe protruding from the other, an extremely useful audio signal injector will be added to your test gear. ■

"Listen in" on the World with HEATHKIT shortwave receivers

TREAT YOURSELF TO A WORLD TOUR . . . *WITHOUT LEAVING HOME!*



GR-54

DELUXE 5 BAND SHORTWAVE RECEIVER GR-54

This receiver offers exceptional performance and many special features at such a low price. It covers 2MHz to 30MHz plus 550KHz to 1550KHz AM broadcast band and 150KHz to 420KHz aeronautical and radio navigation band. Receives AM/CW/SSB, 6 x 4in. PM speaker and sleek, "low-boy" styling. Operates on 115–230V 50Hz AC.

Kit K/GR-54 £44.0.0. Carr. 9/-

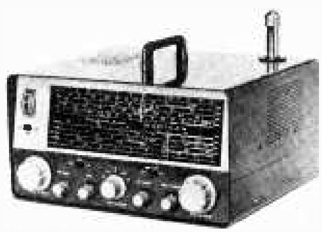
LOW COST 4 BAND SHORTWAVE RECEIVER GR-64

Makes an ideal present for the youngster. It has high performance features plus world-wide reception, shipping, aircraft, radio amateurs plus the popular medium broadcast band. It covers 1MHz to 30MHz plus 550KHz to 1620KHz AM, with sleek "low-boy" styling, operates on 115–250V 50Hz AC.

Kit K/GR-64 £22.8.0. Carr. 9/-

GR-64

GENERAL COVERAGE RECEIVER GC-1U



A welcome traveller wherever you go! Covers 580 to 1550 KHz and 1·69 to 30MHz in 5 bands with calibrated bandspread scales for 80, 40, 20, 15 and 10 metre amateur bands. Completely solid state and self contained for portability. Operates on two internal PP6 batteries (not supplied) or 230V AC with a suitable power supply.

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Unequalled value for the radio amateur. Covers 160 to 10 metres. High quality lattice crystal filter for optimum communications selectivity. Optional 100KHz crystal calibrator plugs in inside receiver. 8 valve and 2 diode circuit. Operates on 115, 200–250V AC, 50Hz.

Kit K/RA-1 £39.16.0. Carr. 9/-

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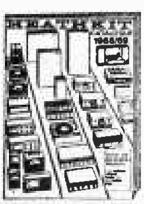

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For the Home Constructor

R. M. MARSTON,
technical author and design consultant

This is a book which will appeal equally to the electronics amateur and to the professional engineer. 110 different circuits are described and the operation of each one is explained in simple and precise terms. The main feature of the book is that it fulfils a long-awaited need for readable information on these devices.

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a comprehensive transistor tester

Last month the circuits for the transistor tester were given. This month the second part gives the constructional details and uses.

THE constant current supplies are the first things to be built and tested, as these are one of the most complicated parts of the apparatus. A meter is inserted in series with a resistor and a battery (preferably the battery to be used in the completed instrument), and the trimming resistor is adjusted to give approximately the right current. The resistor is now carefully shorted out, whereupon the current should not change.

Remember that the resistor used depends on the current range being tested, and that the electronics of the supply need about 6V to operate at all, so this fixes a maximum on resistor Rx depending on the battery voltage. For 30V, the resistor should be about 20kΩ for 1mA, 2kΩ for 10mA, 200Ω for 100mA. No overheating should occur, even on the 100mA range. Once this is completed, the switching circuitry is constructed.

The prototype was built in an Eddystone Box, type 6827P with the Veroboard circuit fastened to the lid by 2in. 6BA machine screws. The "function" switch and the current range switch were fixed to the lid first, and the Veroboard was positioned. 6BA machine screws were then passed through the Veroboard, secured with nuts, then further brass nuts were soldered to the frame of the switch. This secures the current switch to the board, and wiring can commence.

In view of the size and number of wafers required for the function switch, this was built up around the circuit board with two wafers on one side and two on the other. The spacers are cut to accommodate the arrangement.

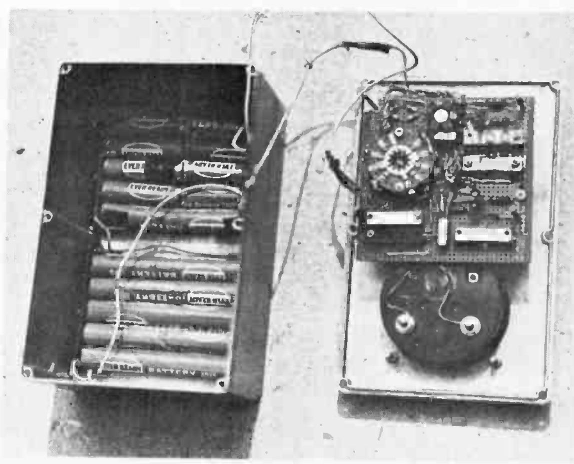
A battery carrier was made from four pieces of laminate board fixed to the inside of the box with 6BA screws and spring loaded to provide pressure on the ten penlight cells which provide the power. These cells will give 100mA for short periods with no trouble. The meter is a 100μA surplus type with a coil resistance of approximately 1kΩ.

Two transistor holders are provided for wire-ended transistors, one for JEDEC types and the other for European types. The difference is in the lead arrangements.

A holder for TO-3 type is fashioned from 4BA screws and miniature wander plug sockets. A 5-pin Philips plug is provided for connection via flying leads to transistors permanently fixed into equipment.

Diodes may be tested for forward and reverse resistance, and for type of semiconductor material by inserting the diode into the collector and emitter sockets of one of the transistor holders, selecting Iceo and 1mA on the switches (shunt the meter to 1mA). Operation of the polarity switch should give the result that the diode conducts one way, but not the other. Switching to Vce should give the usual 0·2V or 0·7V reading depending on the diode construction.

The mode of operation of this device demands more complicated circuitry than is required for other types of tester, but it is felt that the tests offered are more



The interior of the transistor tester, note the batteries lain across the base and the way in which the Veroboard panel is sited.

valid and meaningful. Quite apart from this is the illustration of the techniques used in design of constant current sources, and also of the theory of transistor operation.

Operating instructions

1. Insert the device in the slot. The colours on the extension leads go: red = e black = b.

2. Having set switches to Iceo and 1mA, select the polarity required, and shunt the meter. If the meter fails to register a reading, remove the shunt and repeat. If there is still no reading, replace the shunt, switch to 10mA, and press button. If there is no reading, remove the shunt. A perfect transistor will pass all tests.

3. (a) Set the switch to Vce (sat) and the other switch to 1mA. Press the button. Germanium may read 0·1V, silicon may read 0·5V.

(b) Set to 10mA. Germanium reads 0·25–0·4V, silicon reads 0·6–0·8V.

A short-circuited transistor always gives a low reading. An open-circuit transistor always gives a very high reading.

4. Set to Icbo, and use switches as for Iceo. By noting which junction fails the leakage test (Icbo tests collector/base, and Iceo tests both) a fault may be traced to a particular junction, and the device used as a diode.

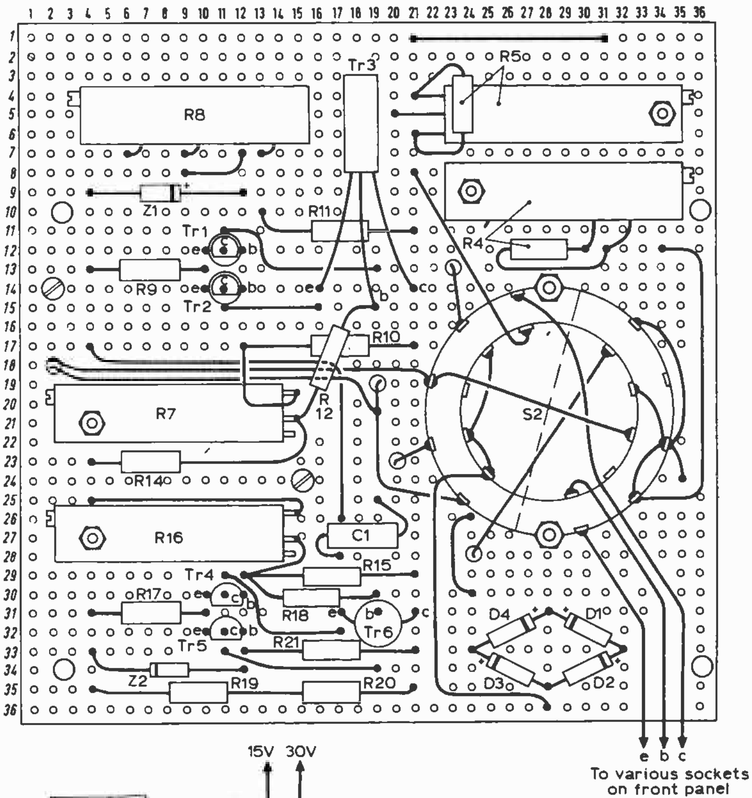


Fig. 1 (above): The location of the main components.

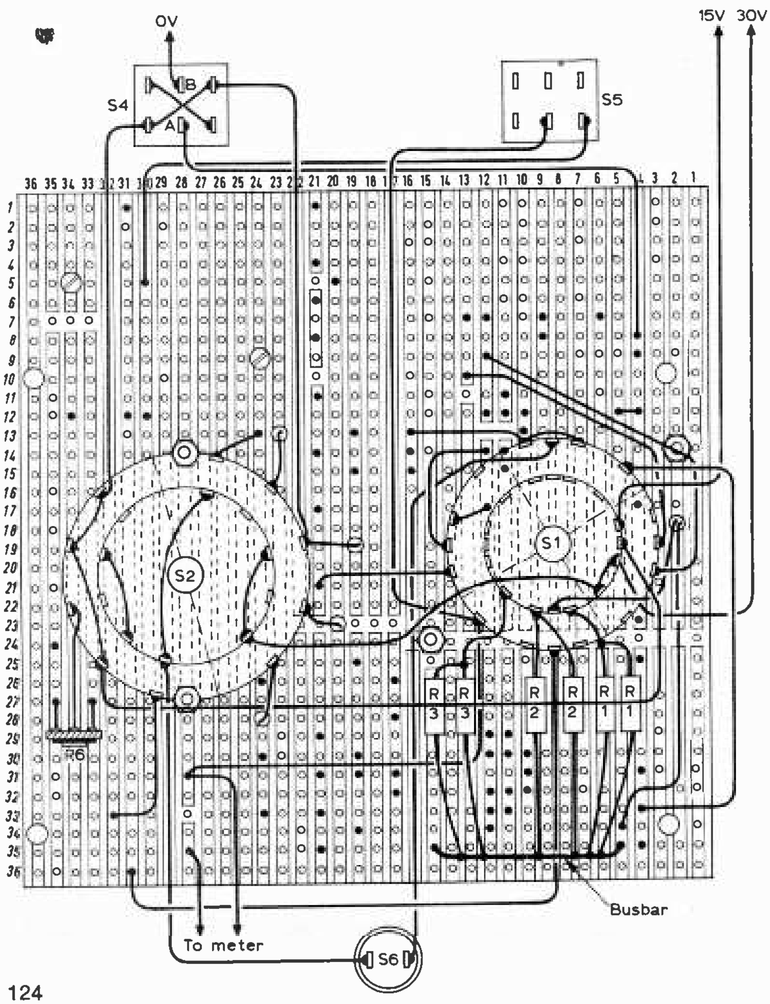


Fig. 2 (left): The copper side of the Veroboard showing the switch connections and the breaks in the laminate. Note that S6 was incorrectly labelled R5 in the circuit last month.

Testing Diodes

1. Set to Iceo and 1mA, then shunt the meter. Insert the device or connect it to c and e terminals. Now switch on and operate the polarity switch. The diode will conduct one way and not the other. Remove the shunt and measure the leakage at 15V or 30V.

