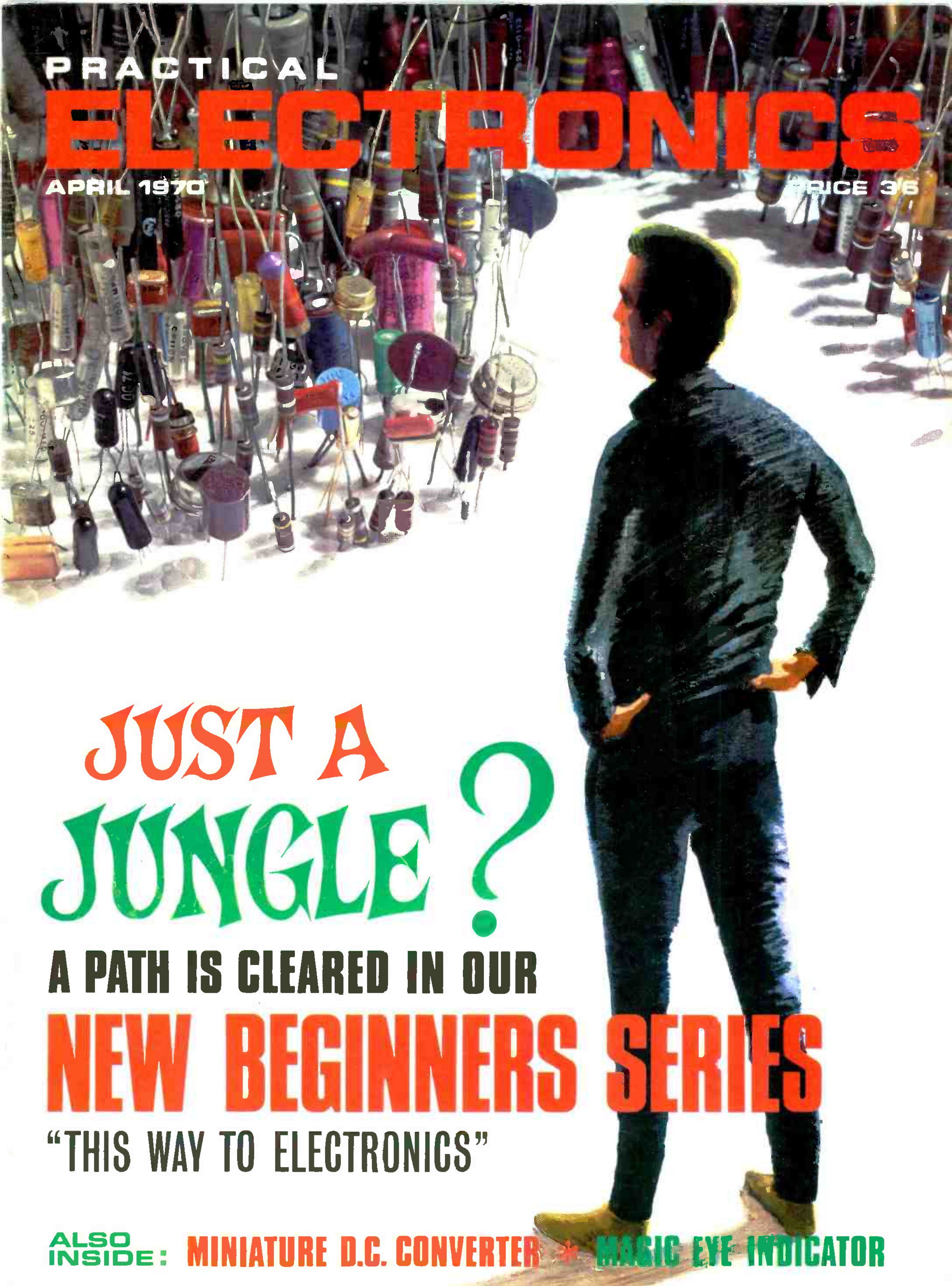
PRACTICAL

ELECTRONICS

APRIL 1970

PRICE 3/6



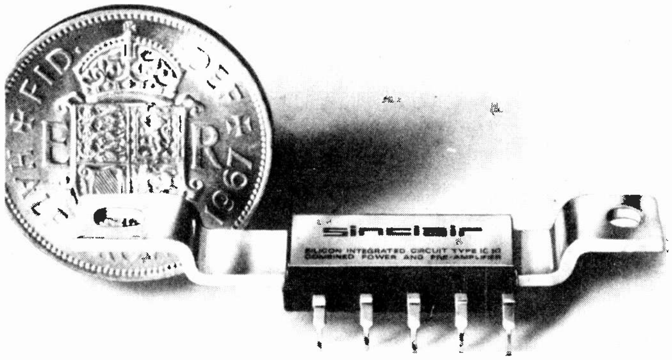
JUST A JUNGLE?

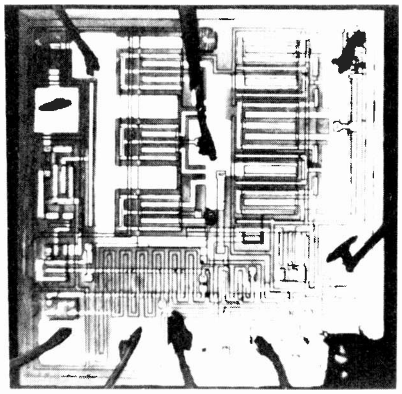
A PATH IS CLEARED IN OUR NEW BEGINNERS SERIES

"THIS WAY TO ELECTRONICS"

ALSO INSIDE: MINIATURE D.C. CONVERTER * MAGIC EYE INDICATOR

MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER AND PRE-AMP





the world's most advanced high fidelity amplifier

The Sinclair IC-10 is the world's first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself, a chip of silicon only a twentieth of an inch square by a hundredth of an inch thick, has an output 5 watts R.M.S. (10 watts peak). It contains 13 transistors (including two power types), 2 diodes, 1 Zener diode and 18 resistors, formed simultaneously in the silicon by a series of diffusions. The chip is encapsulated in a solid plastic package which holds the metal heat sink and connecting pins. This exciting device is not only more rugged and reliable than any previous amplifier, it also has considerable performance advantages. The most important are complete freedom from thermal runaway due to the close thermal coupling between the output transistors and the bias diodes and very low level of distortion.

The IC-10 is primarily intended as a full performance high fidelity power and pre-amplifier, for which application it only requires the addition of such components as tone and volume controls and a battery or mains power supply. However, it is so designed that it may be used simply in many other applications including car radios, electronic organs, servo amplifiers (it is d.c. coupled throughout) etc. The photographic masks required as part of the process of producing monolithic I.Cs are expensive but once made, the circuits can be produced with complete uniformity and at very low cost. This enables us to cover every IC-10 with the Sinclair guarantee of reliability.

■ SPECIFICATIONS

Output	10 Watts peak, 5 Watts R.M.S. continuous.
Frequency response	5 Hz to 100 KHz±1dB.
Total harmonic distortion	Less than 1% at full output.
Load impedance	3 to 15 ohms.
Power gain	110dB (100,000,000,000 times) total.
Supply voltage	8 to 18 volts.
Size	1 × 0.4 × 0.2 inches.
Sensitivity	5mV.
Input impedance	Adjustable externally up to 2.5 M ohms.

■ CIRCUIT DESCRIPTION

The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. Class AB output is used with closely controlled quiescent current which is independent of temperature. Generous negative feedback is used round both sections and the amplifier is completely free from crossover distortion at all supply voltages, making battery operation eminently satisfactory.

■ APPLICATIONS

Each IC-10 is sold with a very comprehensive manual giving circuit and wiring diagrams for a large number of applications in addition to high fidelity. These include stabilised power supplies, oscillators, etc. The pre-amp section can be used as an R.F. or I.F. amplifier without any additional transistors.

SINCLAIR

IC.10 *with IC-10 manual* **59/6**

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22 NEWMARKET ROAD · CAMBRIDGE
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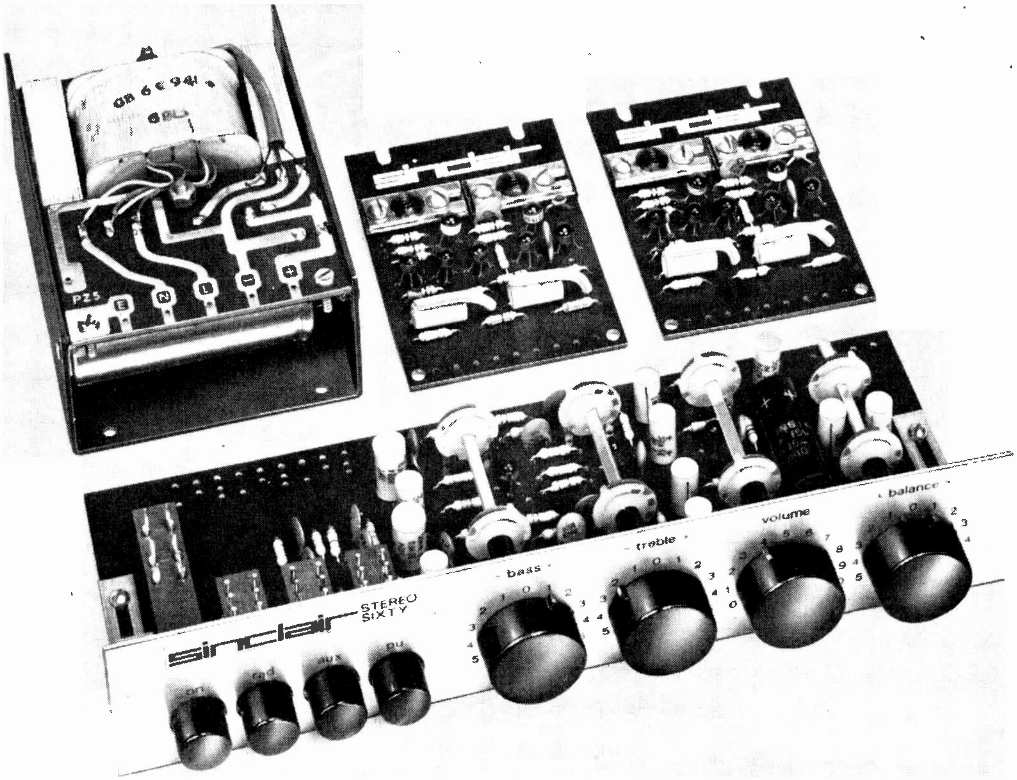
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Q.16

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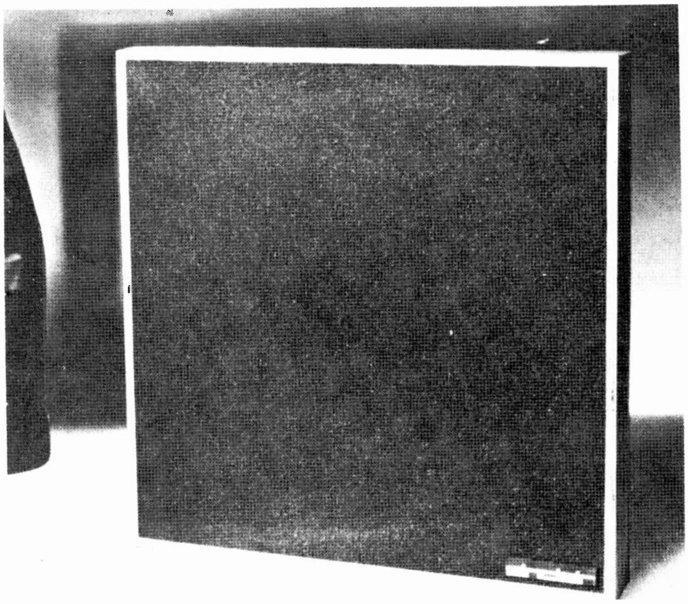

All the superb features which went to make the Sinclair Q.14 have been incorporated in the new Q.16 which gives an exciting new opportunity for you to match your Sinclair equipment with modern decor. Employing the same well proven acoustic system in which materials, processing and styling are used in such a radical and successful departure from conventional design, the new Q.16 presents an entirely new appearance with its attractive teak surround and all-over special cellular foam front chosen as much for its appearance as for its ability to pass all audio frequencies without loss. The Q.16 is compact and slim. Its new styling makes it eminently suitable for shelf mounting, but it is no less versatile than its famous predecessor. Listen to a pair of Q.16s in stereo and marvel at the standards of quality and clarity they give.

The Q.16 will handle loading up to 14 watts R.M.S. and presents an 8 ohm impedance to the amplifier output. Frequency response extends from 60 to 16,000 Hz. with exceptional smoothness. A specially designed driver system is used in a sealed and contoured pressure chamber to ensure good transient response at all frequencies. Size: 9¾" square × 4¾" deep from front to back.

£8.19.6

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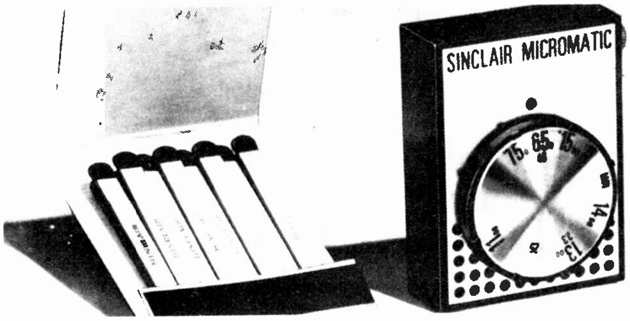
SINCLAIR MICROMATIC

The world's most successful miniature radio



Specifications

Size:
1 13/16" × 1 5/16" × ½" (46 × 33 × 13mm).

Weight incl. batteries:
1 oz. (28·35gm) approx.

Tuning:
Medium wave band with bandspread at higher frequency end.

Earpiece.
Magnetic type.

Case:
Black plastic with anodized aluminium front panel, spun aluminium dial.

Complete kit incl. earpiece, case, solder and instructions in fitted pack. **49/6** *Inc. P/Tax*

Ready buit, tested and guaranteed, with earpiece. **59/6** *Inc. P/Tax*

Mallory Mercury Cell RM675 (2 required) each 2/9d.

Considerably smaller than an ordinary box of matches, this is a multi-stage A.M. receiver meticulously designed to provide remarkable standards of selectivity, power and quality. Powerful A.G.C. is incorporated to counteract fading from distant stations; bandspread at higher frequencies makes reception of Radio 1 easy at all times. Vernier type tuning plus the directional properties of the self-contained special ferrite rod aerial makes station separation much easier than with many larger sets. The plug-in magnetic earpiece which matches exactly with the output provides wonderful standards of reproduction. Everything including the batteries is contained within the attractively designed case. Whether you build your Micromatic or buy it ready built and tested, you will find it as easy to take with you as your wristwatch, and dependable under the severest listening conditions.

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RELAYS

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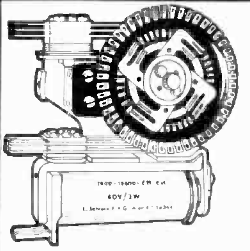
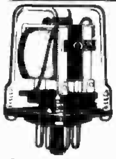


A 48-pole stepping relay with 4 isolated wipers, allowing wiring as 1p. 48W, 2p. 24W, 4p. 12W. Extra contacts allow one momentary make and break per step and a D.P.D.T. every 12th step on the 6th position. Quotes for quantities.

RT TYPE	COIL WATTS	VOLTS d.c.
319240	2	24
314120	4	12
319600	2	60
314480	4	48

***LASKY'S PRICE* 59/6** Post 3/6

THORN PYGMY PLUG-IN



A compact pygmy relay on an 8-pin base with D.P.D.T. contacts rated to 10A. (Some types are 3 P.D.T. on an 11-pin base.) Quotes for quantities.

RN TYPE	Contacts	Base	Coil Voltage
215048	D.P.D.T.	8 pin	48V a.c./d.c.
235004	D.P.D.T.	8 pin	40V d.c.
215060	D.P.D.T.	8 pin	60V a.c./d.c.
305030	3.P.D.T.	11 pin	60V d.c.
205024	D.P.D.T.	8 pin	24V d.c.
215042	D.P.D.T.	8 pin	42V d.c.

OTHERS AVAILABLE IN LIMITED QUANTITIES

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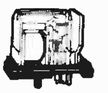
AEI MINIATURE

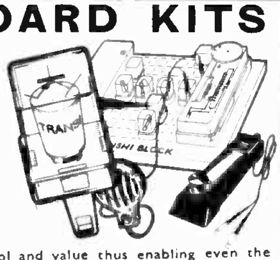


A miniature shrouded 3-pole "make" relay of the chassis mounting type. D.c. coil, 6 or 12V operation (please specify). Useful for remote audio switching circuits, control systems, using low voltage and current, controlling small d.c. motors and pilot lights, etc., and any application switching three circuits from one switch. Quotes for quantities.

***LASKY'S PRICE* 8/6** Post 1/6

EXCLUSIVE

DENSHI BOARD KITS



EDUCATIONAL AND EXPERIMENTAL CIRCUIT SYSTEM

The **DENSHI BOARD** system enables the young experimenter and electronics hobbyist to produce a wide range of transistor circuits of increasing sophistication—without soldering or the use of any tools at all! Basically the system comprises a slotted circuit board into which plug-in components and bridge pieces are set to produce up to 30 different circuits. The components are encapsulated in transparent plastic blocks bearing the appropriate circuit symbol and value thus enabling even the complete novice to visually grasp the fundamentals of circuitry after only a few moments study. **Each DENSHI BOARD KIT comes complete with 80-page manual of circuits and data.** *THESE ARE JUST A FEW OF THE CIRCUITS YOU CAN BUILD IN MINUTES:* VARIOUS RADIO RECEIVERS, AMPLIFIERS, MORSE CODE PRACTICE DEVICE, SIGNAL INJECTOR, SIGNAL TRACER, WIRELESS MICROPHONE, ETC.

DENSHI BOARD KIT SR-1A *comprises:* Base board; tuner block; 4 resistors; choke coil transformer; 2SA transistor for RF; 2 diodes; 3 capacitors; battery block; morse key; antenna lead; crystal earphone; various bridge and connecting pieces and manual. **This kit permits the building of 16 basic circuits.**

***LASKY'S PRICE* 87/6** Post 3/6

WIEN FMX-1917 AM/FM STEREO TUNER AMP

A solid state AM/FM Multiplex tuner Amplifier offering excellent quality and pleasing design at a price you can afford. Brief spec.: 18 transistors, 9 germanium diodes, 1 variable diode and 1 silicon rectifier. Single ended push pull amplifier—output 5W RMS per channel into 8 ohms. Frequency response 30Hz to 12kHz. Frequency range: FM–88 to 108MHz, AM–535 to 1605kHz. Stereo separation 15dB at 100μV input. External FM aerial; built-in ferrite rod antenna for AM. Controls: Balance, Mode, Tone, Vol./on-off, tuning. Input for ceramic phono-pick-up. Powered by 220/250V a.c. 50/60Hz. Extremely well made oiled walnut cabinet with large clear tuning dial (black/grey/silver trim). Size 14 × 8½ × 5½in.

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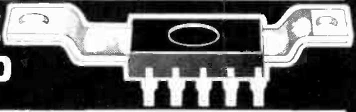
SPECIAL PACKAGE PRICE £51 Post 30/-

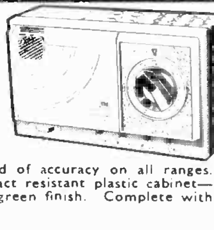
IC-403 INTEGRATED CIRCUIT



Suggested circuits for the IC-403 have been featured in P.E. Originally developed for computer and space projects—these tiny modules—size only 25 × 10 × 5 millimetres—represent the most amazing breakthrough in circuit design since the introduction of the transistor. The IC-403 is an integrated power and pre-amplifier requiring only the addition of tone and volume controls, power source and speaker to form a complete audio amplifier of 3W output. **SPECIFICATION** (ratings at 25°C): Output power typically 3W from 250mV input. Frequency response 20Hz to 80kHz + 3dB. Max. operating voltage 21V. Min. operating load 7·5 ohms. Pre-amp. input imp. 2M/Ohms. Pre-amp. D.C. input current 50nA. COMPLETE WITH INSTRUCTION DATA AND SUGGESTED CIRCUIT APPLICATIONS.

***LASKY'S PRICE* 49/6** Post 1/6 **2 for 95/-** Post free

TTC C-1051 METER



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***LASKY'S PRICE* 75/-** Post 2/6

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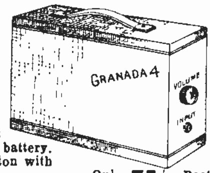

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TWIN GANG. "0-0" 208pF+176pF, 10/6; 365pF, miniature 10/6; 500pF standard with trimmers, 12/6; 500pF midget less trimmers, 7/6; 500pF slow motion, standard 9/-; small 3-gang 500pF 19/6. Single "0" 365pF 7/6. TWIN 10/6.

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TRANSISTOR MAINS POWER PACKS. FULL WAVE 9 volt 500mA. Size 4½ 2½ 2in. Metal case. Crackle finish. Output terminals. On/off switch. **49/6**

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MAINS TRANSFORMERS Post 5/- each

250-0-250 50 mA. 6.3 v. 2 amps, centre tapped	19/6
250-0-250 80 mA. 6.3 v. 3.5 a. 6.3 v. 1 a. or 5 v. 2 a.	35/-
350-0-350 80 mA. 6.3 v. 3.5 a. 6.3 v. 1 a. or 5 v. 2 a.	35/-
300-0-300 v. 120 mA., 6.3 v. 4 a. C.T.; 6.3 v. 2 a.	45/-
MINIATURE 200 v. 20 mA., 6.3 v. 1 a. 2½ 2 1½in.	12/6
MIDGET 220 v. 45 mA., 6.3 v. 2 a. 2½ · 2½ 2in.	17/6
HEATER TRANS. 6.3 v. 1½ a., 10/6; .. 6.3 v. 4 a.	15/6
Ditto tapped sec. 1.4 v., 2, 3, 4, 5, 6.3 v. 1½ amp. ..	15/6

GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 a. 35/-

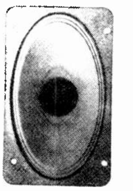
1 amp., 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60. 35/-

AUTO TRANSFORMERS 0-115-230 v. Input/Output, 60w. 18/6; 150w. 35/-; 500w. 95/-; 1000w. 195/-.

CHARGER TRANSFORMERS. Input 200/250v for 6 or 12v., 1½ amp., 22/-; 4 amp., 35/-.

FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12v. outputs. 1½ amp. 8/9; 2 amp. 11/3; 4 amp. 17/6.

COAXIAL PLUG 1/3, PANEL SOCKETS 1/3, LINE 3/6. OUTLET BOXES, SURFACE OR FLUSH 4/6. BALANCED TWIN FEEDERS 1/- yd. 80 ohms or 300 ohms. JACK SOCKET Std. open-circuit 2/6, closed circuit 4/6; Chrome Lead Socket 7/6. Phono Plugs 1/-. Phono Socket 1/-. JACK PLUGS Std. Chrome 3/-; 3·5mm Chrome 2/6. DIN SOCKETS Chassis 3-pin 1/6; 5-pin 2/-. DIN SOCKETS Lead 3-pin 3/6; 5-pin 5/-. DIN PLUGS 3-pin 3/6; 5-pin 5/-. VALVE HOLDERS. 9d.; CERAMIC 1/-; CANS 1/-.



E.M.I. 13½ × 8in. LOUDSPEAKERS

With flared tweeter cone and ceramic magnet. 10 watts. Bass res. 45-60 cps. Flux 10,000 gauss. Speech coil, 3 or 15 ohm. **45/-**

Recommended Teak Cabinet Size 16 · 10 × 9in. **94/6**

Also with twin tweeters 3 or 8 or 15 ohms. 10 watt. **79/6**

MINI-MODULE LOUDSPEAKER KIT

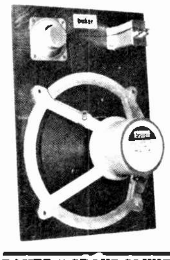
10 WATT **65/-** CARRIAGE 5/-

Triple speaker system combining on ready cut baffle. ½ in. chipboard 15 in. × 8½ in. Separate Bass, Middle and Treble loudspeakers and crossover condenser. The heavy duty 5 in. Bass Woofer unit has a low resonance cone. The Mid-Range unit is specially designed to add drive to the middle register and the tweeter recreates the top end of the musical spectrum. Total response 20-15,000 cps. Full instructions for 3 or 8 ohm.

TEAK VENEERED BOOKSHELF ENCLOSURE. 16 × 10 · 9 in. Modern Scandinavian fluted front design for Mini-Module. **94/6** Post 5/-

ALL MODELS "BAKER SPEAKERS" IN STOCK

BAKER 12in MAJOR £8



30-14,500 c.p.s., 12in double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 45 c.p.s. Rated 20 watts. Voice coils 3 or 8 or 15 ohms.

Module kit, 30-17,000 c.p.s. with tweeter, crossover, baffle and instructions. **£10.19.6**

BAKER "GROUP SOUND" SPEAKERS POST FREE

'Group 25' 12in 25 watt **6gns.** 'Group 35' 12in 35 watt **8½gns.** 'Group 50' 15in 50 watt **18gns.**

TEAK HI-FI SPEAKER CABINETS. Fluted wood front.

For 10 or 12in round Loudspeaker	£8.10.0.
For 13 8in or 8in round Loudspeaker	£4.14.6.
For 10 6in or 6½in round Loudspeaker	£3.16.6.

LOUDSPEAKER CABINET WADDING 18in wide. 2/6ft

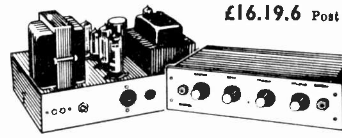
Goodmans Tweeter 3½in 3 ohm 35/-, EMI 2½in 8 ohm 17/6. Horn Tweeters 2-18kc/s, 10W 15 ohm 29/6. Crossover 16/6. LOUDSPEAKERS P.M. 3 OHMS. 2½in, 3in, 4in, 5in, 5×3in, 7 4in. 17/6 each; 6½in 22/6; 8 · 5in, 21/-; 8 · 2½in 21/-; 10 6in. 30/-; 10in. or 12in. Double cone 3 or 15 ohm 39/6.

SPECIAL OFFER: 80 ohm. 2½in, 2¾in. 35 ohm, 3 in. 25 ohm, 6 4in; 8 · 5in. 15 ohm. 7 × 4in.; 8 · 5in. **15/6** EACH TYPE

8in LOUDSPEAKER UNITS 3 ohm 27/6; 15 ohm 30/-. ELAC 8 in. De Luxe Ceramic 3 ohm 45/-; 15 ohm 50/-. 8in LOUDSPEAKER. TWIN CONE 3 ohm 35/-. 5 in. WOOFER. 8 watts max. 20-10,000 cps. 8 or 15 ohm. 39/6. OUTPUT TRANS. EL84 etc. 4/6; MIKE TRANS. 50:1 3/9. SPEAKER COVERING MATERIALS. Samples Large S.A.E.

THE FAMOUS "MULLARD 510"

£16.19.6 Post 10/6



Main power. amplifier and 2 valve pre-amplifier. Silver grey facia panel. Volume, treble, bass controls. Function switch: Radio, Tape 1, Tape 2, Mic, Gram LP, Gram 78. Tape output socket. Valves: 2 · EL84, 3 · EF86, 1 ECC83, 1 EZ81. Ultra linear Parmeko output transformer. 20 db negative feedback, 10 watts rms. mono. 3 and 15 ohm output. Brand new. Guaranteed.

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SUPPLIED AT LOWEST PRICES. ILLUSTRATED EAGLE CATALOGUE 5/-. Post free.

BARGAIN AM TUNER. Medium Wave. Transistor Superhet. Ferrite aerial. 9 volt. **79/6**

BARGAIN DE LUXE TAPE SPLICER Cuts, trims, joins for editing and repairs. With 3 blades. **22/6**

BARGAIN 4 CHANNEL TRANSISTOR MIXER. Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9 volt. **59/6**

BARGAIN FM TUNER 88-108 Mc/s Six Transistor. 9 volt. Printed Circuit. Calibrated slide dial tuning. Walnut Cabinet. Size 7 · 5 4in. **£9.10.0**

BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built, with volume control. 9v. **69/6**

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Practical Transistor Receivers	5/-
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Supersensitive Transistor Pocket Radio	3/6
Radio Valve Guide, Books 1, 2, 3, or 4 ea. 5/- No. 5 ea.	6/-
T.V. Fault Finding 405/625 lines	8/6
Shortwave Transistor Receivers	5/-
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Sub-Miniature Transistor Receivers	5/-
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Transistor Circuits for Radio Controlled Models.........	7/6
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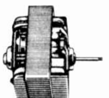
3 inch MOVING COIL METERS BRITISH MADE

Various calibrations/movements. 500 Microamp; 1 Milliamp; 50-0-50 Microamp. etc. S.A.E. for list. **37/6**



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(120v. or 240v. AC). Size 2½ × 2½ × 1½in. Clockwise 1,200 r.p.m. off load. Heavy duty 4 pole 50mA. Spindle ⅞ 3/20. BARGAIN PRICE **17/6** EACH Post 2/6 3 for 50/-; 6 for 90/-.

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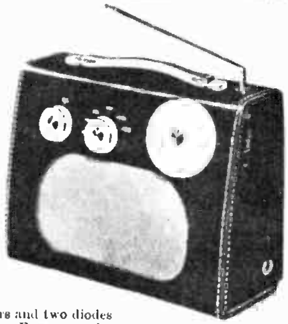
NEW! roamer eight mk 1

WITH VARIABLE TONE CONTROL

7 Tunable Wavebands: Medium Wave 1, Medium Wave 2, Long Wave, S.W.1, S.W.2, S.W.3, and Trawler Band. Built in ferrite rod aerial for Medium and Long Waves. 5 section 22in chrome plated telescopic aerial for Short Waves can be angled and rotated for maximum performance. Push-pull output using 600Mw type transistors. Socket for car aerial. Tape record socket. Selectivity switch. Switched earpiece socket complete with earpiece for private listening. 8 transistors plus 3 diodes. Famous make 7 × 4in speaker. Air spaced ganged tuning condenser. On/off switch volume control. Wave change switch and tuning control. Attractive case in rich chestnut shade with gold blocking. Size 9 × 7 × 4in approx. Easy to follow instructions and diagrams make the Roamer Eight a pleasure to build. Parts price list and easy build plans 5/- (FREE with parts).

Total building costs **£6.19.6** P. & P. 7/6

roamer seven mk IV

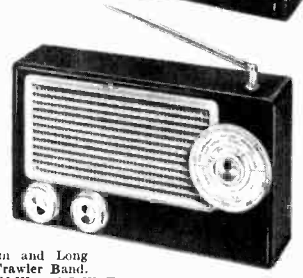


7 FULLY TUNABLE WAVE BANDS—M.W.1, M.W.2, L.W., S.W.1, S.W.2, S.W.3 and Trawler Band. Extra Medium waveband provides easier tuning of Radio Luxembourg, etc. Built in ferrite rod aerial for Medium and Long Waves. 5 Section 22in chrome plated telescopic aerial for Short Waves—can be angled and rotated for peak S.W. listening. Socket for Car Aerial. Powerful push-pull output. 7 transistors and two diodes including Micro-Alloy R.F. Transistors. Famous make 7 × 4in P.M. speaker. Air spaced ganged tuning condenser. Volume/on/off control, wave change switches and tuning control. Attractive case with carrying handle. Size 9 × 7 × 4in approx. Easy to follow instructions and diagrams make the Roamer 7 a pleasure to build. Parts price list and easy build plans 3/- (FREE with parts).

Total building costs **£5.19.6** P. & P. 7/6

Personal Earpiece with switched socket for private listening, 5/- extra.

NEW! transeight



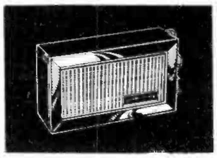
SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive case in black with red grille and cream knobs and dial with polished brass inserts. Size 9 × 5½ × 2¾in. approx. Tunable on Medium and Long Waves, 3 Short Waves and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 8 improved type transistors plus 3 diodes. Push-pull output. Ample power to drive a larger speaker. Parts price list and easy build plans 5/- (FREE with parts).

Total building costs **89/6** P. & P. 5/6

Earpiece with switched socket for private listening 5/- extra.

pocket five



MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER AND EARPIECE

Attractive black and gold case. Size 5½ × 1½ × 3½in. Tunable over both Medium and Long Waves with extended M.W. band for easier tuning of Luxembourg, etc. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker, also Personal Earpiece with switched socket for private listening. Easy build plans and parts price list 1/6 (FREE with parts).

Total building costs **44/6** P. & P. 3/6

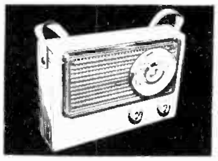
transona five

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER AND EARPIECE

Attractive case with red speaker grille. Size 6½ × 4½in × 1½in. 7 stages—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker also Personal Earpiece with switched socket for private listening. Easy build plans and parts price list 1/6 (FREE with parts).

Total building costs **47/6** P. & P. 3/9

roamer six



SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive case with gilt fittings. Size 7½ × 5½ × 1½in. Tunable on Medium and Long Waves, two Short Waves, Trawler Band plus an extra M.W. band for easier tuning of Luxembourg, etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 8 stages—6 transistors and 2 diodes including Micro-Alloy R.F. Transistors, etc. (Carrying strap 1/6 extra). Easy build plans and parts price list 2/- (FREE with parts).

Total building costs **79/6** P. & P. 4/6

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ROAMER EIGHT	☐	ROAMER SEVEN	☐
TRANSEIGHT	☐	POCKET FIVE	☐
TRANSONA FIVE	☐	ROAMER SIX	☐

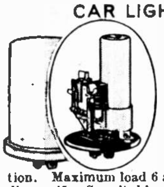
Parts price list and plans for ....

Name ....

Address ....

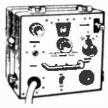
PE16

CAR LIGHT FLASHERS



Heavy duty light flasher employs a condenser discharge principle operating on electro mechanical relay. (As inset.) Housed in strong plastic case. Flashing rate between 60-120 per minute. 12 volt DC operation. Maximum load 6 amps. Size 2 11/16" dia. × 4". Supplied brand new at a fraction of original cost. **6/6 each.** P. & P. 2/6. (3 for 17/6. P. & P. 4/6.)

CLASS D WAVEMETERS



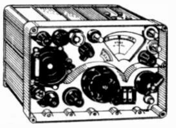
A crystal controlled heterodyne frequency meter covering 1·7–8 Mc/s. Operation on 6V d.c. Ideal for amateur use. Available in good used condition. **£5.19.6.** Carr. 7/6, or brand new with accessories. **£7.19.6.** Carr. 7/6.

CLASS D WAVEMETERS No. 2

Crystal controlled. 1·2–19 Mc/s. Mains or 12V d.c. operation. Complete with calibration charts. Excellent condition. **£12.10.0.** Carr. 30/-.

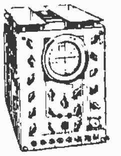
R209 MK II COMMUNICATION RECEIVER

11 valve high grade communication receiver suitable for tropical use. 1·20 Mc/s on 4 bands. AM/CW/FM operation. Incorporates precision vernier driver, BFO. Aerial trimmer, internal speaker and 12 V d.c. internal power supply. Supplied in excellent condition, fully tested and checked.



£15 Carr. 20/-.

TYPE 13A DOUBLE BEAM OSCILLOSCOPES



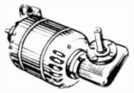
An excellent general purpose D/B oscilloscope. T.B. 2 c/s–750 kc/s. Bandwidth 5·5 Mc/s. Sensitivity 33 mV/CM. Operating voltage 0/110/200/250 V. a.c. Supplied in excellent working condition. **£22.10.0** or complete with all accessories, probe, leads, lid, etc. **£25.** Carriage 30/-.

MARCONI CT44/ TF956 AF ABSORPTION WATTMETER

1 μ/watt to 6 watts.

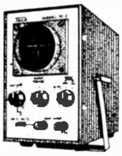
£20. Carr. 20/-.

GEARED MAINS MOTORS



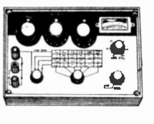
Paralux - type SD19 230/250V a.c. Reversible. 30 RPM. 40 lb in. Complete with capacitor. Excellent condition. **99/6.** Carr. 10/-.

TO-2 PORTABLE OSCILLOSCOPE



A general purpose low cost economy oscilloscope for everyday use. Y amp. Bandwidth 2 CPS-1 MHZ. Input imp. 2 meg Ω 25 P.F. Illuminated scale. 2in. tube. 115 × 180 × 230mm. Weight 8lb. 220/240 V a.c. Supplied brand new with handbook. **£22.10.0.** Carr. 10/-.

TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE

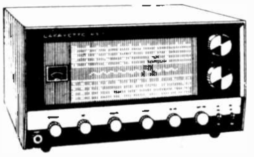


A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1 Ω–11·1 meg Ω 6 Ranges ±1%. L.1 μH – 111 HENRYS 6 Ranges –2%. C. 10pF ±1110 mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000–1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7¾ × 5 × 2in. **£20.** P. & P. 5/-.

UNR-30 4-BAND COMMUNICATION RECEIVER

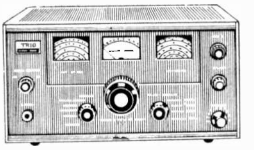
Covering 550 Kc/s–30 Mc/s. Incorporates BFO. Built-in speaker and phone jack. Metal cabinet. Operation 220/240V. a.c. Supplied brand new, guaranteed with instructions. Carr. 7/6 **13 gns.**

TRIO JR-310 NEW AMATEUR BAND 10-80 METRE RECEIVER. In stock. **£77.10.0.**



LAFAYETTE SOLID STATE HA600 RECEIVER

5 BAND AM/CW/SSB AMATEUR AND SHORT WAVE 150 kc/s–400 kc/s and 550 kc/s–30 Mc/s FET front end ● 2 mechanical filters ● Huge dial ● Product detector ● Variable BFO ● Noise limiter ● S meter ● 24in Bandspread ● 230V a.c./12V d.c. neg. earth operation ● RF gain control. Size 15in × 9¾in × 8½in. Weight 18lb. EXCEPTIONAL VALUE. £45. Carr. 10/-. S.A.E. for full details.



TRIO COMMUNICATION RECEIVER MODEL 9R-59DE

4 band receiver covering 550Kc/s to 30Mc/s. continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW ● ANL ● Variable BFO ● S meter ● Sep. bandspread dial ● IF 445Kc/s ● Audio output 1·5W. ● Variable RF and AF gain controls. 115/250V A.C. Mains. Beautifully designed. Size: 7 × 15 × 10in. With instruction manual and service data. **£42** Carriage paid.
TRIO COMMUNICATION TYPE HEADPHONES Normally **£5.19.6.** OUR PRICE **£3.15.0** if purchased with above receiver.

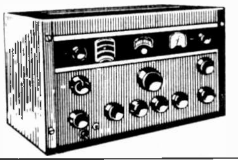
TRIO JR-500SE 10-80 Metre AMATEUR RECEIVER £69.10.0

TRIO TS 510 AMATEUR TRANSCEIVER with speaker and mains P.S.U. £212

UR-1A SOLID STATE COMMUNICATION RECEIVER

4 bands covering 550 Kc/s–30 mc/s continuous. Special features are use of FET transistors, S meter, built in speaker and telescopic aerial, variable BFO for SSB reception, noise limiter, bandspread control, sensitivity control. Output for low impedance headphones. Operation 220/240 volt A.C. or 12 volt D.C. Size 12⅞" × 4½" × 7". Excellent value. ONLY **£24.** Carr. 7/6.

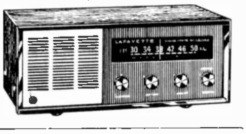
LAFAYETTE HA.800 6-BAND AMATEUR RECEIVER. £57.10.0. Carr. Paid.



RCA COMMUNICATION RECEIVER AR88D

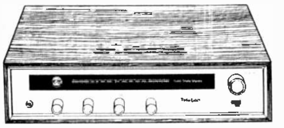
Latest release by ministry BRAND NEW in original cases. 110–250V a.c. operation. Frequency in 6 Bands. 535Kc/s–32Mc/s continuous. Output impedance 2·5–600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price **£87.10.0.** Carr. £2.

LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER

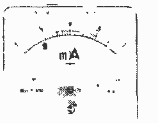


A completely new transistorised receiver covering 152–174 Mc/s. Fully tuneable or crystal controlled (not supplied) for fixed frequency operation. Incorporates 4 INTEGRATED CIRCUITS. Built in speaker and illuminated dial. Squelch and volume controls. Tape recorder output. 75 Ω aerial input. Headphone jack. Operation 230V. A.C./12V. D.C. Neg. earth. **£37.10.0.** Carr. 10/-.

TELETON MODEL CR 10T AM/FM STEREO TUNER AMPLIFIER



A new model from Teleton. 31 solid state devices. 4 + 4 watt output. Inputs for ceramic/crystal cartridge. Frequency range AM 540-1600 KHz FM 88-108 MHz. Automatic FM stereo reception. Stereo indicator. Controls: Tuning, function selector, Tone and R & L volume controls. AFC switch. Stereo headphone socket. Size: 13¾" × 3¼" × 9¼" approx. Price **£34.** Carr. 7/6.



CLEAR PLASTIC PANEL METERS

First grade quality Moving Coil panel meters. Type MR 38P. 1 21/32in square fronts.

50μA 40/-	500-0-500μA 27/6	50mA 27/6	150V. D.C. 27/6
50-0-50μA 37/6	1mA 27/6	100mA 27/6	300V. D.C. 27/6
100μA 37/6	1-0-1mA 27/6	150mA 27/6	500V. D.C. 27/6
100-0-100μA 35/-	2mA 27/6	200mA 27/6	750V. D.C. 27/6
200μA 35/-	5mA 27/6	300mA 27/6	15V. A.C. 27/6
500μA 40/-	10mA 27/6	500mA 27/6	50V. A.C. 27/6
	750mA 27/6	3V. D.C. 27/6	150V. A.C. 27/6
	1 amp 27/6	10V. D.C. 27/6	300V. A.C. 27/6
	2 amp 27/6	20V. D.C. 27/6	500V. A.C. 27/6
	5 amp 27/6	100V. D.C. 27/6	S meter 1mA. 32/-
	20mA 27/6		VU meter 42/-

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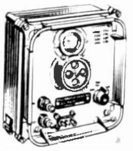
50 WATT. 10/25/50/100/250/500/1,000/2,500 or 5,000 ohms, **21/-.** P. & P. 1/6.
100 WATT. 1/5/10/25/50/100/250/500/1,000 or 2,500 ohms, **27/6.** P. & P. 1/6.

CRYSTAL CALIBRATORS No. 10



Small portable crystal controlled wavemeter. Size 7" × 7½" × 4". Frequency range 500 Kc/s. 10 Mc/s (up to 30 Mc/s on harmonics). Calibrated dial. Power requirements 300 V.D.C. 15mA and 12 V.D.C. 0.3A. Excellent condition. **89/6.** Carr. 7/6.

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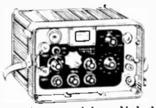

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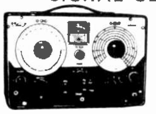
Also see oppos. page

ARF-100 COMBINED AF-RF SIGNAL GENERATOR



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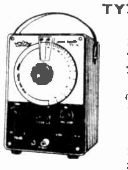

Sine Wave 20c/s to 200kc/s. Square Wave 20c/s to 30kc/s. High and low impedance output. Output variable up to 6 volts. 220/240 volts a.c. Size 210 × 150 × 120mm. Brand new with instructions. **£16.** Carr. 7/6.

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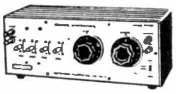
TE111. DECADE RESISTANCE ATTENUATOR



Variable range 0–111dB. Connections. Unbalanced T and Bridge T. Impedance 600 Ω range (0·1dB · 10) + (1dB × 10) + 10 + 20 + 30 + 40dB. Frequency: d.c. to 200kHz (−3dB). Accuracy: 0·05dB. +indication dB × 0·01. Maximum input less than 4W (50V). Built in 600 Ω load resistance with internal/external switch. Brand new **£27.10.0.** P. & P. 5/-.

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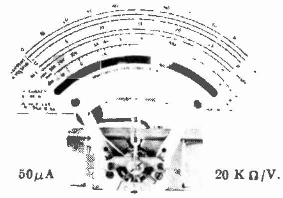

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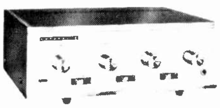

19 transistors, 8 diodes. IHF music power, 30W at 8 Ω. Response 30–20,000 2dB at 1W. Distortion 1% or less. Inputs 3mV and 250mV. Output 3 16 Ω. Separate L and R volume controls. Treble and bass control. Stereo phone jack. Brushed aluminium, gold anodised extruded front panel with complementary metal case. Size 10¼ 3 9/16 7 13/16in. Operation 115/230V. A.C. **£24.** Carriage 7/6.

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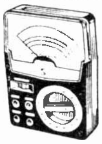

TE-51. NEW 20,000 Ω/VOLT MULTIMETER with overload protection and mirror scale. 0/6/60/120/1,200V a.c. 0/3/30/60/300/600/3,000V d.c. 0–60μA/12/300mA d.c. 0/60K/6 meg. ohm. **92/6.** P. & P. 2/6.

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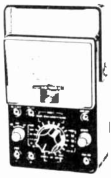

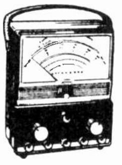

TE-900 20,000 Ω VOLT GIANT MULTIMETER 6in full view meter. 2 colour scale, overload protection. 0/2·5/10/250/1,000/5,000V a.c. 0/25/12·5/10/50/250/1,000/5,000V d.c. 0/50μA/10/100/500mA 10A d.c. 20K/200K/20 MΩ. **£15.** P. & P. 5/-.

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MODEL TE-90 50,000 O.P.V. MIRROR SCALE OVERLOAD PROTECTION 0/3/12/60/300/600/1,200V d.c. 0/6/30/120/300/1,200V d.c. 0/03/6/60/600MA d.c. 16k Ω/160k Ω/1·6/16M Ω. −20 to +63dB. **£7.10.0.** P. & P. 3/-.

MODEL TE 80. 20,000 O.P.V. 0/10/50/100/500/1,000V. a.c. 0/5/25/50/250/500/1,000V d.c. 0·5μA. 5/50/500mA/0/6K/60K/600K/6 Meg **£4.17.6.** P. & P. 3/-.

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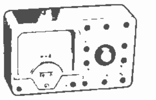

MODEL PT-34. 1,000 O.P.V. 0/10/50/250/500/1,000V a.c. and d.c. 0/1/100/500 mA d.c. 0/100 KΩ **39/6.** P. & P. 1/6.

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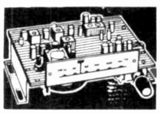
★ TRANSISTORISED FM TUNER ★



6 TRANSISTOR HIGH QUALITY TUNER. SIZE ONLY 6 × 4 × 2½in. 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88–108 Mc/s. Ready built ready for use. Fantastic value for money. **£6.7.6.** P. & P. 2/6. Stereo multiplex adaptors **99/6.**

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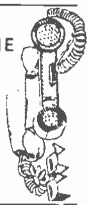

Operative over amazingly long distances. Separate call and press to talk buttons. 2-wire connection. 1000's of applications. Beautifully finished in ebony. Supplied complete with batteries and wall brackets. **£6.19.6.** P. & P. 3/6.

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5¾in. 1,200ft. L.P. mylar	16/–
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VOL. 6 No. 4
April 1970

PRACTICAL ELECTRONICS

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DOMESTIC HELP

THE achievements of electronic technology have long been in evidence in every home. Products such as radio, television and hi-fi equipment are an essential part of modern life. Thus in the average household electronics is naturally enough associated first and foremost with entertainment. And there is little reason to suppose this will not always remain so.

This is not to deny that other quite distinctive and immensely important roles for electronic techniques will enter into the domestic scene in due course. Power control is very much a case in point. Electronic methods for controlling electric power have been in use in industrial equipment for a very considerable time, but only during the last six months or so have we seen the emergence, in any consequence, of electronically controlled domestic appliances. Now there are on the market a number of washing machines which incorporate electronic control, giving a smooth drum operation with several spin speeds, without the need for complex mechanical gear boxes.

The advantages of electronic power control are not restricted to washing machines, and we can expect further penetration into the domestic appliance field by electronics. But only in the medium power range, it seems. Immediately one contemplates controlling loads of the order of kilowatts, technical and cost problems arise.

Washing machines (and other medium power appliances such as food mixers, and electric blankets, for instance) can operate satisfactorily with the phase shift method of thyristor operation. But if large loads, such as electric fires, were to employ this method a serious distortion of the mains supply waveform could occur. For this reason the Electricity Council has advised that where large loads are involved an alternative method known as burst-fire operation should be used.

Unfortunately, burst-fire operation is considered too complex and costly for domestic appliances. So the advantages in comfort and economy of a continuously variable heat control over step switching of elements will not be realised, not for a while at any rate.

Even the Gas Industry is coming to recognise the services electronic devices can offer. Already, electric ignition is in common use in gas ovens and fires. The introduction of natural gas poses some new problems, since it is more difficult to ignite by the normal glow coil. A high frequency spark generated by an electronic circuit may be the answer here.

In these behind the scene roles, electronics is giving valuable support to the basic but essential domestic services, and so demonstrating that it is truly a maid-of-all work, and that entertainment is only one of its functions in the home even if, inevitably, the more apparent and glamorous one.

F.E.B.

THIS MONTH

CONSTRUCTIONAL PROJECTS

SPECIAL SERIES

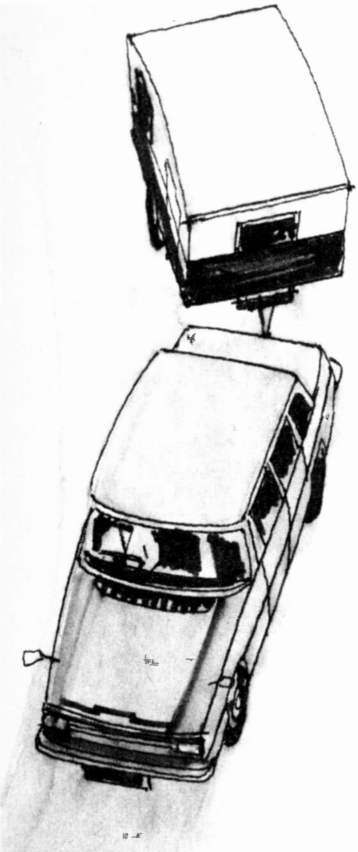
GENERAL FEATURES

BEGINNERS

NEWS AND COMMENT

Our May issue will be published on Monday, April 13

Editorial and advertisement offices: Fleetway House, Farringdon St., London, E.C.4. Phone 01-236 8080



USE IT IN YOUR CAR, CARAVAN OR BOAT!

EACH year the number of caravans, campers and boat owners continues to grow. With this there is the need for a simple converter to enable electric shavers and other low power appliances—e.g. fluorescent tubes—to be run from a 12V battery. The source of power is usually a car battery, producing an output from the converter of 240 volts. Ideally the 240 volts should be at 50Hz a.c., but as will be seen later there are considerable advantages in making the output d.c.

There are a number of alternatives available for power conversion, namely: rotary converters, vibrator packs and transistorised converters. Rotary converters tend to be inefficient, noisy and large. Vibrator packs have reasonable efficiency but are noisy, bulky and often unreliable. The transistorised converter does not suffer from any of these disadvantages and, provided the power requirements are not excessive, can be physically quite small.

OPERATING FREQUENCY

The operating frequency of the converter governs the inductance requirements of the transformer for a given output power. The lower the frequency the higher the inductance and consequently a larger transformer is needed.

If 50Hz operation is required the transformer must be fairly large and so it was decided to use a higher frequency and rectify the output to give 240 volts d.c. The d.c. output is suitable for most purposes as the majority of shavers are of the a.c./d.c. variety.

Using the transistors and transformer specified the maximum output power is governed by the peak current handling capacity of the AD162 transistors (2 amps) and is about 23 watts with a 12 volt input. The use of larger transistors will increase the output power but this is unlikely to be necessary if the converter is to be used with electric shavers.

The no load current is about 200mA compared with 2 amps for some rotary converters, giving an overall efficiency of approximately 90 per cent. Although the transistors are mounted on aluminium heat sinks their dissipation is low and they should not get hot during use; the same is true for the transformer.

CIRCUIT DESCRIPTION

The circuit (Fig. 1) is of the conventional saturating transformer with feedback type oscillator. As TR1 switches on it is held on by its feedback winding. The magnetising current builds up until a core saturation point is reached, reducing the drive to TR1. This starts to bring TR1 out of saturation, causing a reversal of drive, thus switching it off rapidly and switching TR2 on. The same process happens to TR2 until TR1 is again in saturation. R1 and R2 provide a small forward bias to ensure the oscillator starts under full load.

In order to avoid the need for two windings a bridge circuit (D1 to D4) is used to provide the d.c. output. The smoothing capacitor need not be large because of the working frequency. A neon across the output indicates that the unit is functioning. In order to protect the transistors and the car battery in the event of a short circuit the unit is provided with fuses at both input and output. If the shaver takes a very heavy starting current it may be necessary to use anti-surge fuses, although standard 2·5A and 150mA fuses should not blow under full output.

TRANSFORMER CONSTRUCTION

The operating frequency was chosen to be about 1·5kHz, this enabled the primary to be reduced to 42 turns, centre tapped and wound on a 45mm Mullard pot core type FX2243.

MINIATURE CONVERTER

By S. J. HOLMES

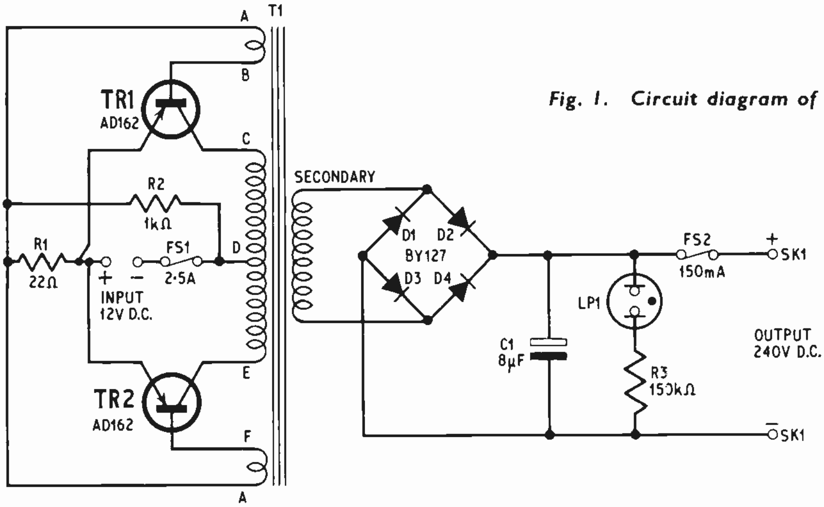
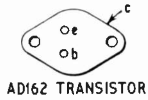
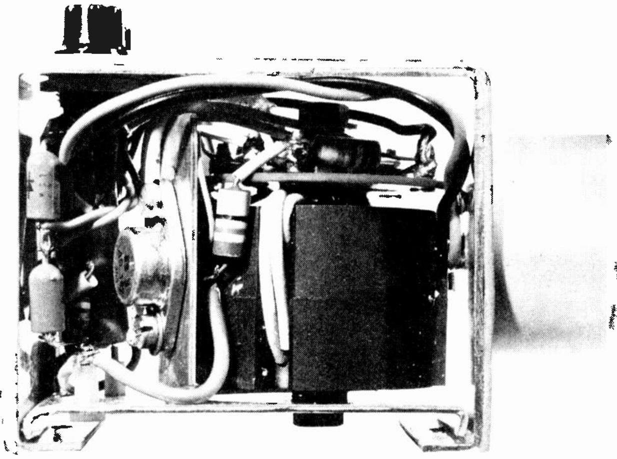


Fig. 1. Circuit diagram of the miniature converter



METALWORK

The actual size of the converter may vary according to individual preferences, but it was decided here to reduce the size to a minimum. Cutting and drilling details for the case shown are given in Fig. 2. The transistors are first mounted on the heat sink, using insulating washers, and this is attached to the transformer. The transformer heat sink assembly is then screwed to the chassis by means of the 2B.A. screw through the pot core (Fig. 3). The main purpose of the chassis is to keep the transformer and transistors in a firm position when they are in the case.