2. Set to Vce (sat) and 1mA. A germanium diode will give a reading 0·1–0·5V, depending on the current. A silicon diode will give 0·5–0·7, depending on the current. ■

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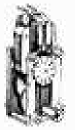

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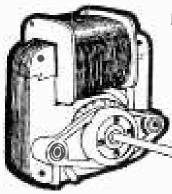
These infra-red binoculars when fed from a high votage source will enable objects to be seen in the dark, providing the objects are in the rays of an infra-red beam. Each eye tube contains a complete optical lens system as well as the infra-red cell These optical systems can be used as lenses for TV cameras—light cells, etc. (details supplied). The binoculars form part of the Army night driving (Tabby) equipment. They are unused and believed to be in good working order but sold without a guarantee. Price £3.17.6, plus 10/- carr. and ins. Handbook 2/6.



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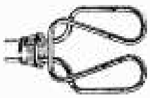
MINIATURE WAFER SWITCHES

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 3/6 each. 36/- dozen, your assortment.

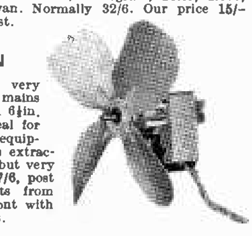
WATERPROOF HEATING ELEMENT
26 yards length 70W. Self-regulating temperature control. 10/- post free.



KETTLE ELEMENT

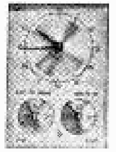
230/240V 1500 watt. Made by Best for kettles with $1^{9}/_{16}$ in. dia. hole including: Best, Besco, Chalfont, Davidson, Dimplex, Grafton, Hawkins, Jurymaid, Mirroware, Monogram, Pifco, Revo, Towen, Swan. Normally 32/6. Our price 15/- plus 2/6 post.

AC FAN



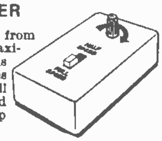
Small but very powerful mains motor with 6½in. blades. Ideal for cooling equipment or as extractor. Silent but very efficient. 17/6, post 4/6. Mounts from back or front with 4BA screws.

ELECTRIC CLOCK WITH 25 AMP. SWITCH



Made by Smith's these units are as fitted to many top quality cookers to control the oven. The clock is mains driven and frequency controlled so it is extremely accurate. The two small dials enable switch on and off times to be accurately set. Ideal for switching on tape recorders. Offered at only a fraction of the regular price—new and unused only 39/6, less than the value of the clock alone—post and insurance 2/9.

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 29/6, plus 2/6 post.

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FULL FI 12 INCH LOUDSPEAKER. This is undoubtedly one of the finest loudspeakers that we have ever offered, produced by one of the country's most famous makers. It has a die-cast metal frame and is strongly recommended for Hi-Fi load and Rhythm Guitar and public address.
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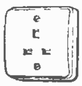
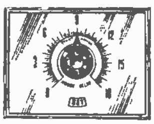
THIS MONTH'S SNIP

G.E.C. 13A SOCKETS



Opportunity to re-equip your house or workshop, or if a contractor, to stock up for future jobs. We offer bakelite 13A sockets for flush or surface mounting made by the famous G.E.C., company and listed from 6/6 each. YOU CAN HAVE A BOX OF 12 flush type 24/-, surface type 29/6, post and ins. 4/6. (Gross or more carr., free).

PROCESS TIME CONTROLLER



Made by Smiths, motorised and mains driven, enables 15A circuit to be started up to 18 hours in advance and to stay on for a period from 15 minutes to 3 hours. Totally enclosed in metal box with glass front and chrome surround. 49/6 plus 4/6 post and ins.

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LAST CHANCE FOR THIS BARGAIN

CASSETTE LOADED DICTATING MACHINE

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REPAIRABLE RADIOS

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These radios require attention. Circuit diagram is not available. Price only 17/6 each plus 2/9 post and insurance. 4 radios £3 post free.

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Will dim incandescent lighting up to 600 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 £3.19.6.

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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/- dozen.

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

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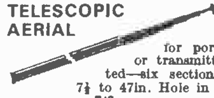

for portable, car radio or transmitter. Chrome plated—six sections extends from 7¼ to 47in. Hole in bottom for 6BA screw. 7/6.

MOVING COIL METER BARGAIN

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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 16/6, plus 3/6 postage.

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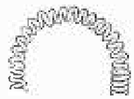
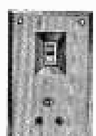
American make—630 ohm coil 20–30 volt operation—2 pole change over 4/6 each, 48/- dozen.



SPRING COIL LEADS

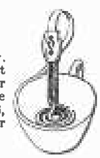
as fitted to telephones, 4 core 2/6 each, 3 core 2/- each.

5A. 3 PIN SWITCH SOCKETS



An excellent opportunity to make that beach dis board you have needed or to stock up for future jobs. This month we offer 6 British made (Hicraft) bakelite flush mounting shuttered 5A switch sockets for only 10/- plus 3/6 post and insurance. (20 boxes post free.)

QUICK CUPPA



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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A.E.I. Fractional H.P. Motor. 200/250 v. 50/60 c.p.s. enclosed, continuous rating 1/40 h.p., ex. equipment. Perfect order, 19/6, plus 4/6.
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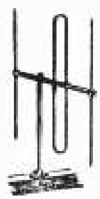

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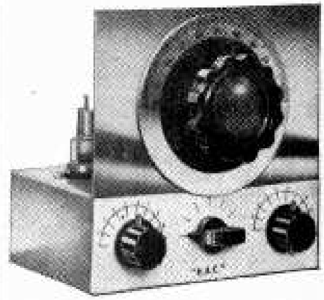
H.A.C. SHORT-WAVE KITS

WORLD-WIDE RECEPTION



Famous for over 30 years for Short-Wave Equipment of quality, "H.A.C." were the Original suppliers of Short-Wave Receiver Kits for the amateur constructor. Over 10,000 satisfied customers—including Technical Colleges, Hospitals, Public Schools, R.A.F., Army, Hams, etc.

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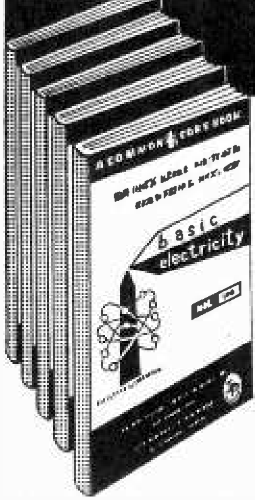

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AERIALS

A. J. WHITTAKER

PART 3—DIPOLE AERIALS

PARTS one and two in this series have described the basic theory of dipole aerials and the properties of vertical arrays when used for transmission of radio waves. This part will discuss effects of adding director and reflector elements to the basic dipole, and how to put the technique into practice by describing the construction of a v.h.f. loft aerial for receiving f.m. transmissions.

The Reflector Aerial

Consider Fig. 3.1, which is of a dipole "A" with the reflector "B" spaced $\frac{1}{4}$ wavelength behind. Assuming the dipole to be a transmitter aerial fed with r.f. energy, the action is as follows:

(i) By the time that the voltage wave radiated from the main aerial "A" has reached the reflector "B" it has changed in phase by 90°;

(ii) The back e.m.f. in the reflector lags 180° on the cause producing it (i.e., the voltage radiated by "A");

(iii) The reflector voltage, therefore, lags 270° behind the main aerial voltage;

(iv) A phase lag of 270° is equivalent to a lead of 90° and so the reflector may be regarded as a directly energised aerial producing a radiated wave 90° or $\frac{1}{4}\lambda$ (λ wavelength lambda) in advance of the main aerial radiation;

(v) As the reflector is a $\frac{1}{4}\lambda$ behind the main aerial, by the time the radiation therefrom has travelled through $\frac{1}{4}\lambda$ it is in phase with the main aerial and so augments the forward radiation;

(vi) The polar diagram of radiation is a cardioid (Fig. 3.2):

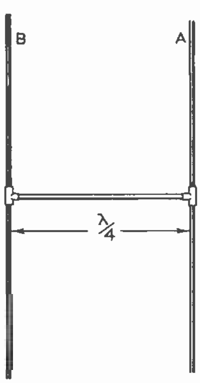
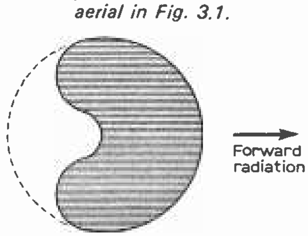


Fig. 3.1: A half-wave dipole with reflector.

Fig. 3.2: The radiation pattern for the aerial in Fig. 3.1.



(vii) A receiving aerial behaves in the same way but in reverse. The wavefront arriving at the main aerial induces a voltage into it. A $\frac{1}{4}\lambda$ after this, a voltage is induced into the reflector element. This sets up a current in it, and it re-radiates, the radiated wave lagging 180° on the cause producing it, implying that the reflector radiation is again 270° lag on the main aerial voltage. As in the transmitter aerial, a lag of 270° is equivalent to a lead of 90°, and as the reflector element is $\frac{1}{4}\lambda$ behind the main aerial, its radiated field is in phase with it and so augments the forward pickup. The polar diagram is a cardioid and use may be made of this when siting the aerial to improve the signal-to-noise ratio.

Dipole with reflector and director

Figure 3.3 shows a dipole with director and reflector elements. The director augments the pickup in the dipole and adding several further improves the dipole gain. Owing to transformer action of directors and reflectors, however, this lowers the matching impedance to as little as 10 ohms.

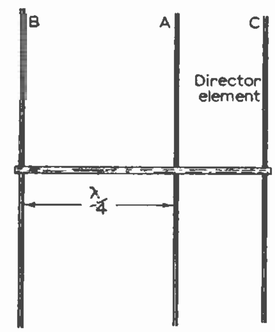


Fig. 3.3.

The Folded Dipole

The $\frac{1}{2}\lambda$ dipole is a balanced aerial requiring in practice a feeder wire of 75 ohms impedance to connect it to the receiver. As has just been mentioned, when reflectors and directors are coupled to it they lower the dipole input impedance, so to overcome this the dipole length is increased to a full wavelength and folded over. The feeder is now connected to the ends of the aerial which may be arranged, by adjustment of the reflector and director elements, to have an impedance of 75 ohms, thus avoiding the use of a matching element. The folded dipole behaves like two dipoles in parallel and an impedance step up of about 4/1 may be obtained.

The forward gain is seriously affected by the spacing of the reflector which is normally about $\frac{1}{4}\lambda$. A considerable change in the feed impedance also takes place when the spacing is varied. The reflector element is usually $\frac{1}{2}\lambda$ long but may be 0·475λ long for closer spacing than $\frac{1}{4}\lambda$.

Directors are usually about 0·43λ long and spaced about $\frac{1}{4}\lambda$ or less from the main dipole. If a number of directors are employed as in the Yagi array, making each progressively shorter in the direction of the transmitter broadens the bandwidth. For an aerial of 18 elements including the reflector and main dipole, the forward gain may be 14dB higher than a single dipole (i.e. about 4·5/1). The gain of a Yagi with one director and reflector is typically 8dB.

Construction of a practical v.h.f. aerial

A 3 element aerial for the reception of v.h.f. f.m.

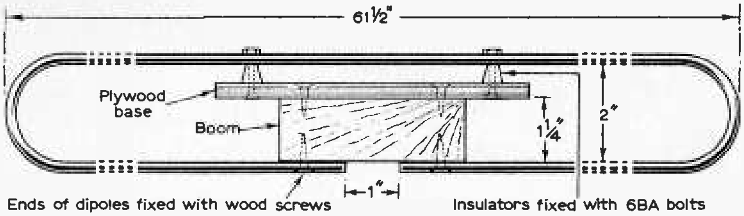


Fig. 3.4: The folded dipole.

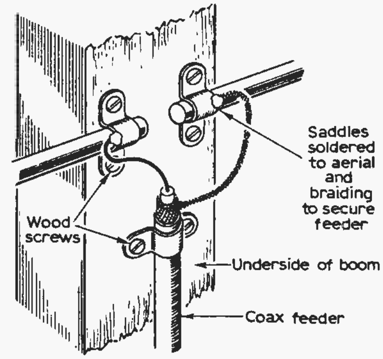


Fig. 3.5.