The complete converter with case removed showing the compact construction

Using 21 s.w.g. enamel copper covered wire the winding occupies two layers and so the ends and centre tap may be brought out from the slots in the side of the former. The feedback windings are another four turns centre tapped wound on top of the two primary layers: all windings are in the same direction. After winding, the primary and feedback layers should be varnished and allowed to dry before starting to wind the secondary.

A layer of insulation tape should be inserted between the primary and secondary. The secondary winding consists of 420 turns of 30 s.w.g. enamelled wire wound with insulating sleeving slipped over the start and finish of the winding. The secondary is then given a coat of varnish before a final insulation layer of tape.

The whole pot core assembly is clamped together with the heat sink and chassis by a 2B.A. screw through the centre. A Paxolin tag strip is fitted on one end of the pot core to serve as anchoring points for the transformer leads. A thin coat of varnish on the faces of the core before clamping together will stop any tendency the transformer may have to chatter when working.

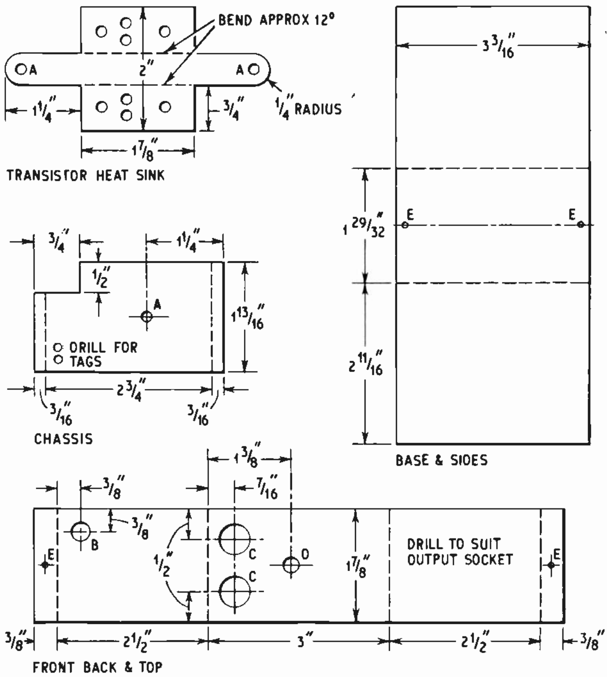


Fig. 2. Chassis cutting and drilling details

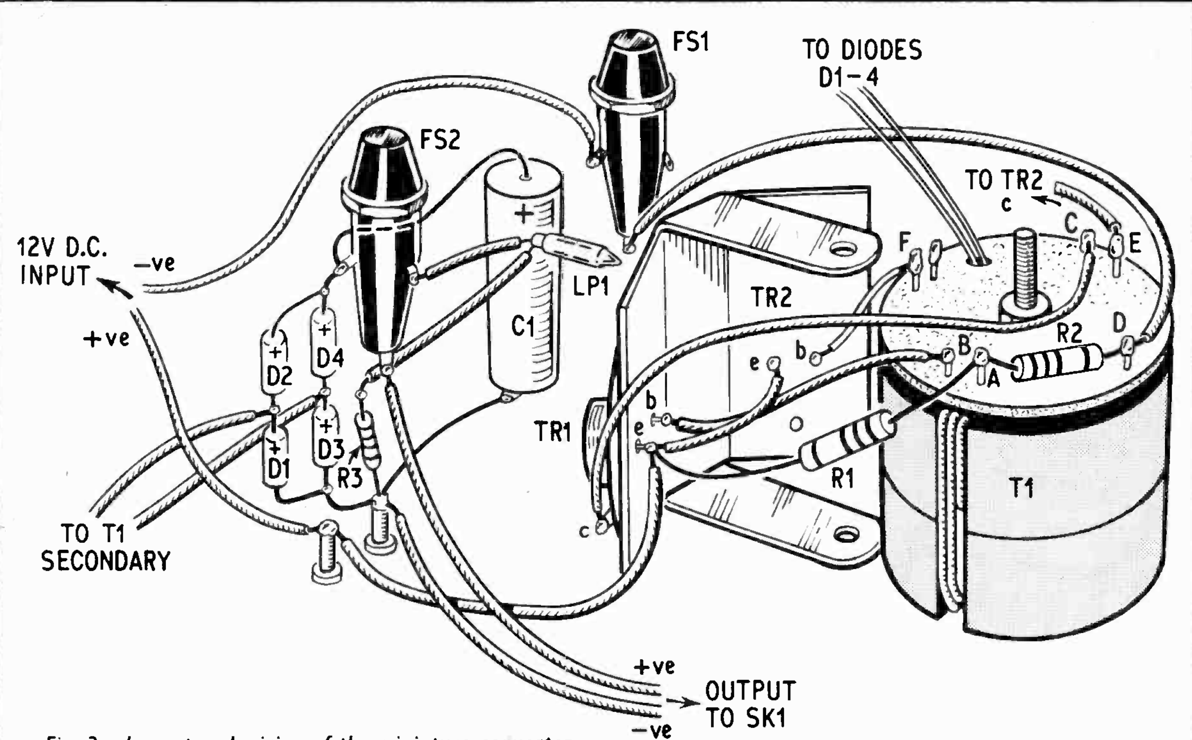


Fig. 3. Layout and wiring of the miniature converter.
Transistors TR1 and TR2 must be insulated from the chassis with mica washers and plastic bushes

COMPONENTS . . .

Resistors
R1 22Ω
R2 1kΩ
R3 150kΩ
All ¼W, 10% carbon

Capacitor
C1 8μF elect. 350V

Semiconductors
TR1, 2 AD162 (2 off)
D1 to 4 BY127 *or* BY100 (4 off)

Miscellaneous
T1 Mullard pot core FX2243 (Gurneys (Radio) Ltd., 91 The Broadway, Southall, Middlesex)
FS1, 2 2·5A and 150mA miniature fuses and holders (2 off)
LP1 miniature wire ended neon
SK1 output socket to suit appliance
Aluminium 18 s.w.g., 7¼in × 8¾in
21 s.w.g. and 30 s.w.g. enamelled copper wire
Small tag strip
Grommet
Fixings

The case is formed by two interlocking "U" shaped pieces of aluminium. The top, front and back are made by bending a 1⅞in strip of aluminium as shown, with a ⅜in fold at each end to take the self tapping screws which secure the second "U" section. Before the top section is bent, holes should be drilled for the fuse holders, neon, grommet and output socket.

Once the components have been fixed to the case the chassis with pot core and transistors can be slotted into the "U" shaped top section. The remaining components may be mounted between the anchor points formed by the fuse holder and tag panel on the pot core. Two extra anchor points were found to be necessary and these were formed by two tags on the chassis.

If the self tapping screws are of the right length they will go through the bottom section together with the ⅜in folds and still have enough length to press against the chassis, clamping it in position. Finally, four rubber feet glued on to the unit will prevent the unit from scratching polished surfaces. A strip of rexine glued over the top "U" section before assembly will enhance the unit's appearance.

TESTING

Before the transistors are wired into the circuit their collectors (cases) should be checked with a meter to ensure that there is no short circuit to the heat sink. To avoid any possible shorts to the case when assembled the inner surfaces of the sides of the lower "U" section should be insulated with tape. Before switching on, the wiring should be checked, in particular the polarity of the diodes and smoothing capacitor, together with the polarity of the supply leads.

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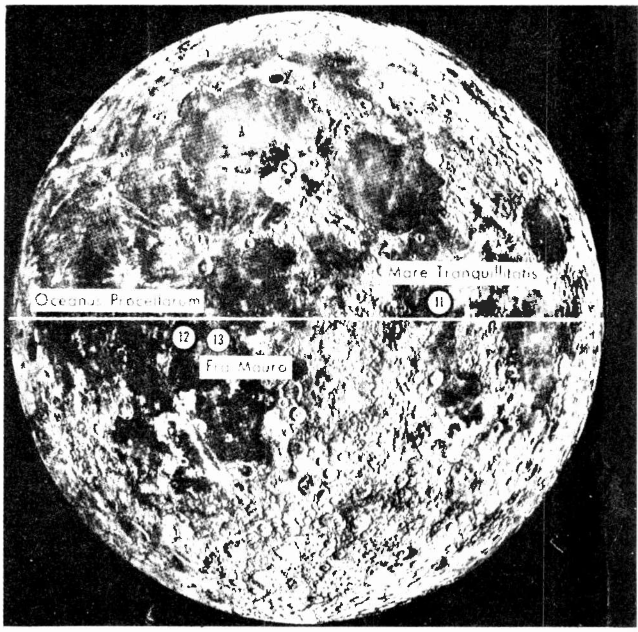
SPACEWATCH

By Frank W. Hyde



APOLLO 13

The target area for the *Apollo 13* moon landing is in a rugged cratered highland known as the "Fra Mauro" formation. It lies a little south-west of the moon's full disc as seen from the earth. The site landing point is just near the crater Fra Mauro (named after a disciple of Saint Benedict) which is about 37 miles wide. Its actual position is 17° 36′ west longitude and 3° 48′ south latitude. This position is about 110 miles from the *Apollo 12* landing site.

The emphasis on this mission is scientific exploration. The astronauts James Lovell and Fred Haise will collect samples from a fairly wide area and also drill for samples. Similar core sampling tools to those employed on the *Apollo 12* mission will be used.

Lunar experts are of the opinion that the Fra Mauro formation is an upheaval of lava rock from deep inside the moon itself. Thus any material collected could represent the lava that has flowed out in the area.

Basically the experiments carried on this mission will be the same as in the previous one, except that the magnetometer will be replaced by a heat flow experiment. It is planned to insert the measuring unit some 10ft below the surface where it will record the change of temperature level between lunar day and night.

SUB-LUNAR

It is thought in some quarters that because of the nature of the surface rock that there may not be any great change. If this is so, and the level is reasonably below that of the surface, it could mean that lunar colonies will be best located underground. As the emphasis is on scientific exploration, this area has been chosen because of the amount of new data that may be acquired about the interior of the moon.

Part of the *Apollo 12* mission was to crash the lunar module on the surface. The module weighed 2·5 tons and impacted with a speed of 3,740 miles per hour. The reverberations forming the shock waves on this occasion lasted half an hour. This was a surprising result. It has been calculated that the shock waves penetrated about six miles into the moon.

As much of the top surface of the moon is thought to be made up of shattered structure and large volcanic blocks of rock, the *Saturn* third stage, which will be crashed to the surface on this mission, will be very interesting. The *Saturn* third stage weighs about 15 tons and will impact at about 5,700 miles per hour.

LONGER WORKING HOURS

The reports of the astronauts Bean and Conrad are very interesting. They say that they were able to work easily and comfortably on their moon mission. They did not tire quickly and could have undertaken more strenuous tasks. They worked easily and did not tire or get hot.

FIFTH "HAM" SATELLITE

Australis-Oscar 5 was launched with *Itos* for amateur use. It operates on two bands and was built by a group of amateur radio operators in Melbourne University. The craft weighs 39lb; amateurs will be able to train in tracking techniques and conduct propagation experiments.

Four earlier satellites of a similar type, but built by an amateur group in California, have been launched previously and are used widely by "hams".

NEW MULTI-DISH RADIO TELESCOPE

Stanford University (California) is building one of the world's most advanced radio telescopes. It consists of five dishes each 60ft in diameter arranged in a row with a length of some 675ft. The proposed operation frequency is in the X-band. The wavelength which will be used to study special features of some of the radio sources is 3cm.

This arrangement of dishes, with their 15,000 square feet of collecting area, will provide a higher sensitivity and better resolution at this point of the radio spectrum than any other telescope operating. Aligned exactly east and west, the dishes can be steered to give a precise beam of one minute of arc.

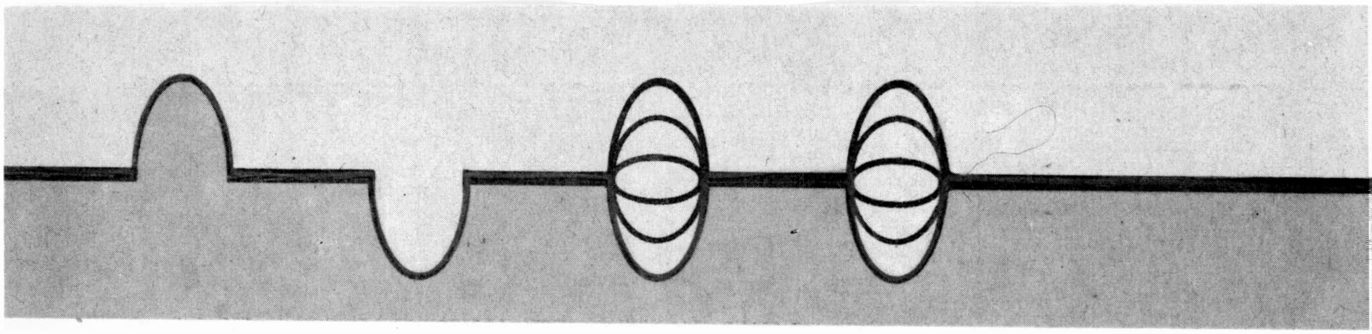
There will be another dish added to the east to complete the interferometer to give a width of 10 seconds of arc. Later it is hoped to have a mobile dish that can be arranged at right angles to the line and thus achieve a pencil beam. About 75 of the known quasars can be studied from this location.

WEATHER SATELLITE

The new world weather satellite, launched on January 23, is another step in the improvement of the accuracy of weather forecasting. Such forecasts are needed to make agriculture more productive, storms and hurricanes less destructive, and air and sea travel safer.

The new satellite, the first of a new series called *Itos* (Improved Tiros Operational Satellite) is a box shaped spacecraft weighing 682 pounds. The first one is in an orbit of 798 nautical miles. As it is in a near polar orbit every part of the Earth can be viewed daily. It carries four television cameras for daytime pictures of cloud cover, and two infra-red cameras for night-time pictures. Thus the full coverage of the earth can be made every 12 hours.

The satellite also carries a solar proton counter, for monitoring sun flare activity, and a radiometer to measure the heat that the earth absorbs and radiates back into the atmosphere. The satellite was built by RCA Astro-Electronics of Princeton, New Jersey. It will be turned over to the Environmental Science Services Administration (ESSA) after its check out.



BASIC RADAR PRINCIPLES

PART THREE
COHERENT PULSED RADAR

By A. FOORD

THE doppler radar described last month consists in essence of a source which is amplified to form the transmitted signal and used as the local oscillator for the received signal. This system is sensitive to small changes in range since it measures the phase changes of the signal return, but it cannot give an absolute measurement of range. This phase sensitive detection is called a coherent system.

The pulsed radar on the other hand uses a non-coherent diode detection system which produces the envelope of the received pulse to give range measurement but little information on small changes of range. Combining the two systems would give information on both range and velocity simultaneously.

One possible arrangement would be to use a system similar to the c.w. system but to pulse the power amplifier. Another way is to use a conventional magnetron, but since this only operates for a short time and has a random starting phase from pulse to pulse, it cannot be used directly as the demodulator reference for the signals. Instead a system like that shown in Fig. 3.1 is used.

COHERENT LOCAL OSCILLATOR

The stable local oscillator output (STALO) is mixed with a sample of the magnetron pulse to produce a reference pulse at i.f., which is amplified and used to phase lock a coherent local oscillator (COHO).

The "coho" is used as the reference c.w. signal source to mix the signal returns down to video. The sequence of events, controlled by the waveform generator, is as in Fig. 3.2.

The "coho" stops oscillating just before the transmitter fires; as the transmitter fires the i.f. sample is applied to the tank coil of the "coho" and the clamp released. The "coho" oscillations build up in phase with the i.f. sample, and are used as the reference for the phase sensitive detector (p.s.d.) which provides a coherently detected video signal output.

A fixed target will give a d.c. output level while a moving target will give a different amplitude output for each transmitted pulse, so that the doppler frequency is sampled at the p.r.f. (Fig. 3.3). When these signals are displayed on an "A" 'scope they appear as in Fig. 3.4.

EXTRACTING DOPPLER INFORMATION

In practice an "A" 'scope would be used to determine the range of a target; the target could be gated out and its doppler frequency measured (Fig. 3.5). A variable delay gating pulse is moved in time until it encompasses the selected target.

The output from the gate is the peak of the signal and this is used to charge a capacitor in the "box car" pulse stretcher. This aids the filtering and detection process by eliminating the p.r.f. and its harmonics.

As it stands this doppler frequency output cannot indicate if the target is approaching or receding and the range information can only give this when the target has moved a considerable distance. An offset frequency can be added to the system to provide this information immediately (Fig. 3.6).

For this application the 45MHz reference signal is offset by 300Hz in a single-sideband suppressed carrier modulator before being applied to the p.s.d. For a fixed target the output from the p.s.d. is now 300Hz, for an approaching target the output may be 310Hz (10Hz doppler) while for a receding target the output may be 290Hz, so that the output is no longer ambiguous with direction.

To achieve a reasonable performance the "stalo" requires a stability of 1 part in 10^8 and a specially stabilised klystron with a large cavity has to be used; "coho" stability needs only to be of the order of 1 part in 10^6.

For this system the transmitter locks an i.f. oscillator with coherent detection at i.f. One other possible system involves r.f. locking and r.f. detection.

MOVING TARGET INDICATION

Since a non-coherent pulsed radar measures target range and angular position for each scan, moving targets are indicated by their change in position from scan to scan.

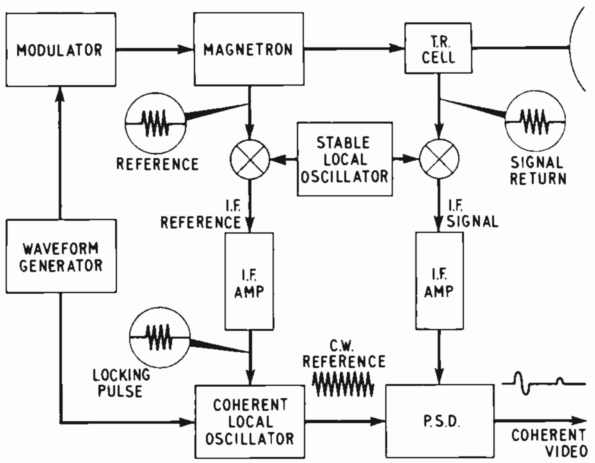


Fig. 3.1. Practical coherent pulsed radar system

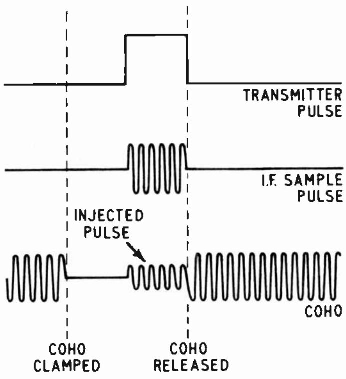


Fig. 3.2. Locking sequence for coherent radar system

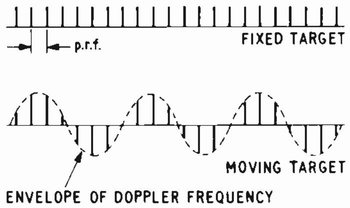


Fig. 3.3. Appearance of stream of received pulses

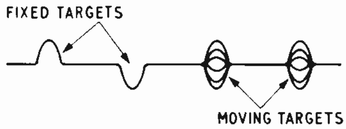


Fig. 3.4. "A" 'scope display for coherent echoes

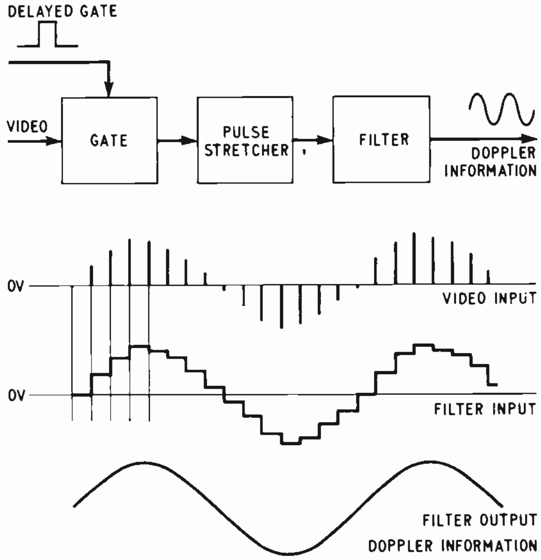


Fig. 3.5. Extraction of doppler information from a selected target

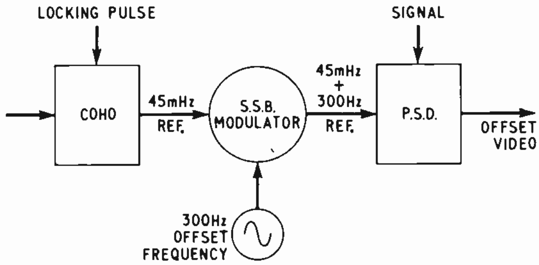


Fig. 3.6. Adding an offset frequency to prevent direction ambiguity

Some assistance in recognising moving targets can be provided by cancelling those echoes due to stationary targets, leaving the display clear of solid masses of "clutter" due to hills or buildings. However the desired moving target echo may have to compete with considerable clutter at a similar range, and the m.t.i. will only be partially effective.

For a coherent pulsed radar, where doppler information is available, the use of m.t.i. techniques enables the moving target signal to be extracted even if the unwanted clutter signal is 100 times greater than the target signal. M.T.I. is therefore more usefully applied to a coherent pulsed radar.

Since the permanent echoes remain constant from one sweep to the next, whilst the echoes from moving targets vary, subtraction of one sweep from the previous sweep should remove the permanent echoes but leave the moving targets (Fig. 3.7).

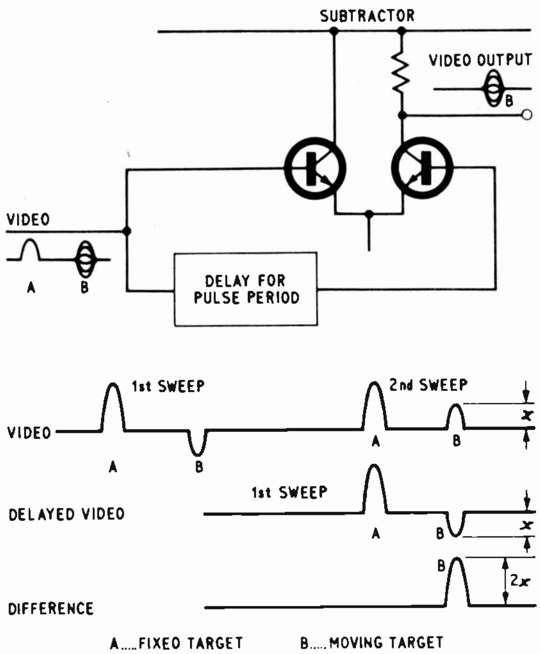


Fig. 3.7. Cancellation of echoes from fixed targets

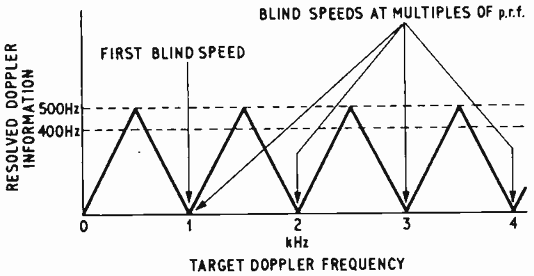


Fig. 3.8. Blind and ambiguous speeds for a pulsed doppler radar

The receiver output is split into two, and one half is delayed by one pulse period and then subtracted from the other half. Possible delay methods include an ultrasonic delay line, or the "writing" of signals on a storage tube and "reading" them off after a delay of one pulse period.

BLIND AND AMBIGUOUS SPEEDS

For a coherent pulsed radar the doppler frequency is measured by discrete pulses (or samples) at the p.r.f. It is one of the axioms of sampling theory that at least two samples in a cycle are required in order to reconstruct a waveform.

If a radar has a p.r.f. of 1kHz then doppler information can only be resolved unambiguously up to 500Hz. This is shown in Fig. 3.8. Doppler frequencies of 1·5kHz, 2·5kHz, and so on, all appear as 500Hz. Doppler frequencies of 400Hz, 600Hz, 1·4kHz, 1·6kHz, and so on, all appear as 400Hz. Any moving target whose doppler frequency happens to be a multiple of the p.r.f. (1kHz, 2kHz, etc.) will be rejected. For a 1kHz p.r.f. and X-band the first blind speed will be 30 knots. ★

MINIATURE CONVERTER

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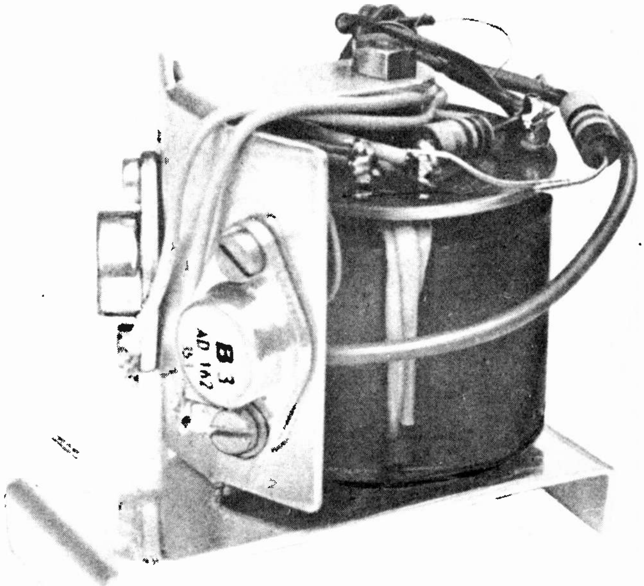
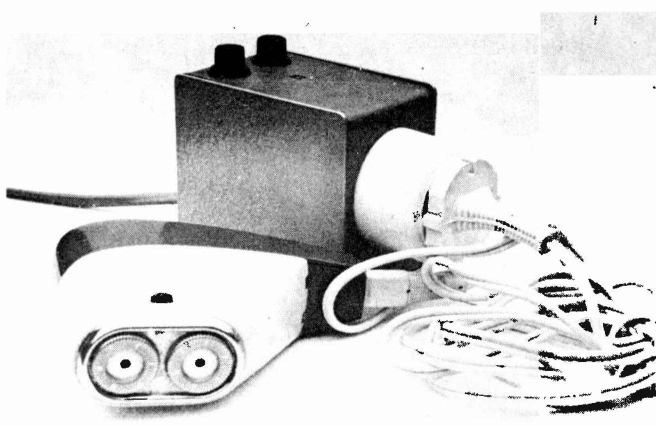


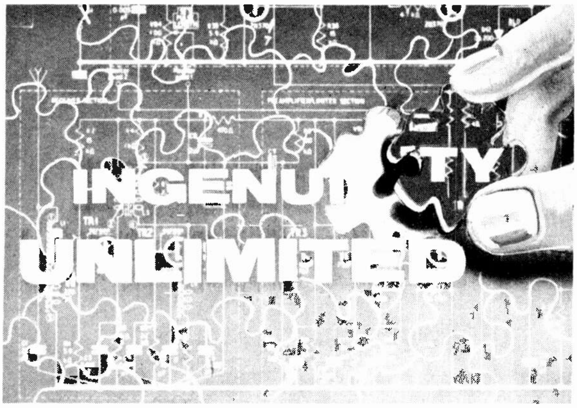
Transformer T1 before installation, note the tag board to secure the ends of the windings

A meter may be connected across the output (on 250 volt d.c. range) to indicate oscillation, although there will usually be enough vibration in the transformer to show that the converter is working. If there is no output then the phase of the feed-back windings is wrong. The feedback windings may be reversed systematically, i.e. reverse TR1 base and retest; if still not working reverse TR2 base and retest; if the unit still refuses to start reverse TR1 base again. This gives all four combinations.

Once the correct phasing has been found the converter should start under full load. With no load connected the standing current should be about 200mA, while the on load current will, of course, be determined by the shaver used. If the unit is to be used in conjunction with fluorescent tubes the connections to the tube should be reversed from time to time in order to avoid discolouring at the ends. ★



Converter ready for use



A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.
This is YOUR page and any idea published will be awarded payment according to its merit.

GUITAR PICK-UP SYSTEM

Like most electric guitar pick-ups, this one is based on Faraday's first law of electromagnetic induction.

In this case the conductors are the steel strings of a guitar, and the magnetic field for each string is produced by several small bar magnets, placed close to them to give roughly equal fields around each string, see Fig. 1.

The magnitude of the e.m.f. produced is too small for most purposes (about 1mV), and the output impedance is very low (less than 1 ohm). Since all the strings are connected in parallel, further amplification is therefore required. A conventional common emitter stage is used, Fig. 2, but with a transformer at the input, to match the strings to the amplifier. A 3 ohm loudspeaker transformer, used in the step-up mode, was found to work very well.

The transistor used was a 2N697 *npn* silicon, but almost any type would do, silicon or germanium, provided that the polarity of the main amplifier power supply matches that of this pre-amplifier.

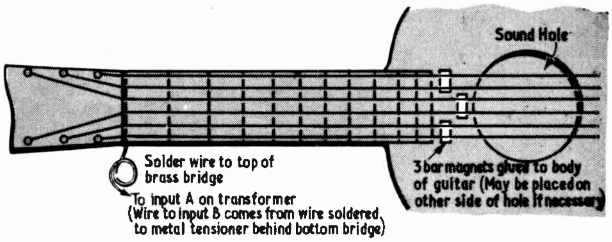


Fig. 1. Position of small bar magnets beneath guitar strings

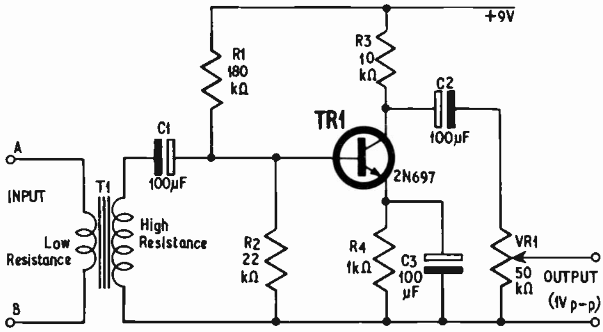


Fig. 2. Circuit diagram for a simple pre-amplifier for the guitar pick-up system

Low noise resistors should be used in the base bias chain if the noise level proves unacceptably high. A volume control is also included so that the pre-amplifier can be fed direct into a guitar amplifier.

This system may be used with any steel stringed instrument, such as a violin or ukelele. It has the advantage that any feedback produced can easily be controlled by touching the particular string which is vibrating and damping it. A large range of bizarre effects can also be obtained by waving a powerful magnet around near the strings while they are being played.

S. Kravis,
Chelmsford.

SOUND MIXER

The circuit in Fig. 1 shows a simple mixer unit which is very adaptable. The balance control is used to fade out one signal, while another is simultaneously faded in. This gives a more professional touch than simply turning down one signal and then turning up the other, as well as being much simpler to use.

Another possible use is for mixing speech and music for entertainments at dances and parties.

As the mixer consists of only passive components, there is a considerable loss in signal, however, this can be remedied by using a simple audio amplifier. A suitable design incorporating the amplifier is shown opposite.

J. R. Morris,
Chorley.

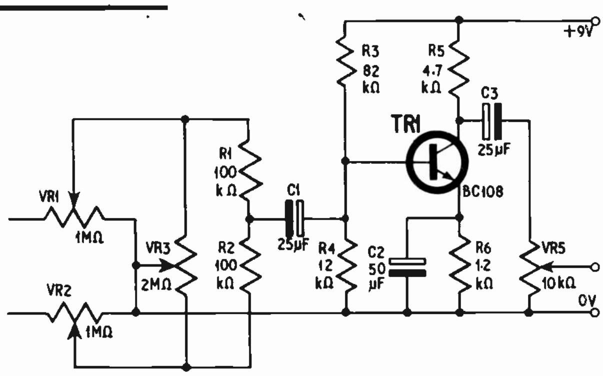
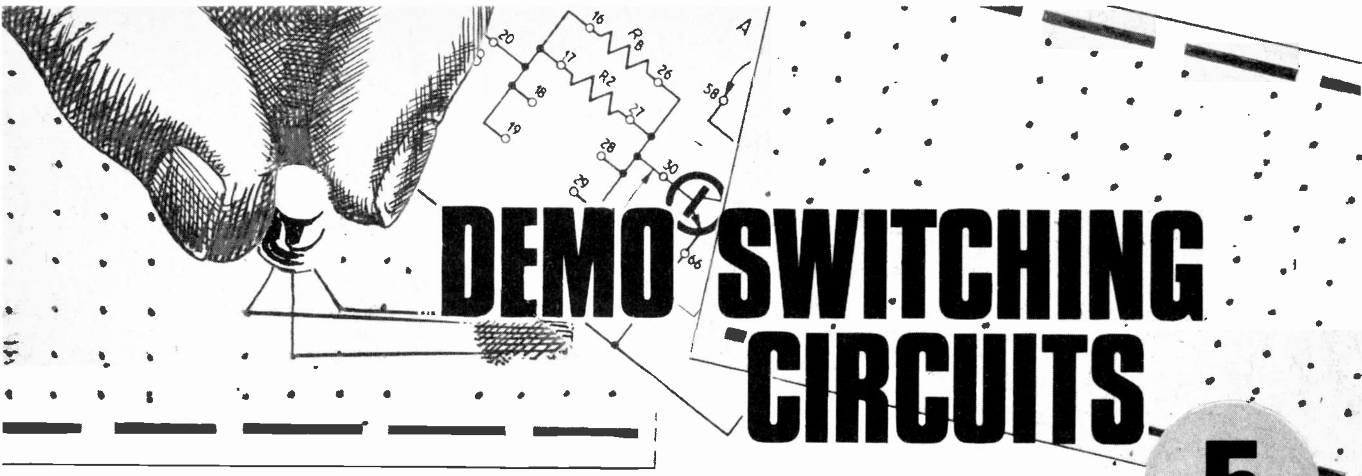


Fig. 1. Circuit diagram of the mixer and audio amplifier



DEMO SWITCHING CIRCUITS 5

BISTABLE MULTI By B. Pounder

The bistable multivibrator is one of the most important circuits in the whole field of electronics. As one of the basic "building block" circuits in digital computers, there is hardly anything the bistable or a suitable combination of bistables cannot be made to do in switching operations.

The basic circuit is shown in Fig. 5.1. Like the Schmitt trigger, it looks deceptively simple. It is not difficult to derive some approximate equations from which basic designs can be carried out.

SWITCHING ACTION

Suppose that both transistors TR1 and TR2 are conducting, but that for some reason, there is a small increase in the collector current of TR1. This causes the collector voltage to fall because of the increasing potential difference across the collector resistor R1. This fall in collector voltage is transmitted to the base of TR2 via R2.

The falling base voltage of TR2 causes a fall in the collector current of TR2 and a corresponding rise in the collector voltage. But this rise in collector voltage is transmitted back to the base of TR1 so the collector current of TR1 is increased further. This increase is accompanied by an increased drop in collector voltage of TR1, and this is transmitted to the base of TR2.

Obviously, the circuit is naturally regenerative, the initial disturbance being magnified until it is no longer possible for the magnification to increase. This situation is reached when the collector voltage of TR2 has risen to the supply voltage V_{CC}, and the collector voltage of TR1 has fallen to $V_{CE(sat)}$. TR1 is now hard on and TR2 cut-off.

The circuit action could have started with a transient rise in the collector current of TR2 and finished up with TR1 cut-off and TR2 hard on. Thus the circuit possesses two stable states, TR1 on, TR2 off, or TR1 off, TR2 on. Hence the name "bistable".

An obvious application for the circuit is as a "gate" which can be opened by a command or set trigger pulse which switches the on transistor off, and closed by a second command or reset trigger pulse which switches the other transistor off, the other transistor having been turned on when the first is turned off.