Fig. 3.6: The complete aerial.

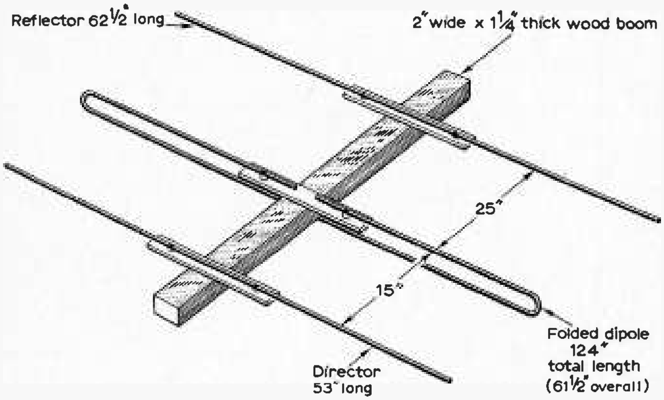
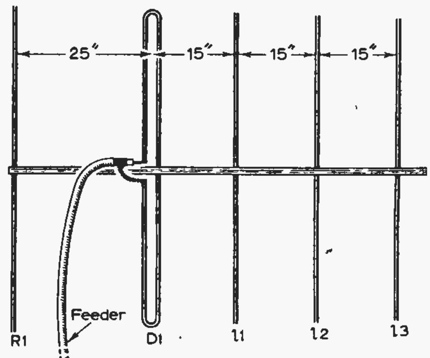


Fig. 3.7.



broadcasts, suitable for use in a loft, will be described.

The radiating element is a folded dipole, bent to the shape shown in Fig. 3.4. It is made from $\frac{3}{8}$in. diameter copper tube, which can be bent by plugging the ends, filling it with sand, and folding it to the desired radius. The sand can then be emptied, and the ends flattened to seal the tube and provide a suitable surface for the terminal screws. All the dimensions are given in the sketch, and if these are carefully adhered to the aerial will tune to the mid-band frequency of 90Mc/s.

The reflector rod should be cut to $\frac{1}{2}\lambda$, which is about 62½in. This figure is calculated from the formula:

$$\tfrac{1}{2}\lambda \text{ element length (ft.)} = \frac{468}{\text{freq. (Mc/s)}}$$

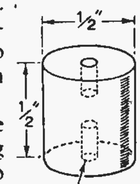
This allows for the difference in velocity of electromagnetic waves in copper wire to the velocity in free space.

The director should be cut to a length of 0·43λ, which is about 54in. The ends of the reflector and director should be sealed off, and if the aerial is to be used out of doors, all elements should be painted.

Having prepared the aerial elements as above, they must be assembled on the wooden boom, which is cut from 2 x 1¼in. timber to a length of 45in. The first operation is to mark off the centre of the boom at 22·5in. from one end, and attach to it, at right angles, a strip of plywood, 6 x 2 x ¼in. After screwing it on, two holes should be drilled about 1in. from each end of the plywood to accommodate a plastic insulator pillar. These pillars are fastened to the folded dipole. The dipole can then be mounted, the ends to which the feeder is attached being fastened to the underside of the boom by two saddles fixed by woodscrews, as shown in Fig. 3.5.

In a similar fashion to the driven element, the director is attached by cutting a piece of plywood 6 x 2 x ¼in., and drilling a 6BA clearance hole, 1in. from each end to accommodate the insulated mounting pillars. The plywood should be screwed to the boom at a centre-to-centre distance of 15·5in. from the dipole, and the rod can then be screwed to the insulators. For the reflector repeat this operation, but space it from the dipole a distance of 25in.

The director and reflector rods should now be drilled with a 6BA clearance hole at a position 2in. either side of the centre line of the rod. These holes are to accommodate the fixing screws for the insulating pillars to which these rods are fixed. The sketch shows the completed aerial, Fig. 3.6.



Tapped screw holes in insulated pillar

The insulated pillars may be made from Perspex, Paxolin, or any insulating material usually found in the workshop odds-and-ends box. The dimensions are given in the sketch.

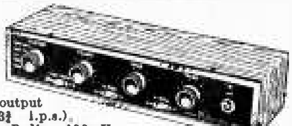
The wooden boom was purposely made about 5in. longer than necessary to allow for possible adjustment of the reflector or director in the interests of getting the optimum matching conditions for the feeder.

Reception of VHF FM Stereo

For the reception of stereo broadcasts it is desirable to have an aerial system with more forward gain than the simple aerial described above. This may be quite simply done by adding more directors to the array, as shown in Fig. 3.7 which has two more director elements. These are cut progressively shorter in the direction of the transmitter to broaden the bandwidth. The boom will have to be lengthened to 75 in. to accommodate these extra directors.

TO BE CONTINUED

THE CLASSIC



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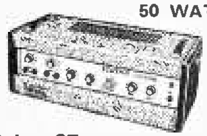

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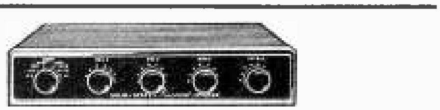

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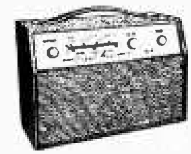

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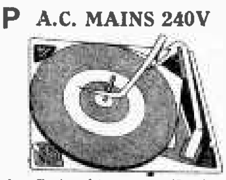

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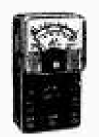

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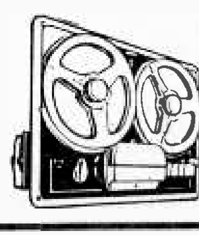

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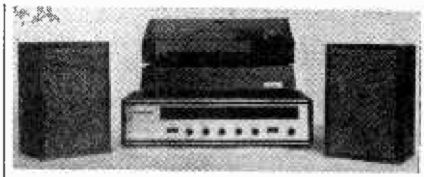

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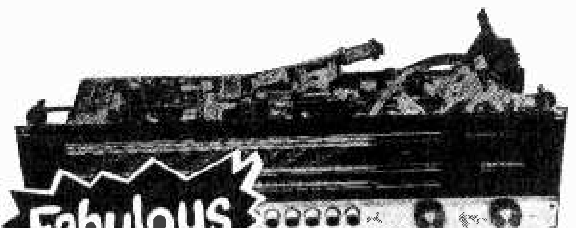

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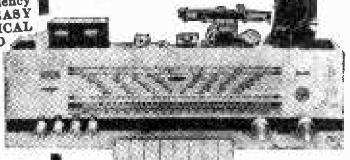

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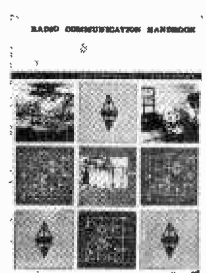

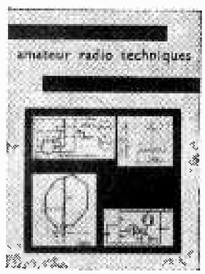

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commentary by HENRY

No. 57

Sitting by Nelly

HOW would you feel if the Time and Motion Study man came into your den with his stopwatch? More than a little aggrieved, I'll warrant. Perhaps a bit guilty about the clutter under the bench that you meant to clear up—was it last Michaelmas? Uneasily aware that reaching across for the soldering iron and sending the precariously perched valve rack toppling would not meet with his approval. Nervous about the habitual way one tips out the cocoa tin of hardware to search for a 6BA washer.

My own den, since Mrs Henry laid down the law about trailing wires and fire hazards, has expanded into the loft—where the aforesaid forewoman's incipient vertigo guarantees privacy. The rear bedroom, vacant since the Henry fledglings left the nest, is now a hi-fi centre, with equipment scattered around fairly neatly, and wires tucked away out of sight. Come to think of it, why *did* they fly away?

But I would hate to see Mr Slide-rule sniffing superciliously around my loft. I remember we had to saw laterally across the old washstand to get it through the hatch; its reassembly is as complete as need be, but technically imprecise. Have you ever tried to re-assemble a washstand that seems to be one of the reasons for Queen Victoria's lack of amusement? The fact that its slate top provides as good a base for turntable testing as one could hope to devise, and the handy little pot-sized cupboard whose door was not designed to shut, is just right for an easy cable entry, has nothing to do with efficiency or design. I feel sure Mr. David Michaelis would disapprove.

The Time and Motion man with his stopwatch.

This gentleman is not a blood brother of our erudite contributor of the same name but a leading light in the TMS world. And the reason he finds himself immortalised by Henry is a trenchant article by Ann Batt of the *Daily Mail*, in which Mr. M. was quoted on the subject of women and housework.

"Would a man do six little batches of washing up in half an hour?" he asks. Not if he is wise enough to break the odd dish now and again, when asked. But that is not his point. He asserts that women " . . . *toil on making a virtue out of hard slog by doing things the traditional way your mothers did instead of asking yourselves 'is there a better way?' There probably is; you just don't think*".

Much of the way women work comes from learning in the manner that industry terms "Sitting by Nelly". That is, picking up the job as you go along, without specific training.

Be honest—when did you last remember to give that soldering iron bit a twitch, to make it easier to free when the time comes for replacement? How many pieces of your equipment are operating on supply lines stuffed into a socket and pinioned by the blades of another plug? Come to that, how much gear have you got multi-plugged to that single socket? Don't look at me—I'm only *asking* the questions.

My own home workshop would horrify Mr. Michaelis.

We had to saw across the old washstand.

Darn it, the place scares *me* at times. But even in our "official" workshop the den atmosphere persists and Nelly is lurking in every cluttered corner. One of our chaps still talks about "Anoids and Cathoids" because that was the way his mentor talked during his far-off apprentice days. Another has jumped gleefully for a recent exposition of transistor theory because he never really believed in "holes" anyway. Yet he manages to cope quite ably with repairs to semiconductor equipment.

And what about Henry's legacy from Nelly? Well, I think it must be a harkback to the Army days, when to leave a tool unattended was to invite its disappearance.

Perhaps we ought to ask Mr. Michaelis to take a long look at our dens. In one respect I know he is right. *"A form of Parkinson's Law operates,"* he says, talking about working surfaces. *". . . your accumulated clutter responds to the stretchable space made available for it."*

He could have been talking about the slate top of that old washstand. Maybe I can get Nelly to come and clear it up—one day!

ON THE SHORT WAVES

MONTHLY NEWS FOR DX LISTENERS

Times GMT
Frequencies in kc/s

THE BROADCAST BANDS by CHRISTOPHER DANPURE

TIME certainly seems to fly when conditions are good, especially during the spring season when the h.f. bands are open until late evening. Here's a good DX-tip: have a listen to *R. Australia* on 15,240 from about 0600–0800. Power is only 10kW from the Shepperton transmitter. I always get good results, some days even better than the 100kW transmitter on 11,710.

During the past year when I have been writing this column I sometimes wonder what you readers think of the column, especially as to how useful you find the propagation predictions which are published each month. Do you find them useful? Let's have your comments please over this one, and any other suggestions you may have to help other people in their DX-ing and SWL-ing. Talking of SWL-ing and DX-ing, during the past few years there have been confusion in the use of these words. The translation which I believe is correct is that SWL-ing is listening generally to shortwave stations from all over the world, low and high power, but mainly to listen to specific programmes and taking interest in various countries, generally listening to shortwave radio to learn about the world and for entertainment. Now the DX-er or DX-ing is literally translated as "Distance listening", that is listening to stations outside the continent he resides in unless there are low power stations in his own continent, but generally listening to low power stations on the shortwave bands, and writing out reports to get as many QSL cards as possible. So how do you class yourself as a SWL or DX-er?

Over the past year I have tried to cater for both SWLs with new station schedules and for the DX-ers with short tips. But I seem to be providing more for the SWLs than the QSL card hunters, so come on you good DX-ers let's have those "heard and noted" lists of those stations you have heard in Latin America, Africa, Asia and Pacific Area like *R. New Zealand* and *R. Cordac*. I'll look forward to receiving your logs.