DESIGN PROCEDURE

The approximate equations useful in calculating component values are as follows and should be followed in conjunction with Fig. 5.1.

For the conditions shown in Fig. 5.1a, i.e. TR1 is off and TR2 is on,

$$I_{R1} = I_{R2} + I_{c1}; \quad I_{R2} = I_{b2} + I_{R6}$$

$$I_{R4} = I_{R3} + I_{c2}; \quad I_{R3} = I_{b1} + I_{R5}$$

Therefore $I_{R2} = (V_{CC} - V_{be})/(R_1 + R_2)$

If $R_5 = R_6 \gg R_2 = R_3$

Then $I_{R2} \gg I_{R6}$

and $I_{R2} \simeq I_{b2} = I_{c2}/h_{FE}$

Therefore $R_1 + R_2 = (V_{CC} - V_{be})h_{FE}/I_{c2}$

From Fig. 5.1b

$$V_{b1} = -V_{BB}\left(\frac{R_2}{R_2 + R_6}\right)$$

Let $V_{b1} = 0{\cdot}5$V reverse bias to ensure that TR1 is off. Substitution of this value gives

$$R_6 = R_2(2V_{BB} - 1)$$

For satisfactory operation, it can be shown that the following condition must be fulfilled:

$$R_2 < h_{FE}R_1$$

Suppose we wish to demonstrate the circuit by making it switch a 180 ohm relay on and off on command by

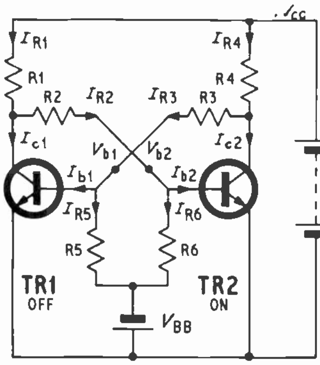


Fig. 5.1a. *Theoretical circuit of the bistable multivibrator*

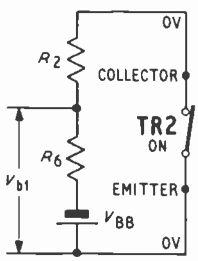


Fig. 5.1b. *Passive equivalent of switching TR2*

DESIGN STEPS (*Fig.* 5.1)

1. Choose V_{CC} equal to the required output voltage swing. Choose I_{c2}
2. Choose V_{BB} to be between V_{CC} and about $\frac{3}{4}V_{CC}$
3. Calculate $R_1 = R_4 = V_{CC}/I_{c2}$
4. Calculate $R_4 + R_3 = (V_{CC} - V_{be})h_{FE}/I_{c2}$ where h_{FE} can be taken as 20 or 30 and $V_{be} = 0{\cdot}3V$ for germanium transistors and $V_{be} = 0{\cdot}8V$ for silicon transistors
5. Calculate $R_2 = R_3 = (R_4 + R_3) - R_4$
6. Calculate $R_5 = R_6 = R_3(2V_{BB} - 1)$
7. Check that $R_6 \gg R_3$
8. Check that $R_3 < h_{FE}R_4$

set and reset pulses. Following through the design procedure, we get the following results.

A 180 ohm relay usually operates at 6V. Hence choose V_{CC} = 6V. (step 1)

Also, I_{c2} = 6/180 = 33mA or 0·033A.

Choose V_{BB} = 6V also. (step 2)

R_4 = 180 ohms (given). (step 3)

$R_4 + R_3 = (6 - 0{\cdot}8) \times 20/0{\cdot}033 = 3{,}100$ ohms (step 4)

(We have assumed a silicon transistor is used with $h_{FE(min)} = 20$.)

$R_3 = 3{,}100 - 180 = 2{,}920$ ohms. Use preferred value 2·7kΩ. (step 5)

$R_6 = 2{,}700 \times (2 \times 6 - 1) = 29{,}700$ ohms. Use preferred value 27kΩ. (step 6)

Note that $R_6 \gg R_3$. (step 7)

Note that $R_3 < h_{FE}R_4$. (step 8)

BREADBOARDING

The circuit, with suggested S-Dec connections, is shown in Fig. 5.2. The diode shown in the circuit eliminates the possibility of damage to TR2 due to the back e.m.f. generated by the relay coil when the current through it is suddenly switched off. The trigger set and reset pulses are obtained by momentarily short-circuiting the base and emitter leads of the *on* transistor to switch it off.

Alternative component values for the 5mA meter circuit and the bulb circuit are as follows.

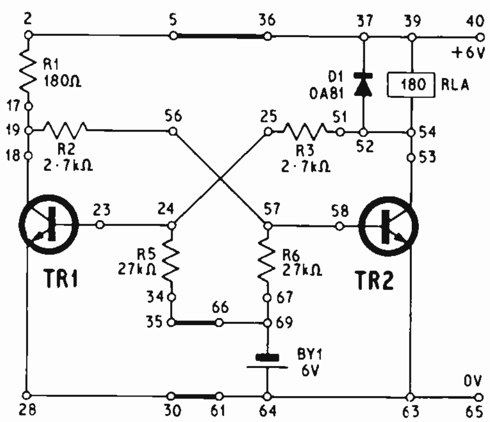
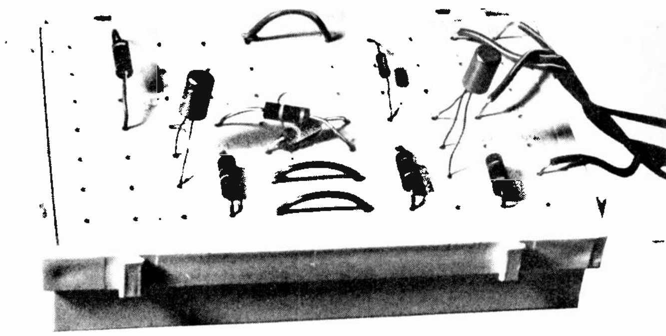


Fig. 5.2. Practical design of the bistable with S-Dec connections



Layout of components on S-Dec for basic bistable in Fig. 5.2

	Bulb Circuit	5mA Circuit
R_4	6V, 100mA bulb	1·2kΩ
R_3	1·1kΩ	22kΩ
R_6	12kΩ	220kΩ
V_{BB}	6V	6V
V_{CC}	6V	6V

If a relay is not at hand, the circuit can be demonstrated by connecting a voltmeter between the collector and emitter leads of one of the transistors. If this is done, it will be desirable to recalculate the circuit values to operate on a smaller collector current, say 5mA.

Another possibility is to design the circuit with 6V, 100mA bulbs used as the collector resistors R1 and R4. Metal-canned transistors should be used in order to ensure safe operation at 100mA collector current. Some transistors may require heat sinks if the collector current rating is close to the bulb current rating.

EMITTER-COUPLED BISTABLE

In the circuit shown in Fig. 5.3, the V_{BB} power supply has been replaced by a resistor R7 through which the emitter current of the *on* transistor flows. The voltage dropped by this current across R7 causes both emitters to be at a positive potential.

Thus if one of the transistor bases is maintained at or near zero potential, that transistor will be cut-off. The use of R7 to provide negative bias on the base is analogous to the use of a cathode bias resistor in a valve circuit which provides a negative bias on the grid.

The equations from which component values may be calculated are given in the "Design Steps" panel below.

TRIGGERING THE BISTABLE

There are many ways of triggering a bistable by the application of trigger pulses. However, most of the methods have one thing in common; the trigger pulse is applied in such a way as to turn the *on* transistor off rather than vice-versa. To turn the *off* transistor on requires that the trigger pulse is capable of overcoming the reverse bias which is holding the transistor off before it can proceed with the actual switching process.

For simplicity, only one trigger circuit will be used in this article. It utilises collector triggering since the trigger terminals are connected to the transistor collectors.

DESIGN STEPS (*Fig.* 5.3)

Step. 1. Decide on required output voltage swing V_0 and I_{C2}
Step 2. Choose V_{CC} and V_e from $V_{CC} - V_e = V_0$
Step 3. Calculate R_4 from $R_4 = (V_{CC} - V_e)/I_{C2}$
Step 4. Calculate R_2 from
$$R_2 = \left\{V_{CC} - (V_e + V_{be})\frac{2V_e}{2V_e - 1}\right\}[h_{FE}/I_{C2}]$$
Step 5. Check that $R_2 \gg R_4$
Step 6. Calculate R_6 from $R_6 = (2V_e - 1)R_2$
Step 7. Calculate R_7 from $R_7 = V_e/I_{C2}$

Remember, however, that the collectors in a bistable are connected to the bases of the other transistors via cross-coupling networks. Thus a trigger pulse applied to the collector of one transistor is directly coupled to the base of the other. The circuit is shown in Fig. 5.4a.

Suppose TR1 is off and TR2 is on. If a positive-going step is applied to the SET terminal, it is transmitted to D1 and D2 and reverse biases D2. However, D1 will become forward biased so will allow C1 to discharge.

When the SET voltage is reduced as a step to zero, the voltage reduction will be transmitted to D1 and D2 and forward bias D2. A negative-going voltage is therefore applied to the base of TR2 which turns off.

Similarly, the circuit can be made to undergo another transition if a negative-going step is applied to the RESET terminal. Fig. 5.4b shows part of the same circuit but with the diode D1 replaced by resistor R7. Having calculated the component values, it is worth while to check that the saturation collector current can be supplied.

DESIGN

The circuit is easily demonstrated by the use of 6V, 100mA bulbs in place of resistors R1 and R4. In this case, $V_0 = 6$V and $I_{C2} = 100$mA, so Step 1 is covered. Now proceed as follows.

Choose $V_{CC} = 9$V, so $V_e = 9\text{V} - 6\text{V} = 3$V. (step 2)

$R_1 = R_4 = (9 - 3)/0{\cdot}1 = 60$ ohms (step 3)

$$R_2 = R_3 = \left\{9 - (3 + 0{\cdot}8) \times \frac{6}{6-1}\right\} \times [20/0{\cdot}1]$$
$= 890$ ohms (step 4)

(Used preferred value of 820Ω for R2)

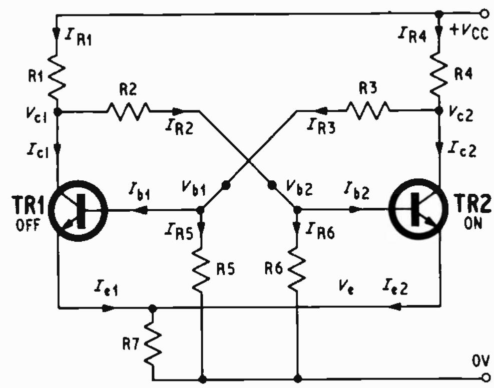


Fig. 5.3. Theory of emitter-coupled bistable

$R_2 \gg R_4$ as required. (step 5)

$R_5 = R_6 = (6 - 1) \times 820 = 4{,}100$ ohms (use 3·9kΩ) (step 6)

$R_7 = 3/0{\cdot}1 = 30$ ohms (use preferred value 27Ω) (step 7)

The calculations can be checked as follows:

Allowing for the voltage drop across R1 in TR1 under the conditions shown in Fig. 5.3.

$$I_{R_1} = \frac{V_{CC} - V_{c1}}{R_1} = \frac{V_{c1} - (V_e + V_{be})}{R_2}$$

Hence $(9 - V_{c1})/60 = (V_{C1} - 3{\cdot}8)/820$

so $V_{C1} = 8{\cdot}5$V approx.

and $I_{R_1} = (9 - 3{\cdot}8)/820 = 5$mA approx.

Also, $I_{R6} = \frac{V_e + V_{be}}{R_6} = \frac{3{\cdot}8}{3{\cdot}9} = 1$mA approx.

so $I_{b2} = 4$mA.

This base current is roughly 80 per cent of that

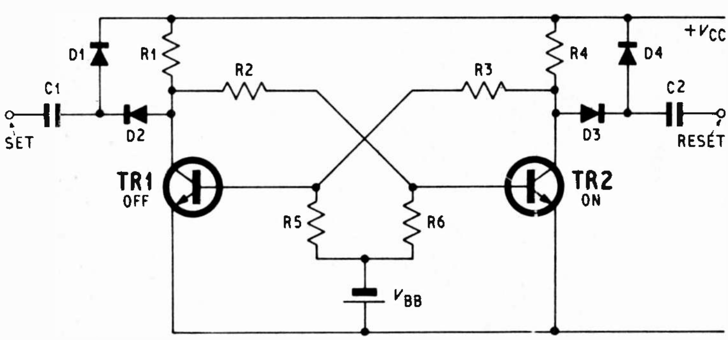


Fig. 5.4a. Trigger inputs to switch the bistable

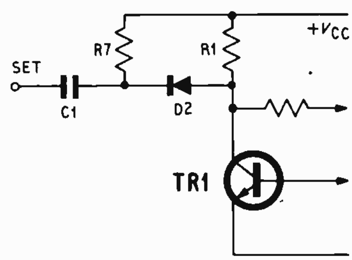


Fig. 5.4b. Diode D1 replaced by a resistor R7

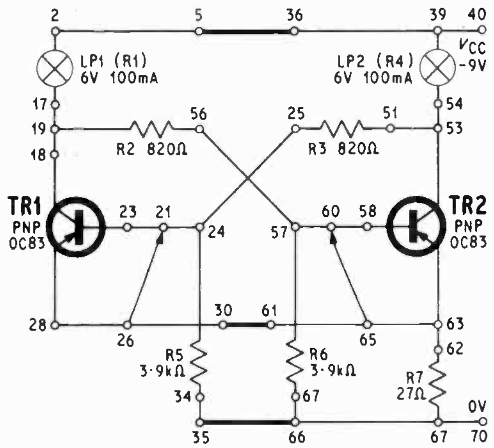


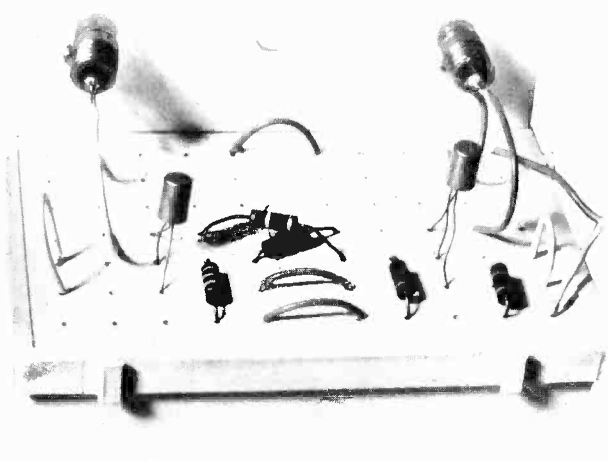
Fig. 5.5. Practical circuit of the emitter-coupled bistable

required to saturate a transistor with $h_{FE} = 20$ at $I_c = 100$mA. If, as is likely to be the case, the transistors used have h_{FE} slightly in excess of 20, the component values should be satisfactory.

Suggested circuit connections for S-DeC are shown in Fig. 5.5. Note that it is drawn for *pnp* transistors. (*NPN* devices may be used if the supply polarities are reversed at holes 40 and 70.) The transistors should be capable of operating at 100mA collector current. Germanium types such as the OC72 or OC83 will be suitable, but note that the calculation assumed a V_{be} value of 0·8V for silicon types such as OC204.

It is left as an exercise to see what difference, if any, a substitution of 0·3V makes to the component values when calculated for germanium types. As with the previous bistable example, triggering is achieved by shorting the base and emitter leads of the *on* transistor.

To be continued next month



Layout of components on S-Dec of emitter-coupled bistable

NEWS BRIEFS

Golden Jubilee

THE 50th anniversary of the founding of the Mullard company will be celebrated this year.

It was in 1920 that Mr Stanley Mullard, born in 1883 and still a member of the Mullard Ltd. board, formed The Mullard Radio Valve Company Ltd.—the first venture to bear his name. It occupied floor space rented from his former employers and its initial product was high-power transmitting valves.

From this beginning the Mullard enterprise has developed into one of the UK's biggest electronic component companies. It employs around 17,000 people, over 1,200 of whom are qualified scientists and engineers, in 14 production centres, laboratories, service depots and other ancillary establishments.

During jubilee year production capacity will be substantially expanded by the addition of three new plants at Thornaby (Teesside), Stockport and Bolton.

New Number

THE Institution of Electronic and Radio Engineers have recently changed their telephone number. The new number is 01-637 2771 (10 lines). Previous numbers have been discontinued.

Learning by Computer

A SPECIAL teaching aid, for various subjects for secondary, higher and vocational education, has been developed by ASEA. The system comprises a computer, typewriter, a high speed reader for punched tape and a television type display. Most classrooms are nowadays provided with television sets and these can be connected up to the systems. This means that several classes can study simultaneously the results presented on the screen in the form of, for example, curves obtained as the solution to a problem fed into the pre-programmed computer.

It is also possible to use these small computers in schools as terminals connected to a larger computer system. Teach-aid will therefore be developed so that it can be connected up to large computers of different types for performing calculations according to special programmes.

Certain computer programmes have in fact already been prepared by ASEA. These programmes are primarily intended for such subjects as mathematics, physics, theory of electricity and the theory of control systems. A programme library has also been established. The programmes can be adapted to the curricula laid down by the Boards of Education in different countries.

POINTS ARISING

P.E. ORGAN (*May '69 to March '70*)

Parts for the PRACTICAL ELECTRONICS Organ as previously supplied by Kimber-Allen Ltd., should now be ordered from Henry's Radio Ltd., 303 Edgware Road, London, W.12.

MAGIC EYE AUDIO SIGNAL INDICATOR

By M.L. MICHAELIS M.A.

This instrument is a form of audio voltmeter obviating the expense of a moving coil meter. It incorporates a simple audio amplifier with input gain control, driving a magic eye tuning indicator as display device. The green luminous sector of the magic eye vanishes to a simple vertical line for zero signal input. The apex angle of the luminous sector increases in proportion to the peak-to-peak amplitude of the applied audio signal.

The gain control and mains on/off switch are the only manual controls. The unit incorporates its own mains power supply and is thus very simple to operate and cheap to construct. The uses are manifold:

- **As a signal tracer**
- **As a comparative a.f. voltmeter**
- **As a bridge balance indicator**

In addition to full constructional details for the Magic Eye Audio Signal Indicator, this article describes a number of bridge circuits which may be used with this unit for various measurement purposes.

THE complete theoretical circuit of the magic eye bridge indicator appears in Fig. 1. The first section of the ECC83 double triode V1a operates as a conventional audio voltage amplifier which drives the second section of the same valve, V1b. This second triode operates as cathode follower to provide the low source impedance necessary for proper functioning of the d.c. restorer C6, D2, R11.

D.C. RESTORER

This d.c. restorer is necessary because the magic eye V2 must be driven with entirely negative-going signals, i.e. the luminous sector width is zero when the applied voltage between grid pin 1 and cathode of V2 is zero, and the sector width increases in proportion to the negative voltage applied to the grid. A positive voltage applied to the grid produces no definite effect.

To satisfy these drive requirements of the magic eye V2, the d.c. restorer functions as follows. C6 charges via D2 to the peak positive amplitude of an arbitrary waveform appearing at V1b cathode pin 3. C6 attempts to discharge through R11, but the time constant C6.R11 is very long compared to the signal period. Thus a negative d.c. voltage appears across R11, equal to the peak positive amplitude of the signal waveform.

Whenever the signal waveform is momentarily at the peak positive value, this just overcomes the negative d.c. voltage across R11 and the net voltage applied to the grid of the magic eye V2 is zero. At all other instants, the net voltage is negative, reaching its greatest negative value, now numerically equal to the peak-to-peak signal amplitude, when the signal waveform is momentarily at its negative peak. Thus the width of the luminous sector is proportional to the peak-to-peak amplitude of the applied signal, irrespective of the actual waveform.

Any d.c. component of the input signal is blocked by C1, so that response is solely to the a.c. component. R1, R5 and R12 are grid stoppers to prevent parasitic oscillation on sharp transients of applied signals.

The circuit employs a valve amplifier, not a transistor amplifier, because the magic eye V2 already requires a valve-type power supply.

POWER SUPPLY

The h.t. power supply is derived from a half wave rectifier circuit. Any small silicon h.t. rectifier is

suitable for D1. The exact values of the electrolytics C3 to C5, and C7 are not critical.

Do not use mains transformer with a heater winding rated for much higher currents, although up to about 1·5A rating is usable. Higher ratings would mean that unduly high voltages are actually applied to the valve heaters at such low loading. If the available transformer does not possess a centre-tapped heater winding, connect two 5 kilohm resistors in series across the untapped heater winding and earth the centre junction of these resistors to chassis.

CONSTRUCTION

The prototype is housed in an instrument case measuring 8·75in by 5·75in by 6·25in deep. A shallow chassis bolted to the front panel carries most of the circuit components. The smaller components are wired between a pair of tag strips bolted to the underside of the chassis. Arrangement of the components and wiring is given in Fig. 2 and Fig. 3.

Items mounted directly on the front panel are the mains input plug PL1, mains switch S1, gain control VR1, and the signal input socket SK1.

A small rectangle is cut out of the centre of the front panel and a piece of Perspex is fitted to the rear side to provide a window for viewing the magic eye tuning indicator. Cutting and drilling details are given in Fig. 4.

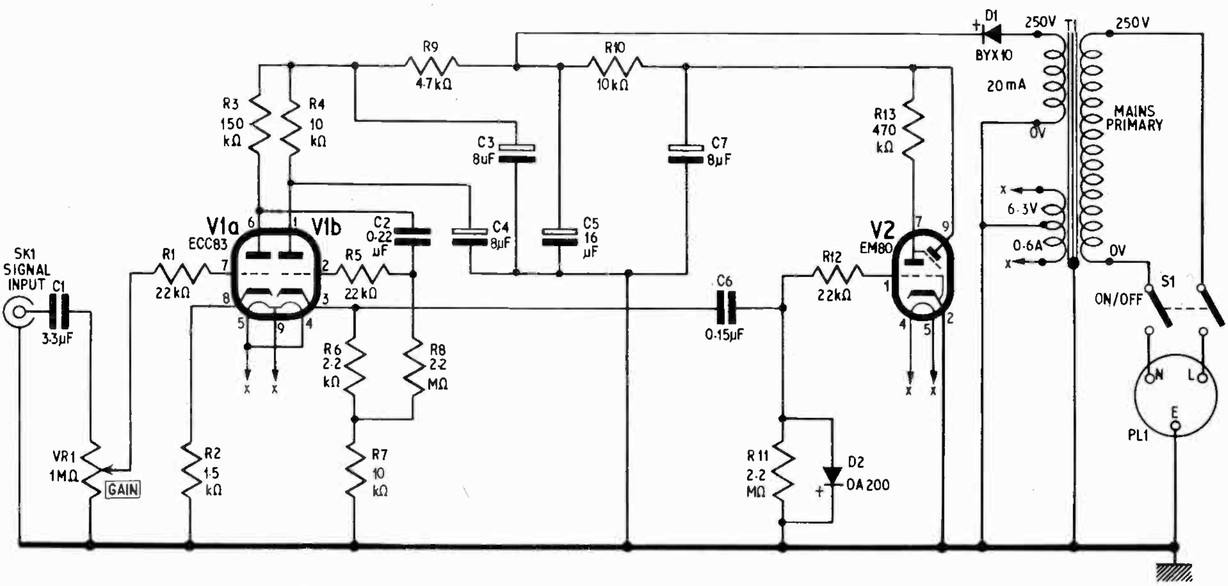


Fig. 1. Circuit diagram of the Magic Eye Audio Signal Indicator

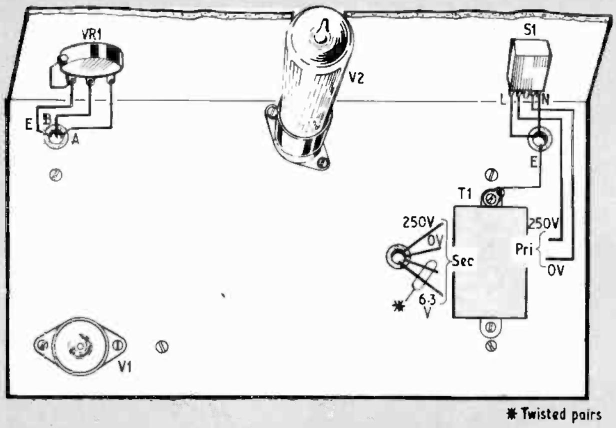


Fig. 2. Top view of chassis

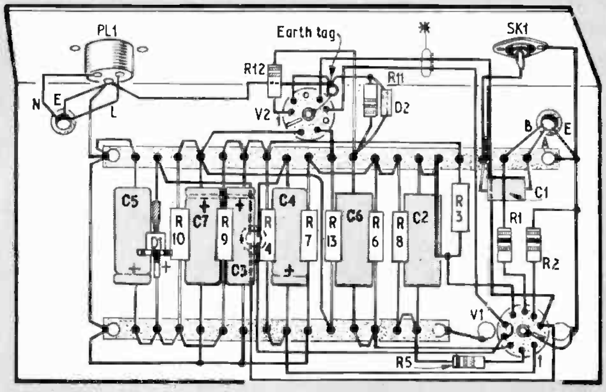


Fig. 3. Underside view of chassis

COMPONENTS . . .

Resistors

- R1 22kΩ $\frac{1}{2}$W
- R2 1·5kΩ $\frac{1}{2}$W
- R3 150kΩ 1W
- R4 10kΩ 1W
- R5 22kΩ $\frac{1}{2}$W
- R6 2·2kΩ $\frac{1}{2}$W
- R7 10kΩ 1W
- R8 2·2MΩ $\frac{1}{2}$W
- R9 4·7kΩ 1W
- R10 10kΩ 1W
- R11 2·2MΩ $\frac{1}{2}$W
- R12 22kΩ $\frac{1}{2}$W
- R13 470kΩ 1W

All carbon, ±10%

Potentiometer

VR1 1MΩ potentiometer, carbon, log.

Capacitors

- C1 3·3μF microfoil 500V
- C2 0·22μF paper 500V
- C3 8μF elect. 350V
- C4 8μF elect. 350V
- C5 16μF elect. 350V
- C6 0·15μF paper 500V
- C7 8μF elect. 350V

Valves

- V1 ECC83 double triode
- V2 EM80 magic eye tuning indicator

Diodes

- D1 Silicon h.t. rectifier 750V p.i.v. 100mA BYX10 (Mullard)
- D2 Silicon junction diode 50V p.i.v. OA200 (Mullard)

Miscellaneous

- PL1 Mains panel connector 3 pin 5A, and cable socket (Bulgin SA1861)
- SK1 Coaxial socket, panel mounting
- S1 Mains switch, d.p.s.t.
- T1 Mains transformer. Secondaries: 250V 20mA; 6·3V 0·6A Elstone MT11 (Home Radio)

Two B9A valveholders. Tag strips, one 14-way, one 19-way. Grommets. Case $8\frac{3}{4}$in × $5\frac{1}{2}$in × $6\frac{1}{4}$in deep (Olson 26A). Aluminium for chassis, Perspex for window. Control knob.

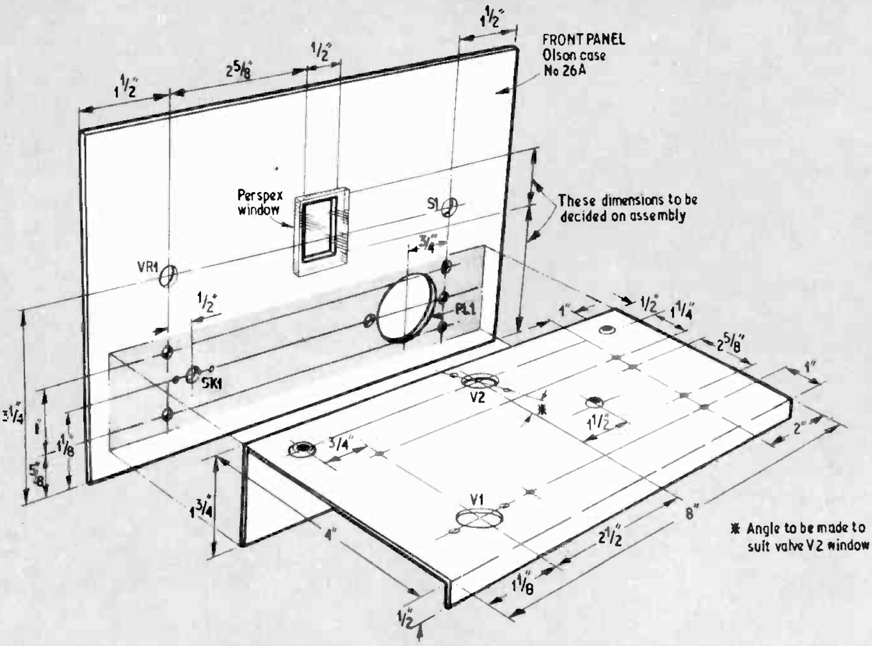


Fig. 4. Front panel and chassis drilling details

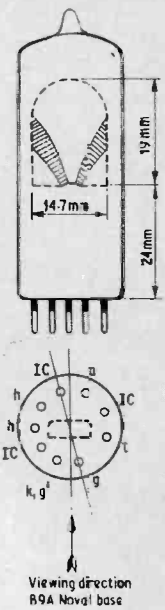


Fig. 5. Outline and base connections of magic eye indicator type EM80

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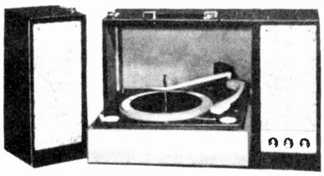

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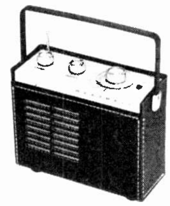

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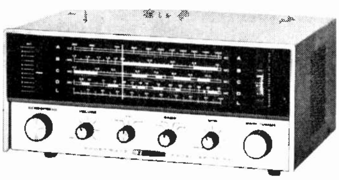

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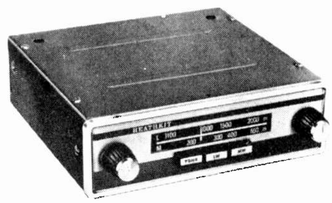

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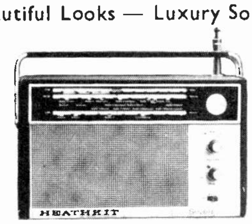

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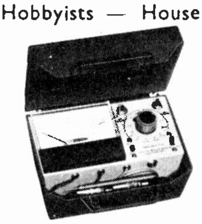

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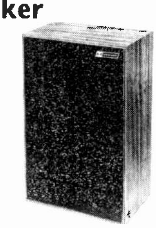

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Code Nos. mentioned above are given as a guide to the type of device in the Pak. The devices themselves are normally unmarked

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PIV	each	each	each	each	PIV	each
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VBOM	2A (TO-1)	6A (TO-66)	10A (TO-48)
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I.C. Operational Amplifier with Zener output. Type 701C. Ideal for P.E. Projects. 8 Lead TO-5 case. Full data.

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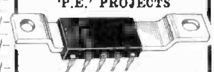

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T6	8	2G344A	OC44
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BP305A, 6-Input AND gate, 9/6 each.
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PERFORMANCE

To express the sensitivity of this instrument, we may define three display sector sizes as follows:

(1) Smallest conveniently observable signal, equal to audio voltage required to double the residual width of luminous line for zero signal
(2) Half-size sector signal, equal to audio voltage required to produce a luminous sector angle equal to the angle of remaining dark sector.
(3) Full sector signal, equal to audio voltage required to extend the luminous sector over the entire screen, leaving only two very narrow dark lines.

The luminous sector angle increases in approximately linear proportion up to (3), beyond which point large further increases of signal amplitude cease to exert any appreciable effect.

With the gain control VR1 at maximum, the necessary peak-to-peak input signal amplitude was measured for the prototype to be:

20mV for sector size (1)
300mV for sector size (2)
600mV for sector size (3)

These sensitivity figures were found to be valid without detectable changes for any frequency from 20Hz to 20kHz, sinewave or squarewave, thus presumably also for any arbitrary waveform as justified theoretically above.

To define the bandwidth, we adjust the input voltage at some medium frequency, e.g. 500Hz, for full sector size according to (3), and then increase or decrease the signal frequency, without changing the signal amplitude, until half sector size is obtained according to (2), showing that the 6dB points of the passband have been reached.

These 6dB points were found to be dependent on waveform and gain control setting. The lower 6dB point lies at one or two Hz for all normal waveforms and all settings of the gain control. With the gain control at maximum, the upper 6dB point lies at about 65kHz for waveforms approximating to sinusoidal, or at 120kHz for waveforms approximating to square, whilst with the gain control at half-way setting, the 6dB point lies at 20kHz irrespective of waveform.

SIGNAL TRACING

Evidently the smallest conveniently detectable audio signal is some 5mV r.m.s., so that the sensitivity of this unit is ample for signal tracing in all types of audio circuits right back to the anode or collector of the first stage following a microphone or tape deck input. Some form of pre-amplifier will be required for measuring the outputs of microphones or tape decks directly, but the sensitivity of the instrument as it stands is fully adequate for direct observations of the output from a crystal pick-up, most other kinds of pick-up, and a.m. or f.m. detectors.

Using an ordinary diode detector probe as found among standard oscilloscope accessories, the instrument can be used for tracing modulated i.f. and r.f. signals, right back to the aerial input circuit when using strong local stations or a signal generator. The choice of diode probe is in no way critical, any type made for a nominal oscilloscope input impedance of about 1MΩ being suitable. The magic eye bridge indicator may be connected directly to the a.m. detector output or to the loudspeaker output as indicator for aligning superhets.

The maximum safely acceptable input signal amplitude is about 50 to 100 volts peak-to-peak, regardless of the gain control setting. The latter must of course be reduced accordingly for proper display of

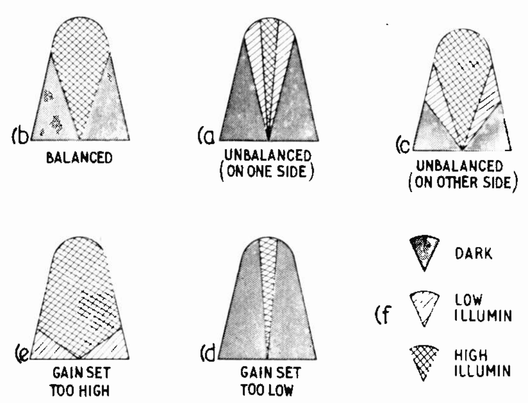


Fig. 6. Interpretation of magic eye luminous display patterns

the larger voltages in this range. If still larger audio voltages must be examined, use a conventional 10:1 ratio oscilloscope probe obtainable from any dealer stocking oscilloscopes. The impedance rating should be about 1MΩ oscilloscope input, but is not critical here. Voltages up to about 1kV peak-to-peak can then be examined. The 10:1 probe is also necessary to reduce capacitive loading when tracing signals in very high impedance audio circuits, or in tuned circuits which are sensitive to detuning (electronic pulse circuits, TV scan circuits, etc.).

COMPARATIVE AUDIO VOLTAGE MEASUREMENTS

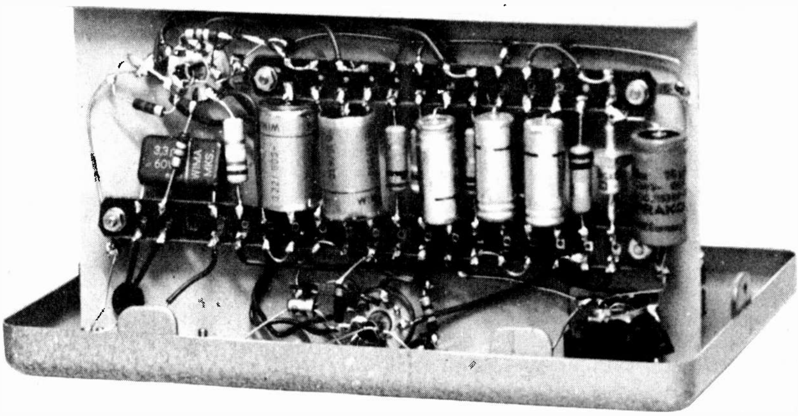
The sensitivity figures quoted in the section on performance enable rough assessments to be made of the peak-to-peak amplitude of any applied audio signal, from the gain control setting and observed sector size. It is possible to calibrate the gain control in terms of peak-to-peak signal amplitude required for half-sector size. The latter is readily observable by virtue of the symmetry present when the luminous and dark sectors possess equal angles. This generally permits ±10 per cent accuracy, or better with care, in assessing a.f. signal amplitudes.

Still better comparative measurements are possible by using a small cable adapter fitted with a switch or push button to alternate between the audio signal and an adjustable 50Hz signal from a mains transformer. The 50Hz reference signal is varied until actuation of the switch or push button produces no change in the luminous sector size. The 50Hz reference voltage can then be measured with an ordinary multimeter whose readings need only be correct at 50Hz mains frequency.