In the October 1968 column I listed all the programmes of interest to SWLs and DX-ers, so if you haven't got a copy of this list send 3s. postal order plus postage and ask for a copy of the October 1968 PRACTICAL WIRELESS. Now to bring this list of programmes up to date here are some alterations:

Sunday—DX-ing Worldwide *R. New York Worldwide* 1930–2000 on 21, 17 and 15Mc/s.

Monday—Delete all details for the *Deutsche Welle* DX-Programme.

Tuesday—Add *Deutsche Welle* DX-Programme every second Tuesday from 0810–0840, on 9,650 and 6,075; 1410–1440 on 11,765; 1710–1740 on 9,655 and 6,075.

Thursday—Add 0730–0745 *Trans World Radio* "DX-Special" on 7,295.

Friday—*Trans World Radio* "DX-Special" from Bonaire runs from 2055–2110.

Saturday—Delete details for *Trans World Radio* schedule.

Now here are some listening tips on new schedules commenced on 4th May.

EUROPE

Holland: *R. Nederland* is now operating on full schedule and has daily 80-minute transmissions in English. From 0630–0750 on 11,730 via Bonaire; 0800–0920 on 9,715 via Bonaire; 0930–1050 weekdays 21,480, 17,810 via Lopik; Sundays 9,715 and 5,980 via Lopik; 1400–1520 on 21,480, 17,810 and 6,020; 1830–1950 on 21,570 and 11,730 via Lopik; 15,220 via Bonaire. 2000–2120 on 9,715, 6,085 and 6,020 via Lopik; 2130–2250 weekdays on 15,425, 11,730 via Lopik; 0200–0320 on 11,730 via Bonaire; 0500–0620 on 11,730 and 9,715 via Bonaire. On Sundays the Happy Station programme is transmitted. The Spanish Happy Station programme is transmitted on Sundays at 2130–2250 on 9,715, 6,085 and 6,020 via Lopik and 17,810 via Bonaire; 2300–0020 on 15,425 and 6,020 via Lopik and 15,320 via Bonaire. 0030–0150 on 6,085 via Bonaire, 0200–0320 on 9,590 via Bonaire; 0330–0450 via Bonaire on 11,730.

Norway: *R. Norway* is now on their summer schedule from 0700–0830 on 25,730, 21,730, 21,655, 15,345 and 15,175; 1100–1230 on 25,730, 21,730, 21,655, 17,825 and 7,210; 1300–1430 on 25,730, 21,730, 21,670, 21,655, and 17,825; 1500–1630 on 25,730, 21,730, 21,670, 21,655 and 17,825; 1700–1830 same as 1500–1630; 1900–2030 on 25,730, 21,730, 21,670, 21,655 and 15,175; 2100–2230 on 25,730, 21,730, 21,655, 17,825 and 15,345; 2300–0030 on 21,655, 17,825, 15,345 and 15,175; 0100–0230 on 11,860, 11,850 and 11,735; 0300–0430 same as at 0100–0230.

AFRICA

South Africa: *Radio R.S.A.* has now altered the timings of some 50-minute transmissions. Now they run 0800–0850 on 21,535 and 17,825; 1000–1050 on 21,535, 17,825 and 15,220; 1600–1650 on 9,525 and 7,270; 1700–1750 on 21,535, 15,220, 9,525 and 7,270. The UK and Eire English transmission now runs from 1800–1850 on 21,500 and 17,795; 2100–2150 on 15,360 and 11,900. To North America from 2326–0320 on 9,705, 6,075 and 5,980. The general service to Africa now runs from 1100–1450 on 21,535, 17,805, 15,220 and 11,900.

Well that's about it for this month. Deadline for those DX-tips is 17th May. So until next month good listening and 73s.

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QUAD 303 Stereo Main Amplifier ...	£55 0 0	£48 15 0
ROGERS Cadet Mark III	£33 15 0	£28 14 0
ROGERS Cadet Mark III in teak case ...	£37 10 0	£31 17 6
ROGERS Ravensbourne 50w. Stereo	£59 10 0	£50 12 0
ROGERS Ravensbourne in teak case	£64 0 0	£54 8 0
LINEAR LT.66 Stereo Amplifier ...	£15 15 0	£13 10 0
PHILIPS GH.925 Stereo Amplifier	£26 0 0	£21 9 0
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	Rec. Retail Price	Comet Price
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LEAK FM Troughline	£35 15 4	£30 10 4
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QUAD Stereo FM Tuner	£50 0 0	£45 15 0
ROGERS Cadet Mark III Tuner ...	£20 12 6	£17 13 0
ROGERS Ravensbourne Tuner with Decoder	£60 15 3	£52 2 0
TRUVOX FM Tuner	£35 5 0	£30 5 0
DULCI FMT.7 FM Tuner	£22 1 0	£19 0 0
DULCI FMT.7S FM Stereo Tuner ...	£29 8 0	£23 0 0

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ARENA 2500 complete with Decoder ...	£97 0 0	£79 0 0
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SHURE M44-5 ...	£14 4 0	£12 0 0
SHURE M44-7 ...	£12 15 0	£10 19 0
SHURE M44-E ...	£17 2 6	£14 2 0
SHURE M55-E ...	£20 7 6	£17 7 6
SHURE M31E ...	£13 19 2	£11 14 0
SHURE M32E ...	£12 14 11	£10 12 0
SHURE M44C ...	£12 14 11	£10 12 0
SHURE M75E ...	£25 9 10	£21 5 0
SHURE M75E/95G	£27 6 3	£23 0 0
SHURE M75/6 ...	£17 2 4	£14 2 0
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MARCONI 4214 twin-track Tape Recorder ...	£35 16 0	£31 0 0
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TWENTY-EIGHT and twenty-one Mc/s are the bands which are usually the first to register dissatisfaction at lack of sunspots. However, with the sunspot count now on the decline, these bands are still pulling-in the stations. Strangely enough it is 21 which has been the more temperamental of the two and 28Mc/s has had some very good moments in the past month. Both bands seem to stay open longer in the evenings so how about a listen before you settle down to tea and telly?

Twenty metres is still a firm favourite in the s.w.l. DX stakes. From 1800 to 0600 it proved very lively with so much DX at times that it paid to have a countries list handy.

The l.f. end has also been busy with 80 metres providing some very good openings. Sadly, very few dared expose their ears to 40 metres where a midnight-till-dawn session is usually very fruitful. How about a 7Mc/s month—go on, unsolder all the other coils in the receiver except those for 7Mc/s. You will probably hear a new country too if you persevere. Speaking of new countries and perseverance, Stew—W1BB has now worked over 100 countries on topband so if 7Mc/s doesn't appeal try draping your earholes around 1·8—2·0Mc/s. Odd weak squeaks heard in this segment could well be G3JDG firing up the latest transistor r.f. oracle—or a ZL? just waiting for a report from you.

HEARD H.F.

Stephen Cole (Newport, Mon.), Trio JR60, Joystick, claims 28Mc/s r.f. s.s.b. emanating from—CR7DS, KR6KM, PY2HY, UA9CBW, XW8CS, 4X4HJ, 5A4TY, 5N2AAF, 9G1GG.

Meanwhile, back at the ranch, well, down in Gloucester, **Chris Witts** was loitering with his Trio JR-500s. Antenna used for lassooing the signals with a 100ft. end fed 30ft. from the terra firma. On 10 Chris hooked—KP4CL, PZ1DA, VE1ABF, VE3ETS, YN2RAC, ZC4TK, ZE1CX plus eight W's. On 21Mc/s his antenna reported signals from—CR4BB, HC1MG, IS1SCB, TF2WLM, VE3SQG, VK2FU, VK3VK, VK5GX, VQ9GA.

Over to Stourbridge in Worcestershire, where **Ron Shilvock** states clearly, in writing, that he has only been DX-ing since his initiation in December 1968. A search on 21Mc/s with his Trio 9R-59DE and 60ft. end fed plus a.t.u. raised—CE3PT, CN8HL, CR6DP, EL9C, EP3REL, G3UHR/VO2, G8KL/W6, HI8LA, HK3AUE, HK4TA, JX3DH, KP4ATS, KR6HB, PJ9PF, PY1DEM, VK3PX, VK4EF, VP2ME, VP8FL, WA6OET, WA8UYJ/KC4, W6GNP, W9BBR, YV3DA, YV5ANE, ZC4HS, ZE5JU, ZL1BEM, ZS3D, ZS4K, ZS5OB, ZS6EU, 4X4BO, 4X4RQ/AM, 5A4TY, 5N2AAU, 5Z4LX, 6W8DY, 6Y5LA, 8R1J, 9H1BI, 9Q5DA, 9X5AV.

T. Rumble (Wilts.), HA700 plus PR30 preselector, 100ft. long wire running N/S at 25ft. logged this lot on 28 Mc/s and on a.m. too—CT2AP, CX3BBU, K1ILT, K3VIG, VE2ABZ, VE3CLJ, WA1KEE, WA9PP, WB2CDX, W1LGS, W9DLZ, ZE1CB, 5A1TA.

If you are in the Bromley area of Kent, and you are an r.f. signal, watch out for **Simon Mummery's** antenna. Those not so fortunate, and who saw it too late to miss it were—CN8CS, CR6CA, CR6LF, CR7IC, HS3DR, JA6AA, JA8ABH, JH1JUN, KV4FA, KV4SQ, SVØWI, VP7NA, YVØAB, ZS5XA—all 10 metres s.s.b. The same gear, B34 plus a.t.u. and 66ft. end fed, snared—CN8BB, EA9AQ, HC2OB, KH6GEL/P/W4, MP4BHG, SVØWN, VKØSL, VO1GL, ZS3LU.

NOT SO H.F.

It's no good, you just can't hide from those 20 metre signals. **L. Boucher** is down in Welsh Wales, but what happens when he switches on his R1155 and 68ft. end fed? Yes, that's right, s.s.b. signals on 20 from—CE3RY, CN8GE, CR4BK, CR6GA, VP5SK, VP8KD, VP8QR, VS6CO, VQ8CS, VU2GE, W6MWF, W7EPA, W7ZYC/MM (Survey ship *Discoverer*), ZB2BC, ZC4AK, ZD8Z, ZE1AA, ZL1ATX, ZL3AB, ZL4BX, ZS1BK, ZS6RM, 4X4KM, 5A4TR, 5A5TS, 5Z4AA, 7G1CG, 7P8YL, 7Z3AB, 9G1GD, 9H1M, 9J2GJ, 9K2AV, 9M2FR, 9Q5HF, 9X5AV.

HA350 plus PR30 plus RQ1OX plus 380ft. end fed plus **Robert James Dinning** plus 20 metres plus—CN8HO, CO2FA, CR7IZ, EP1VR, FP8CS, FR7ZG, HC2GU, KG4AA, KL7EG, KV4FC, KZ5AG, PJ2CB, OX3KG, SVØWEE, VE2AWE VK2APC, VK3AIF, VP2GDL, VP8HS, VQ8BZ, VU2TP, XE3EB, ZE5JS, 5H3JL, 5U7AK, 5V4AP, 9H1M, 9K2CF, 9Y4AR.

Take away his B28, 20ft. indoor antenna, and **Roger Thackery** (Edinburgh), would never have heard—CE8AA, CT2AA, HI3AGS, HC2GU, LU6DZG, PJ2CB, PZ1BF, PY1MX, TN8VK, VE7PJ, VK3ARX, VK5MF, VKØKJ (Macquarie Is.), VP8JK, VP9CP, YV1EJ, ZS5TK, ZD8Z, 6W8DY, 6Y5GB, 7XØWW, 7X2ED, 8P6TV, 9Y4CP.

EVEN LESS H.F.

S. Teague (Worcs.), modified 19 set, 67ft. feeder with Joystick on the end, 80 metres s.s.b.—HB9KL, HV3SJ, K1KTH, MP4TAF, PJ2MI, TF3SD, VO1FG, VP2MK, VP9AT, W1CF, W4YAG, ZD8Z.

M. Pipes (Derby), "Trio RX", 66ft. end fed managed these on 160 metres—GD6IA, GM3VIO/A, HB9CM, OK1ACF, OK1TA, OK1ZW, OK2BGS, ON4WC, ZB2AY.

HAPPENINGS

Meetings, contests and gatherings for the merry month of May include: *May 3rd—4th* 2 metre contest (too late, it's happened); *24th—25th,* 432Mc/s contest; *24th—25th,* 1,296Mc/s contest (I didn't know anyone could live at the frequency). Mobile rallies include: *May 18th,* Northern MR near Leeds; *18th,* Thanet Radio Society's MR at Ramsgate; *June 1st,* A.R.M.S. rally at Old Warren Aerodrome, Biggleswade, Beds. (this will be a good 'un, see you there?), *June 1st,* Maidstone MR.

Deadline for logs is, as usual the 20th of the month. Keep the cans on, the antenna polished and the electricity bills high.

PART TWO

BASIC SEMICONDUCTOR TECHNOLOGY

by M.F. DOCKER, M.Sc.

LAST month we showed that very pure materials were necessary for the manufacture of semiconductor devices. At present the most commonly used materials are germanium and silicon. However many devices are now being made using compounds of atoms with three and five valence electrons, such as gallium arsenide and indium antimonide, the so-called III-V compounds. These and other materials are showing great promise in device fabrication and undoubtedly their names will eventually become as common to the amateur as germanium and silicon are at present.

Germanium and silicon are each found in compound form and each needs to be very carefully purified before it can be used in a diode or transistor. Initially, chemical refining is carried out. Liquid compounds of the required element are prepared and these are then fractionally distilled in the same way that crude petroleum is distilled to separate the various compounds contained in it. This process provides a relatively pure compound which is then processed to yield the element.

Zone Refining

In order to obtain the one part in a thousand million parts purity which is required a process called zone purification which is very important to the semiconductor industry is used. When a vertical rod of the material is suspended in a bath of molten material of the same type, as shown in Fig. 1, impurities migrate to the liquid material to a certain extent. This is because the impurity is more soluble in liquid than in solid material. Thermal motion ensures that the impurity atoms move from the solid to the liquid and vice versa and as their solubility is greater in the liquid the number moving in the first way is greater than that moving in the second way.

The time required however is very long with this

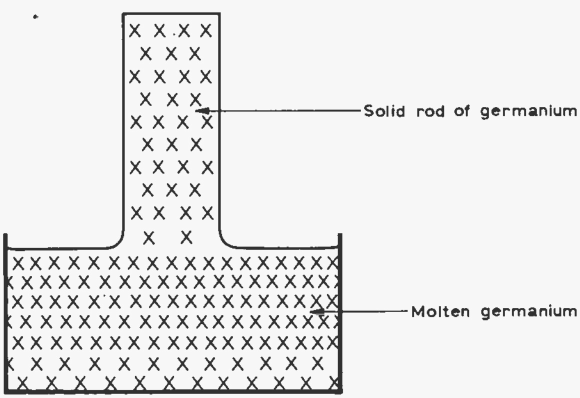

Fig. 1: Impurities concentrate more in molten than in solid germanium.

arrangement so that a different method is applied, the apparatus shown in Fig. 2 being used. A short r.f. heating coil is passed along a rod of the substance to be purified. This produces a short region of molten material which follows the coil along the rod and absorbs a proportion of the impurity present, carrying it to one end of the rod.

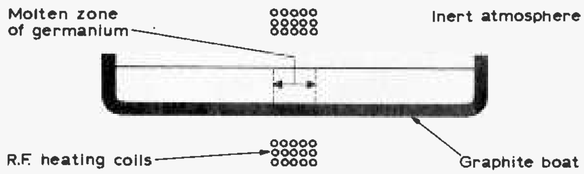

Fig. 2: Zone refining apparatus.

A single pass of the heating coil only reduces the impurity concentration by a certain fraction, this fraction depending on the type of impurity involved. In order to further purify the material the heating coil is swept along the rod several times, each pass resulting in a similar decrease in the impurity concentration. Many passes are required in order to obtain a sufficient degree of purification to permit semiconductor devices to be prepared from the material.

The various semiconductor materials tend to have different impurities depending on the ore from which they are refined. Silicon usually contains the element boron as an impurity, giving p-type material. The boron is very difficult to remove as the solubility of boron in liquid silicon is not very different from that in the solid. Consequently zone-refining is not very efficient in this case. A result of this technical difficulty was that early silicon devices had to be based on p-type material so that n-p-n silicon transistors were the first to make their mark on the market. These devices are still in general cheaper than the complementary p-n-p devices.

Crystal Defects

Having obtained a pure sample of the semiconductor, what else needs to be done to it before a transistor can be made? Last month it was shown that conduction could be due either to movement of electrons or to movement of holes; usually conduction is due to both but it is relatively easy to make one type predominate. The free current carriers in semiconductors only exist because very little energy is required to free them from their fixed positions in the crystal lattice. However there are various forms of binding which can result in the trapping of carriers and one of the most important of these is the presence of some form of crystal defect.

Defects can themselves be of many types, far too numerous to discuss here; however they often constitute discontinuities in the crystal lattice structure and this is equivalent to the presence of localised energy

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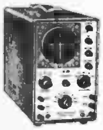

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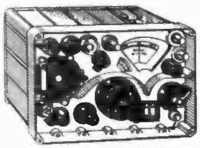

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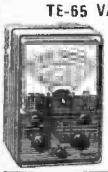

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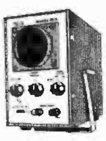

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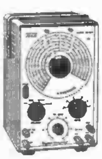

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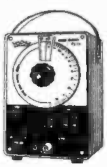

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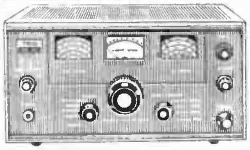

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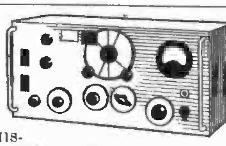

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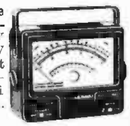

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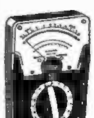

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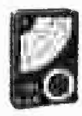

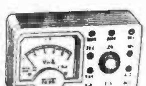

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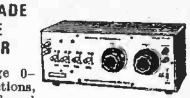

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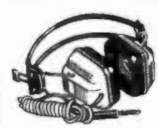

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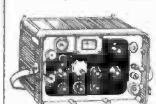

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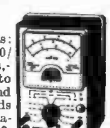

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Crystal Growth

In order to remove these defects a single crystal is produced from the polycrystalline substance. There are several methods of doing this. The one most commonly used is probably the Czochralsky method which was developed in 1916. This involves the growth of a single crystal from a bath of molten semiconductor material as shown in Fig. 3. A small seed crystal is required and this is obtained by cutting very carefully from a polycrystalline sample a small single crystallite. This is then dipped into the melt and very, very slowly withdrawn, rates of between one-hundredth of a centimetre and sixty centimetres per hour commonly being used.

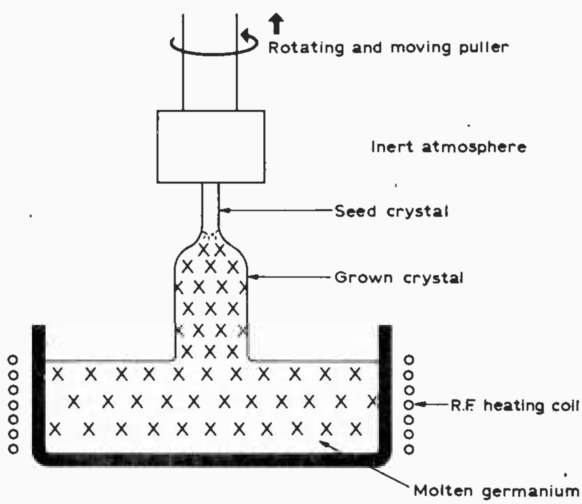


Fig. 3: The Czochralsky apparatus used to produce single crystals.

As the crystal is pulled out new material grows on to the seed. The atoms are deposited in the same orientation as that in the seed and in this way a long single crystal is produced. In order to help maintain a uniform growth rate the crystal is rotated at up to 200 r.p.m. on an axis along its length. Crystals of up to three inches diameter can be produced in this way, but more usually one-inch rods are made. This method can be used to produce single crystals of many different substances including germanium, silicon, gallium arsenide, copper, silver and lead.

In order to avoid the risk of impurities being introduced from the vessel containing the melt it is possible to produce a molten pool of the material in the solid polycrystalline substance by locally heating the required region with a beam of high energy electrons, the same crystal-pulling techniques being used as before.

Another method of making single crystals is the float-zoning process where a seed crystal is again required, but this time a slowly moving r.f. heating coil is used to produce the molten zone, in a similar way

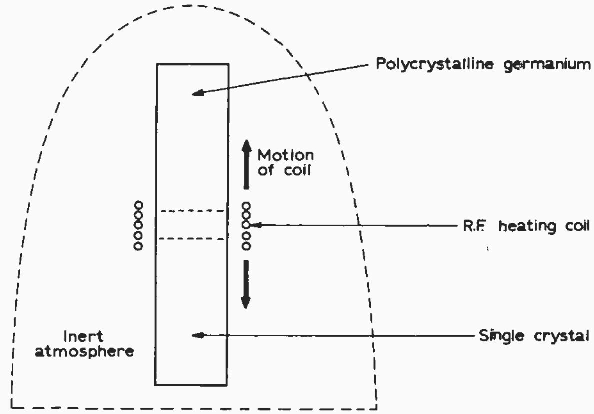


Fig. 4: Float zoning apparatus.

to that used in the zone refining apparatus. The seed crystal is placed at the bottom of the polycrystalline rod as shown in Fig. 4 and the r.f. coil placed around the rod just above the seed. It is slowly moved up the rod and as it moves the melted and then recrystallised material forms an extension of the original seed crystal. This method was developed at the Bell Telephone Systems laboratory during the 'fifties.

A further method is the Bridgeman process in which the polycrystalline sample is slowly lowered through a furnace which is at a temperature above the melting point of the sample. As it comes out of the furnace it starts to recrystallise and a single crystal usually results. However in this method it is not so easy to control the orientation of the crystal faces.

Annealing of the single crystals is carried out to reduce the number of defects present in the lattice and consequently to improve the characteristics. This is done by cooling the single crystal very slowly so that defects have time to move out of the crystal.

Doping

Having obtained a pure single crystal of the material it is then necessary to add impurities! There are various ways of doing this and the different methods are used in the appropriate circumstances. Here only the problem of obtaining a uniform doping will be considered. It should be emphasised that the impurities in a semiconductor have to be very precisely controlled. The word impurity does not in this case mean something

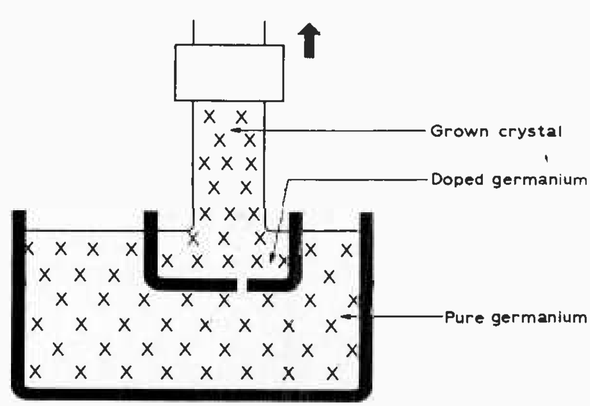


Fig. 5: The double-crucible method of growing doped crystals.

which is undesirable but an added atom which is different from the majority of atoms in the crystal.

Two important methods of doping are used. The first is the floating crucible in which there are two vessels, one having a small hole in its base (see Fig. 5). This contains pure material to which a small amount of the appropriate dope impurity has been added and floats in a quantity of pure material in the outer vessel. The system is used in conjunction with the Czochralsky method for producing single crystals and the resulting crystal has the required degree of doping. The reason for using the rather complicated apparatus is that if the dope were simply added to the melt the concentration of impurity in the crystal would vary as the crystal grew, the last part of the crystal to grow having a much higher doping level and consequently a lower resistivity than the rest. The double crucible compensates for this by keeping the impurity concentration constant as the crystal grows.

The second and perhaps the most important method is that of gas phase doping. This technique is used with the float-zoning method of preparing single crystals. Instead of carrying out the refining in a vacuum, the apparatus is surrounded with a gas containing the required doping atoms. The molten zone slowly absorbs some of the gas thus becoming doped. As the zone moves up the rod the doping proceeds, resulting in a uniform impurity concentration in the crystal.

The resistivity of the long round crystal is measured and it is then cut into thin slices about twenty-five thousandths of an inch thick and one inch in diameter. These are all lapped in order to provide smooth surfaces and finally they are chemically etched to remove damage, e.g. scratches, caused by the slicing process. After being carefully washed in very pure water they are ready to be used for the manufacture of devices. The final slice is about ten thousandths of an inch thick.

Growing Epitaxial Layers

Another manufacturing term which is seen frequently is "epitaxial" and very many devices are now manufactured using the epitaxial planar process. In order to obtain a device with high frequency capabilities it is necessary to use high resistivity material. However it is a disadvantage to make the whole device of this material because of the resultant high impedances. The epitaxial process starts with a low resistivity slice on to which a thin layer of high resisitivity material is grown, the so-called epitaxial layer. The atoms deposited on the surface align themselves with the atoms in the crystal lattice so that they do not constitute crystal defects but are simple extensions of the crystal. The chemical reaction involved in the process is of the form:

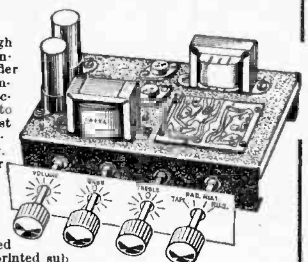
$$SiCl_4 + 2H_2 = Si + 4HCl$$

Silicon tetrachloride reacts with hydrogen to liberate silicon at the surface of the slice. Doping is achieved by adding boron tribromide to the gases to produce p-type material or phosphorous trichloride for n-type material. A similar reduction reaction occurs, boron or phosphorous being deposited as impurity atoms in the epitaxial layer.

An individual transistor, diode, resistor and so on is called a device. An active device is one which can be used to amplify power; a passive device is one which produces no amplification, e.g. a resistor. Next month we shall describe methods of making diodes.

TO BE CONTINUED

NEW! HSL.700 MONO TRANSISTOR AMPLIFIER



A really high fidelity monaural amplifier with performance characteristics to suit the most discriminating listener. 6 transistor circuit with integrated pre-amplifier assembled on special printed sub panel. AD161-AD162 operating in symetrical complementary pair. Output transformer coupled to 3 ohm and 15 ohm speaker sockets. Standard phono input sockets. Full wave bridge rectifier power supply for AC mains 200-240v. Controls: Bass, Treble, Volume/on/off. Function selector for PU1, PU2, Tape, Radio. The HSL.700 is strongly constructed on rigid steel chassis bronze hammer enamel finish, size 9½ × 5 × 4½ in. high.

Performance figures:
Sensitivity—PU1-50m/v, 56K input impedance.
PU2-110m/v, 1 meg input impedance.
Tape—110m/v, 1 meg input impedance.
Radio—110m/v, 1 meg input impedance.

Output power measured at 1Kc—6.2 watts RMS into 3 ohms, 5.8 watts RMS into 15 ohm. Overall frequency response 30 c/s-18 Kc/s: Continuously variable tone controls; Bass, + 8 db to − 12 db at 100 c/s. Treble, + 10 db to —10 db at 10 Kc/s.

The HSL.700 has been designed for true high fidelity reproduction from Radio Tuner, Gramophone deck and Tape Recorder pre amp but is also capable of being used in conjunction with a guitar by connecting to PU1 socket and the peak output power will then be in the region of 15 watts. Supplied complete with knobs, attractive anodised aluminium front escutcheon panel, long spindles (can be cut to suit your housing requirements) full circuit diagram and operating instructions. Limited Number.

Our Special Price **£7.19.6** P. & P. 7/6.

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E.M.I. 8 × 5in. with high flux magnet 21/-. E.M.I. 13½ × 8in. with high flux ceramic magnet 42/- (15 ohm 45/-). E.M.I. 13 × 8in. with two inbuilt tweeters and crossover network. 3 or 15 ohms 4 gns. P. & P. 5in. 2/-, 6½ & 8in. 2/6 10 & 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 Hiflux ceramic ferrobar magnet assembly £5.10.0. P. & P. 5/-. Guitar models: 25w. £6.0.0. 35w. £8.0.0.
E.M.I. 3½in. HEAVY DUTY TWEETERS. Powerful ceramic magnet. Available in 3 or 8 ohms 15/- each; 15 ohms 18/6 each. P. & P. 2/6.
12in. "RA" TWIN CONE LOUDSPEAKER. 10 watts peak handling. 3 or 15 ohm. 35/-. P. & P. 3/6.
35 OHM SPEAKERS
3½in. 12/6; 7 × 4in. 21/-. P. & P. 2/- per speaker.

LATEST COLLARO MAGNAVOX 363 STEREO TAPE DECK. Three speeds 4 track, takes up to 7in. spools. £16.10.0. Carr. 10/-.
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/-.
CRYSTAL MIKES. High imp. for desk or hand use. High sensitivity. 18/6. P. & P. 1/6.
HIGH IMPEDANCE CRYSTAL STICK MIKES. OUR PRICE 21/-. P. & P. 1/6.
CARBON MIKE INSERTS. Brand new 2½in. dia. 5/-. P. & P. 1/6.

NEW S.T.C. TYPE 25 MINIATURE RELAYS—48 volt 4 s/p, c/o contacts. 1 amp rating. Coil resistance 5,800 ohms. Size approx. ¾ × 1¼ × 1¼in. high. 8/6 each. P. & P 1/6

SPECIAL OFFER! PLESSEY TYPE 29 TWIN TUNING GANG. 400pF + 146pF. Fitted with trimmers and 5:1 integral slow motion. Suitable for nominal 470 kc/s I.F. Size approx. 2 × 1 × 1¼in. Only 8/6. P. & P. 2/6.

MAINS TRANSFORMER. Primary 200-240V two separate ½ wave secondaries giving approx 16V at lamp and 20V at 1·2 amp; secs. can be connected in series for 36V at 1·5 amp. Ideal for transistor power supplies. Drop through mounting. Stack size 2¾ × 3½ × ¾in. 15/-. P. & P. 6/-.
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MATCHED PAIR OF 2½ WATT TRANSISTOR DRIVER AND OUTPUT TRANSFORMERS. Stack size 1¼ × 1¼ × ¾in. Output trans. tapped for 3 ohm and 15 ohm output. 10/- pair plus 2/-. P. & P.

HIGH GRADE COPPER LAMINATE BOARDS
8 × 6 × 1/16in. FIVE for 10/- P. & P. 2/-.

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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. to +12dB. Treble cut approx. to —16dB. Negative feedback 18dB over main amp. Power requirements 25V at ·6 amp.
PRICES: AMPLIFIER KIT £10.10.0; POWER PACK KIT £3.0.0; CABINET £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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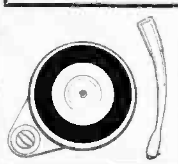

SPECIAL PURCHASE! E.M.I. 4-SPEED PLAYER
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A top quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7" w. × 3" d. × 6" h. Ready built and tested. PRICE 75/-. P. & P. 6/-.
ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet below. PRICE 97/6. P. & P. 7/6.
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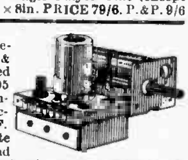
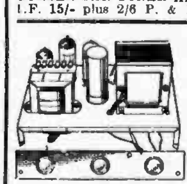
Uncut motor board size 14½ × 12in. clearance 2in. below. 5½in. above. Will take above amplifier and any B.S.R. or GARRARD autochanger or Single Player Unit (except AT60 and SP25). Size 18 × 15 × 8in. PRICE 79/6. P.&P. 9/6

FM/AM TUNER HEAD



Beautifully designed and precision engineered by Dormer & Wadsworth Ltd. Supplied ready fitted with twin ·0005 tuning condenser for AM connection. Prealigned 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 27/6 each. P. & P. 3/-.
GORLER 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)



3-VALVE AUDIO AMPLIFIER MODEL HA34
Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½" w. × 4" d. × 4½" h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker, separate Bass, Treble and volume controls. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £4.5.0. P. & P. 6/-.
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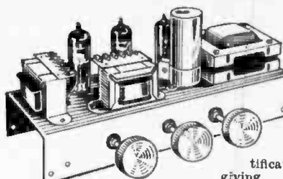
BRAND NEW TRANSISTOR BARGAINS. GET 15 (Matched Pair) 15/-; V15/10p. 10/-; OC71 5/-; OC76 6/-; AF117 3/6; 2G339 (NPN) 3/-.
Set of Mullard 6 transistors OC44, 2—OC45, AC128D matched pair AC128 25/-; ORP12 Cadmium Sulphide Cells 10/6. All post free.

DE LUXE STEREO AMPLIFIER



A.C. mains 200-240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up: —2 × ECL86 Triode Pentodes. 1 × EZ80 as full wave rectifier. Two Dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A Dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate 'Balance' control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v. for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs. Chassis size 11"w × 4"x. Overall height including valves 5". Ready built and tested to a high standard. PRICE 8 gns. P. & P. 8/-.

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LATEST GARRARD MODELS. All types available 1025, 2025, SP25, 3000, AT60 etc. Send S.A.E. for latest Prices!
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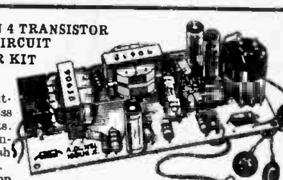

- Peak output in excess of 1½ watts.
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- Built on printed circuit panel size 6 × 3in.
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- Output transformer tapped for 3 ohm and 15 ohm speakers.
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SPECIAL PRICE 45/-. P. & P. 3/-. Also ready built and tested, 52/6. P. & P. 3/-.

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 × 3" deep × 6" high overall. AC mains 200/240v. Supplied absolutely Brand New completely wired and tested with valves and good quality output transformer. FEW ONLY.

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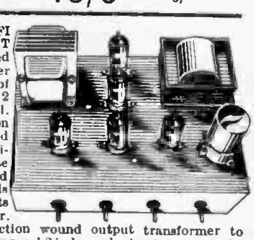

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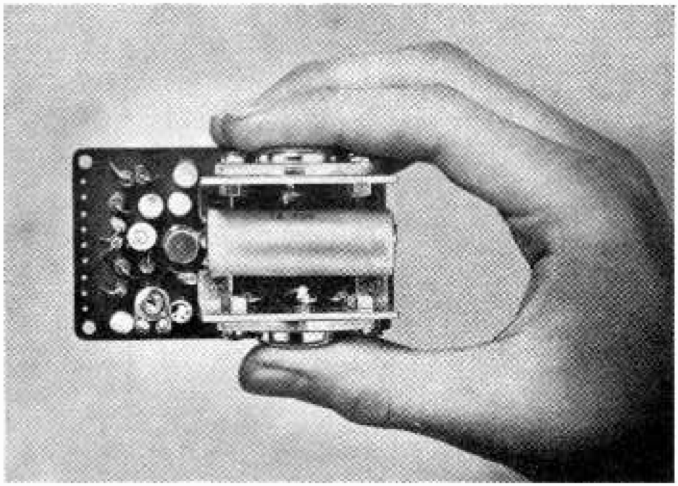
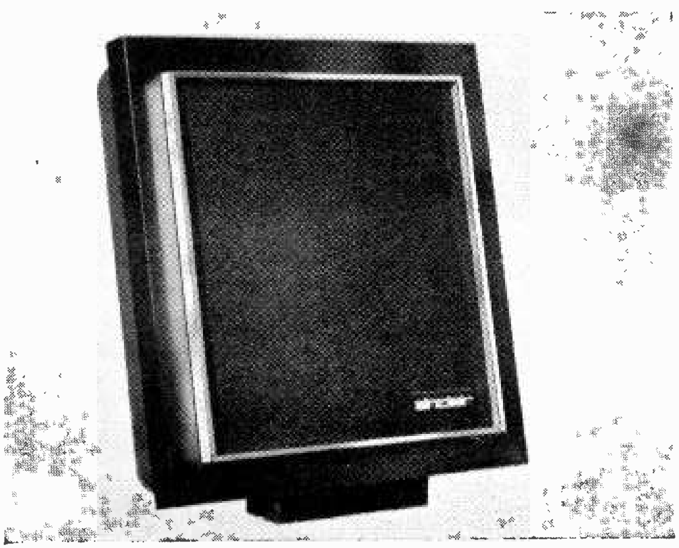


Z.12 - for all you want from any amplifier

The Z.12 is a most versatile integrated amplifier and pre-amp in which power, compactness and true high-fidelity standards are combined within a unit of very modest price. The most widely used unit of its kind in the world, the Z.12 has an output of 12W R.M.S. continuous sine wave (24W peak) or 15W music power (30W peak). It has Class B ultralinear output which can be fed into any loudspeaker from 3 to 15 ohms. (Two 3 ohm speakers can be used in parallel.) Frequency response—15 to 50,000Hz ± 1dB; input sensitivity—2mV into 2 kilohms. The Z.12 will operate from any power source between 6 and 20V d.c. As such, a car battery or the PZ.4 are eminently suitable, giving much wider than usual scope in the applications to which the Z.12 may be put. As well as hi-fi, these include systems for P.A. electronic guitars, organs, intercom systems, laboratory, education or industry. You will find the Z.12 in use in such instances again and again. The Sinclair Z.12 is supplied ready built, tested and guaranteed, complete with manual of circuits and instructions for matching it to your precise requirements. Two may be used in stereo when, with the Stereo 25 and PZ.4 together with two Q.14s, you will have an ideal high fidelity assembly.

89/6
+ P.T. Surcharge



Q.14 - the unique loudspeaker

New materials and original design techniques have been used to produce a speaker of fantastic quality at a most attractive price. Experts and reviewers have enthusiastically endorsed its performance. The shape and size of the Q.14 make it far more adaptable to its environment than is the case with conventionally styled speakers so that it is much easier to position this speaker in the room in which it is to be heard. The Sinclair Q.14 has a substantially flat frequency response from 60 to 16,000Hz and outstandingly good transient response. It will comfortably handle up to 14W loading and is positively brilliant in stereo. Measuring 9¾in. square by 4¾in. deep, this loudspeaker is finished in matt black with solid aluminium bar trim.

Try the Q.14 in your own home without delay. If you are not delighted with it, your money, including cost of return postage to Sinclair, will be refunded immediately.

£7.19.6
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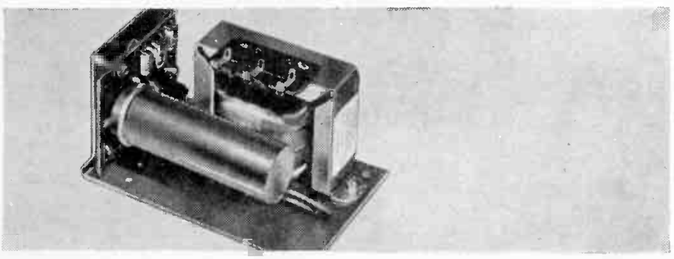
Stereo 25 de-luxe pre-amp/control unit

This is a very elegantly styled unit, which, although designed basically for use with the Z.12, is readily adaptable for use with any high quality power amplifier system. The switched input selector allows for Pick-up, Radio and Auxiliary and there are controls for bass cut and lift, treble cut and lift, volume and stereo balance. P.U. input is equalised to R.I.A.A. curve from 50 to 20,000Hz ± 1dB and the instructions manual provided gives matching details for pick-ups, shows how to connect up, etc. The front panel of the Stereo 25 is finished in brushed and polished aluminium embellished in black. The control knobs are in solid aluminium to match. Size 6½ × 2½ × 2½in. plus knobs. Supplied built, tested and guaranteed.

£9.19.6



PZ.4 - stabilised power supply unit

Designed specially to meet the power requirements for an assembly of two Z.12s and the Stereo 25, this heavy duty transistorized power supply unit has stabilised output of 18V d.c. at up to 1·5A. It is for a.c. mains operation 200/250V.

Supplied built, tested and guaranteed.

99/6

SINCLAIR MICROMATIC

Whether you buy your micromatic in kit form or built ready for use, you must not deny yourself the thrill of owning this fantastically small British receiver. Smaller than a matchbox, it has power range and selectivity that must be experienced to be believed. The high quality magnetic earpiece supplied with the set ensures excellent reproduction indoors and out. The Micromatic tunes over the medium waveband and has A.G.C. to counteract fading from distant stations. Bandpass tuning makes reception of Radio 1 easier; in fact you will find this set performing in some cases where other sets cannot be heard at all. The Micromatic is housed in a neat black case given an elegantly modern appearance by the attractive aluminium front panel and matching tuning control.

Kit in fitted pack with magnetic earpiece, instructions and free solder.

49/6 *+ 11d P.T. Surcharge*

Built, tested and guaranteed, inc. magnetic earpiece.

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Mallor Mercury Cell type RM.675 (2 required) 2/9 each

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PORTABLE CABINET As illustrated. To fit standard player, or autochanger. **75/-**

RCS AMPLIFIER 3 WATT. Ready made and tested This is a 2-stage unit using a triode pentode condenser coupled valve giving 3 watts output into a 3 ohm loudspeaker. Tone and volume controls mounted on chassis with knobs. Supplied with loudspeaker and valve UCL82. Frequency response 50-12,000 cps. Sensitivity 200mV. **59/6** Post 5/6 each item

SINGLE PLAYERS MONO		AUTOCHANGERS MONO	
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Garrard SP25 MkII	£14.19.6	UA70 Transcription	£12.19.6
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E.M.I. PICK-UP ARM Complete with mono cartridge 29/6; Xtal GP67 17/6; Stereo Ceramic 35/-. Powerpoint 56 15/-.

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1½ × ⅝in. 6/6; ACOS 1½ × ⅜in. 9/6. BM3, 1" dia. 9/6
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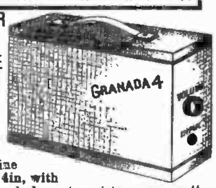

A self-contained fully portable mini p.a. system. Many uses — ideal for Parties, or as a Baby Alarm, Intercom, Telephone or Record Player, Amplifier, etc Attractive rexine covered cabinet size 12 × 9 × 4in, with powerful 7 × 4in. speaker and four transistor one watt power amplifier plus ultra sensitive microphone Uses PP9 battery. Brand new in Makers' carton with full makers' guarantee. World famous make. Only **90/-** Post Free

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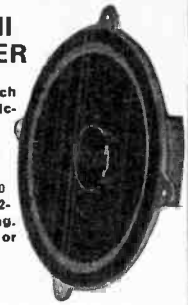

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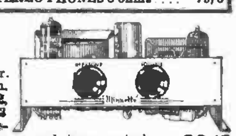

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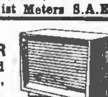

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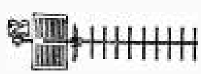

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6F6GB	6/6
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6F11	6/-
6F13	6/6
6F14	12/-
6F15	11/-
6F17	9/-
6F18	7/6
6F23	15/-
6F24	13/-
6F25	14/-
6F28	13/-
6GH8	11/-
6GK6	12/-
6GW6	11/-
6J4	9/-
6J5GT	5/6
6J6	3/6
6J7	8/-
6K6GT	9/-
6K7G	2/6
6K23	9/-
6K25	15/-
6L6GT	8/6
6L7	6/-
6L12	5/-
6L18	6/-

6LD20	5/6
6N7GT	6/6
6P1	11/6
6P25	13/-
6P28	12/-
6Q7	7/-
6SA7	7/-
6SG7	6/-
6SH7	4/6
6SJ7	7/-
6SL7GT	6/-
6SN7GT	5/6
6SQ7	7/-
6SR7	7/-
6SS7	3/-
6T8	6/-
6U4GT	12/-
6U8	6/-
6V6GT	6/-
6X4	4/6
6X5GT	5/-
6X8	11/-
6Y6G	11/6
7C5	13/6
7S7	30/-
7Y4	9/-
7Z4	7/6
9BW6	7/-
9D2	3/6
9D7	9/-
10C2	10/-
10D2	8/-
10F1	18/-
10F9	10/-
10F18	7/6
10L1	7/6
10LD11	10/-
10P13	12/-
10P14	16/-
12AC6	7/-
12AD6	6/-
12AL5	7/6
12AQ5	7/-
12AT6	4/6
12AT7	6/-
12AU7	5/9
12AV6	5/6
12AX7	5/6
12B4A	9/6
12BA6	6/-
12BA7	6/-
12BE6	6/-
12BH7	6/-
12BT6	4/6

12BY7	10/-
12CU6	12/-
12DQ7	10/-
12E1	20/-
12E14	52/6
12K5	10/-
12K8	8/-
12Q7GT	5/6
12SA7GT	8/-
12SC7	4/6
12SG7	6/-
12SK7	6/6
12SQ7	7/6
13D3	5/9
19AQ5	6/-
20CV	62/6
20D1	9/-
20L1	18/-
20P1	10/-
20P3	12/-
20P4	19/-
20P5	19/-
25BQ6GTB	12/-
25C5	9/-
25CU6	12/-
25L6GT	6/6
25Z4G	6/-
25Z5	8/-
25Z6GT	11/-
30A5	7/-
30C15	14/-
30C17	15/-
30C18	14/-
30F5	16/-
30FL1	15/-
30FL12	17/6

30FL13	8/-
30FL14	14/6
30L1	6/-
30L15	16/-
30L17	16/-
30P12	15/-
30P19	14/-
30PL1	15/-
30PL13	17/6
30PL14	17/-
35A5	10/-
35B5	12/-
35C5	6/6
35D5	12/-
35L6GT	8/-
35W4	4/6
35Z3	10/-
35Z4G	4/-
35Z5GT	6/-
50A5	12/-
50B5	12/-
50C5	6/-
50L6GT	7/6
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75C1	8/-
80	7/-
83A1	12/6
85A2	7/6
85A3	7/6
90AG	46/-
90C1	12/-
90CG	25/-
90CV	25/-
150B2	11/-
150B3	10/-
807	9/-
811A	30/-

812A	60/-
813	75/-
837	15/-
866A	14/-
884	10/-
5670	10/-
5751	11/-
5763	12/-
5886	40/-
6080	27/6
6146	27/6
6197	20/-
6360	25/-
6939	40/-
7199	15/-
7360	30/-
7551	30/-
7581	22/6
7591A	20/-
7895	22/6
AZ1	8/-
AZ31	9/-
CCH35	9/-
CY31	7/-
DAF96	7/-
DF96	7/-
DH81	10/-
DH101	9/-
DK92	8/3
DK96	7/6
DL68	13/-
DL96	7/-
DM70	6/-
DY86	6/-
DY87	6/6
DY802	9/-
E55L	52/6

E83F	20/-
E88C	23/-
E88CC	12/6
E130L	100/-
E180F	17/6
EAF801	10/-
EABC80	6/-
EBC33	8/-
EBC41	8/6
EBC81	6/-
EBF80	7/6
EBF83	8/-
EBF89	6/-
EBL1	12/-
EBL31	24/-
EC86	11/6
EC88	11/-
ECC34	8/-
ECC40	10/-
ECC70	17/-
ECC81	6/-
ECC82	5/9
ECC83	5/6
ECC84	5/6
ECC85	5/-
ECC86	8/-
ECC88	7/6
ECC89	11/-
ECC91	3/6
ECC807	14/-
ECF80	6/6
ECF82	6/6
ECF83	14/-
ECF86	9/6
ECF804	32/-
ECH35	11/-
ECH42	10/-

ECH81	5/3
ECH83	8/-
ECH84	9/-
ECL80	7/-
ECL81	7/6
ECL82	6/-
ECL83	10/-
ECL84	10/-
ECL85	10/6
ECL86	8/-
ECLL800	30/-
EF9	8/-
EF37A	8/-
EF39	8/-
EF40	9/-
EF41	9/-
EF42	13/-
EF54	10/-
EF55	12/-
EF80	4/6
EF83	9/6
EF85	6/6
EF86	6/-
EF89	5/-
EF91	4/-
EF92	7/6
EF93	4/-
EF94	5/-
EF95	5/-
EF96	3/6
EF98	10/-
EF183	6/-
EF184	6/6
EF804	20/-
EH90	7/-
EK90	4/6
EL34	9/6
EL36	8/6
EL38	22/6
EL41	9/6
EL42	10/-
EL81	9/-
EL83	7/6
EL84	4/6
EL85	7/6
EL86	8/-
EL90	6/-
EL360	22/-
EL500	17/-
EL821	10/-
EL822	17/-
ELL80	15/-
EM34	15/-
EM71	12/6

EM80	7/-
EM81	7/6
EM84	7/-
EM87	10/-
EN32	30/-
EN91	6/-
EY51	7/-
EY80	8/6
EY81	7/-
EY83	10/-
EY84	9/6
EY86	6/6
EY87	8/-
EY88	8/-
EZ40	7/6
EZ41	8/6
EZ80	5/-
EZ81	5/-
GY501	15/6
GZ32	9/6
GZ33	13/6
GZ34	10/-
HL42DD	8/-
KT66	20/-
KT88	29/-
MH4	7/-
MH41	9/-
ML4	8/-
MSPENT	10/-
N78	19/-
ORP61	5/-
ORP90	22/6
PABC80	7/6
PC86	11/-
PC95	7/6
PC97	8/-
PC900	8/9
PCC84	6/-
PCC85	7/6
PCC88	11/-
PCC89	9/6
PCC189	10/-
PCC805	16/-
PCC806	16/-
PCE800	15/-
PCF80	6/6
PCF82	6/3
PCF84	8/-
PCF86	8/6
PCF87	15/-
PCF800	14/-
PCF801	9/-
PCF802	9/-

PCF805	14/-
PCF806	12/-
PCF808	14/6
PCL80	15/-
PCL81	9/-
PCL82	7/-
PCL83	9/6
PCL84	8/-
PCL85	8/6
PCL86	8/6
PCL88	17/-
PCL800	17/6
PCL801	15/-
PD500	30/-
PE06-40N	35/-
PEN45	6/6
PEN45DD	12/-
PEN383	9/-
PEN384	9/-
PEN453DD	10/-
PF86	10/-
PF818	14/-
PFL200	13/-
PL33	8/-
PL36	10/-
PL81	7/6
PL83	8/-
PL83	7/-
PL84	6/6
PL500	13/6
PL504	15/-
PL509	30/-
PL802	13/-
PY31	5/-
PY32	10/-
PY33	12/6
PY80	5/6
PY81	5/6
PY82	5/-
PY83	6/6
PY88	7/6
PY500	20/-
PY800	9/-
PY801	9/-
QU37	27/-
SP41	5/6
SP61	5/-
TP22	10/-
TT21	35/-
U19	40/-
U20	12/-

U22	8/-
U25	14/6
U26	14/6
U31	8/-
U33	30/-
U76	4/-
U81	10/-
U281	8/-
U282	8/-
U403	8/-
U404	5/-
UABC80	6/-
UAF42	9/6
UBC41	8/6
UBC81	8/6
UBF80	6/6
UBF89	7/-
UBL1	8/6
UC92	6/-
UCC85	7/-
UCF80	9/6
UCH21	9/6
UCH42	9/6
UCH81	6/6
UCL81	10/-
UCL82	7/-
UCL83	9/6
UF9	10/-
UF41	9/9
UF42	10/-
UF43	10/-
UF80	7/-
UF85	7/3
UF89	7/-
UL41	9/6
UL84	6/6
UM4	10/-
UM84	7/-
UU8	7/-
UU9	7/6
UY21	9/6
UY41	7/-
UY82	9/6
UY85	6/-
VU39	9/-
VU111	8/6
VU133	8/-
W76	7/-
W107	7/-
W729	10/-
X65	9/-
Z759	25/-
Z700U	8/-
Z803U	15/-

INTEGRATED CIRCUIT AMPLIFIERS

RCA Type CA3020
Integrated Circuit Audio Amplifier in TO5 encapsulation (size of a small transistor), equivalent to seven n-p-n silicon transistors, 3 diodes and 11 resistors. Power output 550mW. Total harmonic distortion 1%. Will operate on voltage from 3 to 9 volts. 30/- plus 2/- p.p.

GENERAL ELECTRIC Type PA222
Epoxy moulded in-line package equivalent to six n-p-n transistors, one diode and six resistors. It will provide output of up to 1·2 watts into 15 ohms. Battery operation 22 volts. 40/- plus 2/- p.p.

The construction of amplifier using the above integrated circuits had been described in March and August issues of P.W. Please note that we only supply the IC's and no other parts are supplied by us.

GENERAL ELECTRIC TYPE PA234
1-watt Audio Amplifier suitable for supply voltage of 9 to 25V and for output loads of 8, 16 or 22 ohms. Only 3 capacitors and 3 resistors are required for making up a complete amplifier delivering 1 watt for an input voltage of 600mW. Epoxy moulded double four-in-line package. 27/6 each, plus 2/- P. & P.

SILICON WIRE ENDED DIODES
Max. frequency 20mc/s

D223, 50 p.i.v., 50mA 2/-
D233A, 100 p.i.v., 50mA 2/2
D223B, 150 p.i.v., 50mA 2/6

SILICON POWER RECTIFIERS
(Half Wave)

'TOP HAT' type, wire ended:
D226B, 400 p.i.v., 300mA 2/9
D226V, 300 p.i.v., 300mA 2/6

STUD MOUNTED, KD202 series

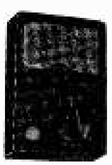
50 p.i.v., 1A	3/-	200 p.i.v., 1A	3/6
50 p.i.v., 3A	5/-	200 p.i.v., 3A	6/-
100 p.i.v., 1A	3/3	300 p.i.v., 1A	3/8
100 p.i.v., 3A	5/-		

SILICON AVALANCHE RECTIFIERS
(Half Wave)

RAS 310 AF, Top Hat type, 1·5A, 1200 p.i.v. 7/6
RAS 508 AF, Stud Mounted, 6A, 960 p.i.v. 10/6

MULTIMETERS

TYPE MF16



D.C. voltage range:
0-0·5-10-50-250-500V.
A.C. voltage range:
0-10-50-250-500V.
D.C. current range:
500μ-10-100mA.
Resistance ranges: 100MΩ-1MΩ.
The meter is also calibrated for capacity and output level measurements. Sensitivity 2000ΩV. Accuracy ±2·5% for D.C. and ±4% for A.C. measurements.
Dimensions: 4¾ x 3¼ x 1¾in. Price £4.5.0.

Type 108-IT: 24 range precision portable meter. 5000 o.p.v. D.C. Volts: 2·5-10-50-250-500-2500V. A.C. Volts: 10-50-100-250-500-2500V; D.C. current 0·5-5-50-500mA Resistance 2000–20,000 ohms; 2–20 megohms. Power output calibration in A.C. for 600 ohms line. Complete with prods and batteries, £6.5.0. P. & P. 5/-.

ZENER DIODES

WIRE ENDED 'TOP HAT' TYPE, 300mW

KC139A 3·9V±1·0%	KC156A 5·6V±10%
KC147A 4·7V±10%	KC168A 6·8V±10%

All at 3/-

WIRE ENDED 'TOP HAT' TYPE, 340mW

D814V 7-8·5V	D814G 10-12V
D814B 8-9·5V	D814D 11·5-14V
D814V 9-10·5V	

All at 3/-

STUD MOUNTED TYPE, 8 WATTS

D815I 4·7±·7V	D815G 10±1·5V
D815A 5·6±·84V	D815D 12±1·8V
D815B 6·8±1·02V	D815E 15±2·2V
D815V 8·2±1·23V	D815Z 18±2·7V

All at 7/6

STUD MOUNTED TYPE, 5 WATTS

D816A 22±3·3V	D817A 56±8·4V
D816B 27±4·0V	D817B 68±10·2V
D816V 33±4·9V	D817V 82±13·2V
D816G 39±5·8V	D817G 100±15V
D816D 47±7·0V	

All at 7/6

Please write for full specification sheet of Zener Diodes

DRY REED INSERTS

Glass dry reed inserts approx. ⅛in. dia. x 1in. long with axial leads. One "make" contact of 100mA capacity at 50V. Can be operated by permanent magnet or 30–50 Amp-turns relay coils. PRICE 18/- per doz. post free.

TRIACS TYPE 40432

Gated bi-directional Silicon Thyristors with integral trigger. The triac will control up to 1440 watts at 240V mains frequency. Supplied complete with heat sink, data sheet and application sheets for motor control and dimmer circuits. 37/6 each.

THYRISTORS

Low current:
Blue spot; 200 p.i.v., 5 Amps. Gate voltage 3·25V at 120mA 12/6

High current:
CR 80-021A, 80 Amps. 25 p.i.v. 25/-
CR 100-151A 30/-
CR 100-201A, 100 Amps. 200 p.i.v. 35/-
CR 100-215A, 100 Amps. 250 p.i.v. 40/-
CR 100-301A, 100 Amps. 300 p.i.v. 45/-
CR 100-351A, 100 Amps. 350 p.i.v. 50/-
CR 100-401A, 100 Amps. 400 p.i.v. 60/-
CR 100-501A, 100 Amps, 500 p.i.v. 70/-

For all CR series Minimum gate firing voltage is 3V at 150mA.

UNIJUNCTION TRANSISTORS 2N2646

Power dissipation 300mW R.M.S. Base-to-Base voltage 35V max. Peak emitter current 2·0A. Suitable for triggering of thyristors. 12/6

TRANSISTORS

Apart from the types listed in our Catalogue the following types are added to our stocks:

2N930	6/8	2N2477	12/6	ASY27	6/6
2N1306	6/-	2N3055	20/-	BC118	8/6
2N2217	6/6	2N3704	5/6	BFX88	5/4
2N2218	7/9	AD161	9/-	P346A	5/-
2N2219	8/6	AD162	9/-		

OUR NEW LIST OF TRANSISTORS IS NOW READY. PLEASE SEND S.A.E. FOR ONE.

PRACTICAL WIRELESS

Query Service

Before using the query service it is important to read the following notes:

The PW Query Service is designed primarily to answer queries on articles published in the magazine and to deal with problems which cannot easily be solved by reference to standard text books. In order to prevent unnecessary disappointment, prospective users of the service should note that:

(a) We cannot undertake to design equipment or to supply wiring diagrams or circuits, to individual requirements.

(b) We cannot undertake to supply detailed information for converting war surplus equipment, or to supply circuitry.

(c) It is usually impossible to supply information on imported domestic equipment owing to the lack of details available.

(d) We regret we are unable to answer technical queries over the telephone.

(e) It helps us if queries are clear and concise.

(f) **We cannot guarantee to answer any query not accompanied by the current query coupon and a stamped addressed envelope.**

QUERY COUPON

This coupon is available until 6th June, 1969 and must accompany all queries in accordance with the rules of our Query Service.

PRACTICAL WIRELESS, JUNE 1969

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