USE AS BRIDGE BALANCE INDICATOR

This instrument is equally satisfactory as balance indicator for various types of conventional bridges for *R*, *C* and *L* measurements and for the novel type of split phase bridge for electrolyte conductivity measurements described in the August 1969 issue of PRACTICAL ELECTRONICS.

For signal tracing, including balance indication in conventional bridges and comparative audio voltage measurements, the number of voltage inverting amplifier stages in the unit would be immaterial, since the d.c.



Underside view of prototype unit

restorer always ensures display of the peak-to-peak value. However, the published split phase conductivity bridge delivers a train of positive half-cycles of a sinewave, whose peak equality is the balance criterion. It is undesirable to have the d.c. restorer diode conducting here, so these peaks must be the negative ones in the waveform applied to the d.c. restorer.

Consequently we need an odd number of voltage inverting amplifier stages—a single one in the present unit. As long as the split phase bridge is not balanced, we obtain two overlapping luminous sectors of different angles. These coincide to a single sector at balance. This balance criterion is quite sharp, although not nearly as sharp as with the described double bright-edge raster oscilloscope display in the cited article. When using the magic eye bridge indicator with the split phase bridge, do not turn up the gain control more than necessary. Quite a small luminous sector gives the sharpest assessment of sector coincidence (see inset sketches on Fig. 6).

For conventional bridges, the purpose of the balance indicator is merely to detect when no, or negligible, signal is present. At all other points of off balance for the bridge, an appreciable signal will be present and indicated as corresponding luminous sector. Thus good maximum sensitivity is required for a satisfactory balance indicator in a conventional bridge.

In this sense, the instrument here described is at least as good as sensitive headphones, and superior thereto because it does not require ambient silence, and visual assessments are clearer than aural ones. For normal operation in a conventional bridge, a low gain setting is used when still far off balance, turning up to maximum gain as the balance point is approached.

CONVENTIONAL BRIDGE TYPES

Fig. 7a shows the generalised four-arm bridge. The arms may be arbitrary impedances composed of *R*, *C* and *L* and designated Z_1 to Z_4. The audio voltage source is applied across one diagonal, and the balance indicator is connected across the other diagonal. It is generally immaterial which diagonal is used for which purpose, so that if the impedances are arranged such that the bridge is balanced (no signal indicated by balance indicator), it is still balanced if the audio source and the balance indicator are interchanged.

THE WHEATSTONE BRIDGE

Fig. 7b shows the Wheatstone bridge, in which all four impedances are simple resistors. This sketch also shows convenient forms of connections for a practical set up, applying analogously for the other bridges, (c) to (e) too. *T* may be any small audio or intervalve type transformer. The ratio is not critical but should not be too great. If dealing with only low impedances in the bridge, connect the winding with the smaller number of turns across the bridge diagonal. If low and high impedances are encountered in the bridge, connect the largest winding across the bridge diagonal.

The audio source may be taken from a low voltage secondary winding of a mains transformer for the Wheatstone bridge, but for the other bridges, especially if the arms contain small *C* or *L* values, a higher frequency is preferable. Neither amplitude nor frequency are critical, so that if an audio signal generator is not available, a radio or tape recorder is usable.

A single balance criterion, expressed in the two alternative forms shown, suffices for the Wheatstone bridge. In general, it is immaterial which one of the four resistors is the unknown one to be determined, which pair of the remaining three is selected in definite ratio to establish the range factor, and thus which fourth resistor is the calibrated variable one.

For example, R_1 may be the unknown one, R_4 a fixed standard resistor, R_2 chosen as a decimal multiple or submultiple thereof to establish the range factor (switch to select various values of R_2), and R_3 is the calibrated variable resistor.

OTHER DERIVATIVE BRIDGES

The possible variants of the general bridge of Fig. 7a are legion. We will select only three particularly useful ones for simple practical work, without making any claims to be comprehensive.

As soon as we introduce capacitors and inductances, we generally need two independent balance conditions which have to be satisfied simultaneously to obtain zero signal in the balance indicator diagonal. The reason for this is that resistive (*R*) and reactive (*C* and *L*) voltages or currents are in phase quadrature, thus vectorially independent and the bridge must be balanced separately for each quadrature component. Consequently two variable calibrated components must be *mutually* adjusted for balance, which considerably complicates the search for the true balance point.

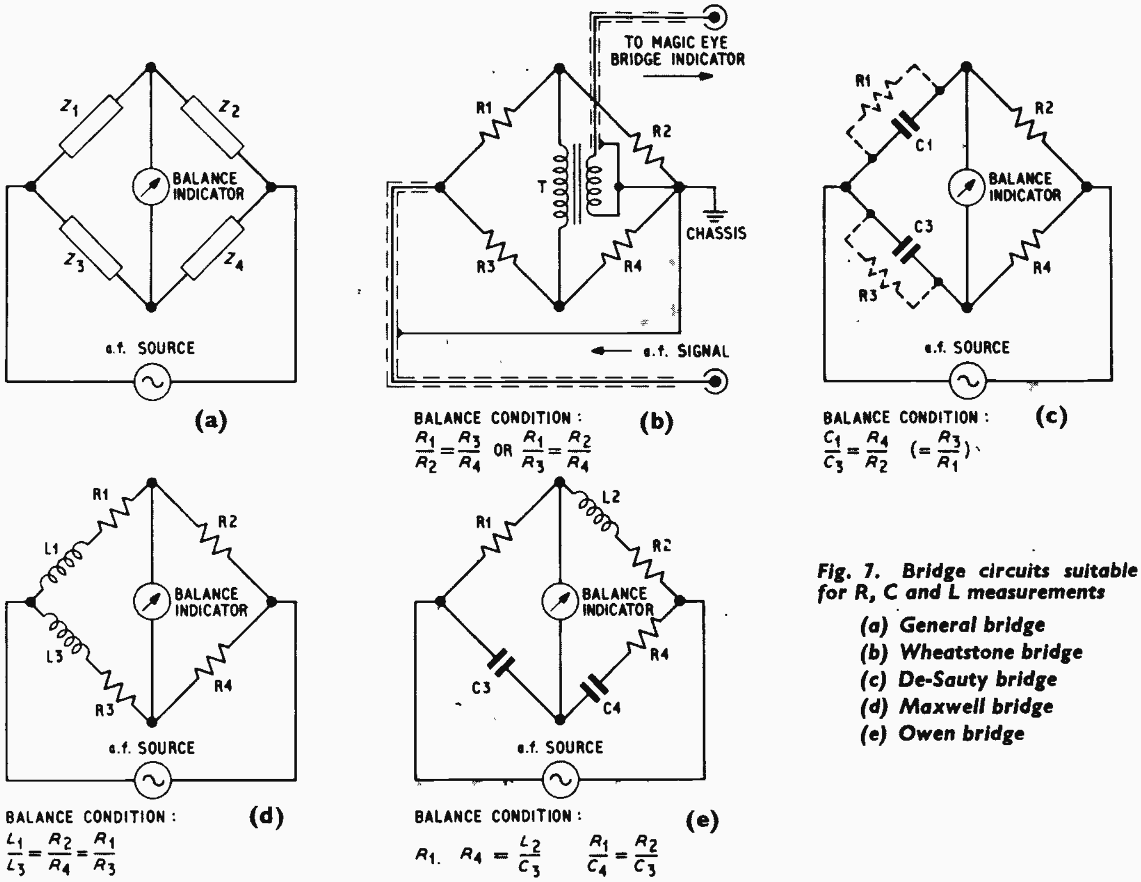


Fig. 7. Bridge circuits suitable for R, C and L measurements

(a) General bridge
(b) Wheatstone bridge
(c) De-Sauty bridge
(d) Maxwell bridge
(e) Owen bridge

THE DE-SAUTY BRIDGE

Fig. 7c shows the De-Sauty bridge for measuring capacitances. As long as the capacitors possess negligible leakage (time constants $C_1.R_1$ and $C_3.R_3$ very long compared to the period of the audio drive waveform), so that R_1 and R_3 may be neglected, this bridge degenerates to one with a single balance criterion. It is immaterial which capacitance arm contains the unknown capacitor. The other one then contains a switch selecting various accurate fixed capacitors to determine the range. One of the resistors is a fixed standard, the other one a variable resistor calibrated directly in capacitance values.

The bridge is extremely useful for making reasonably accurate checks of small capacitors from about 1,000pF up to tens of microfarads, using a 50Hz source. Measurements are possible down to about 100pF with higher audio frequencies, the lower limit being set by confusion due to stray capacitances which are generally about 30pF in an arbitrarily set-up bridge. If the capacitor to be measured leaks, the second balance criterion with respect to R_3 and R_1 must be satisfied too.

THE MAXWELL BRIDGE

The Maxwell bridge shown in Fig. 7d is the counterpart of the De-Sauty bridge for inductances. It is unusual to find inductances with such a high L/R ratio that R_1 and R_3 may be neglected, so this bridge normally does not degenerate to one with only a single balance criterion.

In a typical practical arrangement, L_1 is the unknown inductance and R_1 its own inherent d.c. resistance. A range switch selects various standard L_3, whose d.c. resistances are smaller than those of any unknown coils L_1 likely to be encountered. R_3 is a variable resistor for one balance criterion, R_2 a variable resistor for the other balance criterion and R_4 a fixed standard resistor. The practical difficulty with this bridge arrangement is that R_2 and R_3 have about the same effect on the balance point, so that mutual adjustment is difficult.

THE OWEN BRIDGE

The Owen bridge (shown in Fig. 7e), is easier to balance because R_2 affects the balance point more strongly than R_4. Thus to establish balance, vary R_2 until minimum signal is shown on the balance indicator, and then adjust R_4 for zero signal (repeat for fine zero adjustment if necessary).

The bridge can be switched for L or C measurements. R_1 may be a fixed standard resistor, C_4 a fixed standard capacitor, R_4 a variable resistor calibrated in inductance values and C_3 various values selected by the range switch, for inductance measurements. The same range switch with the same C_3 values can serve for capacitance measurements, whereby C_4 is the unknown component and R_2 is a variable resistor calibrated in capacitance values. ★

ELECTRONICS is not really new, it has been growing up slowly for more than a hundred years. In 1835 Roschenschold published his discovery that an electric current would only flow in one direction through certain solids; he had unwittingly stumbled upon the solid-state or semiconductor diode, and a device for controlling the motion of electrons.

Dramatic progress in radio communications, from about 1900 onwards, tended to overshadow further developments in electronics, and the thermionic valve diverted attention away from solid-state devices.

Electronics really came into its own following the Second World War. There was an enormous proliferation of electronic devices, and semiconductors began to compete with valves.

It is only natural that electronics, like any other specialised subject, has slowly acquired a "language" of its own. However, with just a smattering of school science, and some fairly simple maths, the intelligent electronics tourist can soon pick up the patois and begin to appreciate at least some of the scenery. This series of articles is intended to satisfy a need for a "phrase book" and general guide to electronic theory.

The first part must essentially begin with basic electric currents and the influences of simple components to control these currents. Later parts will progress through more complex devices (using semiconducting materials) to functional circuits.

PART ONE OF A NEW SERIES FOR THE BEGINNER

ELECTRICITY AND ELECTRONS

The general phenomena arising from a surplus or deficiency of electrons (negatively charged particles) in atoms is called static electricity. When electrons are made to drift from atom to atom, this constitutes an electric current.

A *conductor* is a body or substance which readily permits a flow of electrons, while an *insulator* is a body or substance which does not allow such a flow. More about electrical conduction later.

Electrons are far too small to be examined individually, and are too numerous to count, but an electric current can be studied by making use of its effects on components and materials.

Large populations of electrons in motion will cause appreciable heat to be developed in a poor conductor (a resistance), and will also generate a magnetic field. Heat and magnetism in turn can be made to deflect the pointers of measuring instruments. It then remains to find out what aspect of electron behaviour the instrument is actually measuring.

SIX BASIC QUANTITIES

The display panel opposite sets out the six basic quantities used to assess functions of electricity, with quantities in bold capitals and their associated units in bold small letters. Symbols appear inside brackets, and it is important not to confuse the symbol of a quantity with that of its measured unit.

RELATIONSHIPS

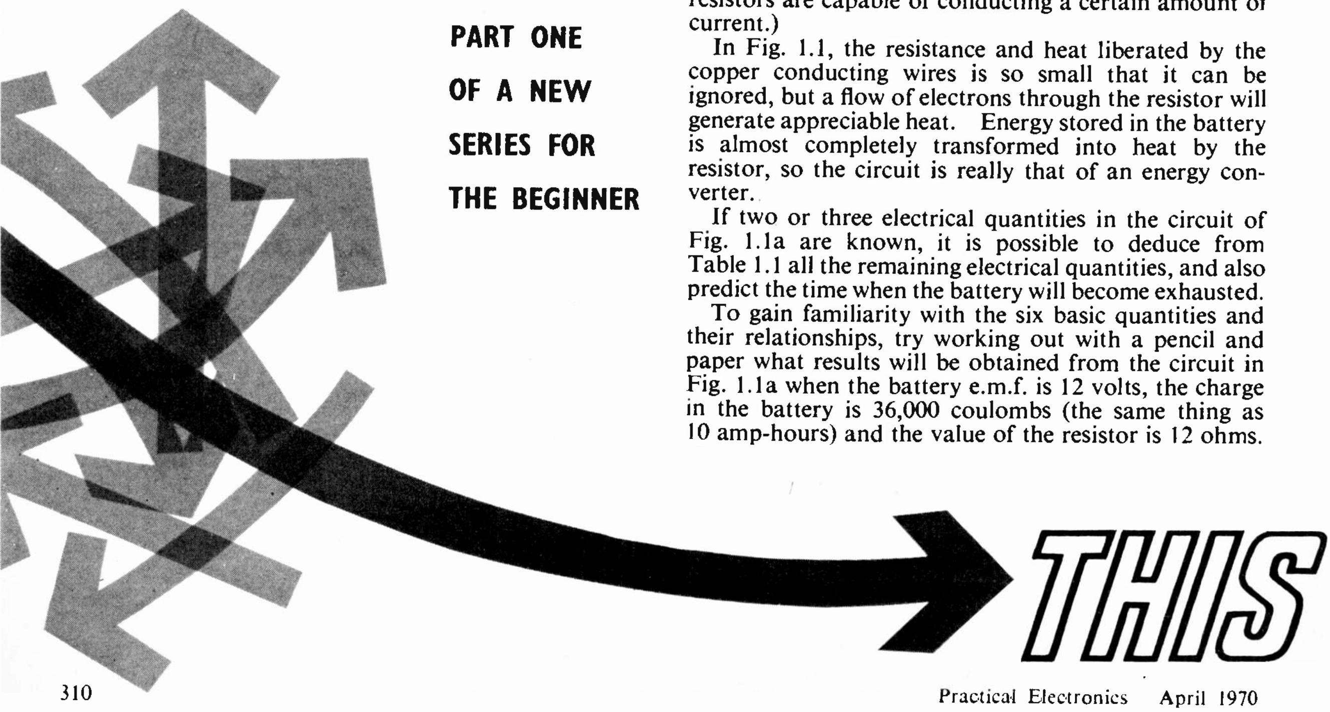
The electrical quantities listed can be arranged in a number of ways to tell us what is happening, and what is likely to happen in an electrical circuit. A very important set of relationships is given in Table 1.1.

To see just how these relationships work in practice, it is instructive to apply them to a simple circuit consisting of a car battery, a switch, and a resistor, which are linked together in series by copper conducting wires of negligible resistance, as in Fig. 1.1. (Resistance is a comparative term. All conductors will exhibit some resistance at normal temperatures, and all resistors are capable of conducting a certain amount of current.)

In Fig. 1.1, the resistance and heat liberated by the copper conducting wires is so small that it can be ignored, but a flow of electrons through the resistor will generate appreciable heat. Energy stored in the battery is almost completely transformed into heat by the resistor, so the circuit is really that of an energy converter.

If two or three electrical quantities in the circuit of Fig. 1.1a are known, it is possible to deduce from Table 1.1 all the remaining electrical quantities, and also predict the time when the battery will become exhausted.

To gain familiarity with the six basic quantities and their relationships, try working out with a pencil and paper what results will be obtained from the circuit in Fig. 1.1a when the battery e.m.f. is 12 volts, the charge in the battery is 36,000 coulombs (the same thing as 10 amp-hours) and the value of the resistor is 12 ohms.



It should be possible to arrive at the following answers by taking any of the several paths of exploration offered by Table 1.1, and jointly consulting the list of quantities given earlier. Energy in the battery will be 432,000 joules, heat liberated by the resistor during the life of the battery 103,075 calories, flow of charge or current 1 amp, rate of energy dissipation or power 12 watts, and time taken for the battery to become exhausted 36,000 seconds or 10 hours.

RESISTANCE NETWORKS

A current can be increased or reduced by changing the value of resistance in a circuit. Indeed, the inter-relationship of electrical quantities means that wholesale changes can be brought about, merely by adjusting a single quantity, such as resistance.

Looking again at the circuit in Fig. 1.1a, if two more 12 ohm resistors are wired in series with the first resistor (Fig. 1.1d) the resulting total resistance will be 36 ohms, the current will be reduced to $\frac{1}{3}$ amp, and the charge in the battery will last three times longer.

On the other hand, if these two extra 12 ohm resistors are wired in parallel with the first (Fig. 1.1d), the total resistance will be reduced to 4 ohms, current will be trebled to 3 amps, and time taken for the battery to discharge will be 3·3 hours.

If a selection of resistors were wired to a special switch, which connected them in series or parallel in the circuit in Fig. 1.1b, a whole range of heat outputs would be readily available, ranging from a great heat for a short time to a small heat over a long period, with intermediate steps, according to the resistance values and wiring arrangement.

Table 1.1: ELECTRICAL RELATIONSHIPS

CHARGE (COULOMBS)	Q	$= \frac{W}{E}$	$= I \times t$	$= \frac{E \times t}{R}$	$= \frac{P \times t}{E}$	
CURRENT (AMPERES)	I	$= \frac{W}{Q \times R}$	$= \frac{E}{R}$	$= \frac{P}{E}$	$= \sqrt{\left(\frac{P}{R}\right)}$	
ENERGY (JOULES)	W	$= Q \times E$	$= P \times t$	$= E \times I \times t$	$= I^2 \times R \times t$	
POWER (WATTS)	P	$= \left(\frac{W}{Q}\right)^2 \times \frac{1}{R}$	$= E \times I$	$= I^2 \times R$	$= \frac{E^2}{R}$	
RESISTANCE (OHMS)	R	$= \frac{W}{Q \times I}$	$= \frac{E}{I}$	$= \frac{P}{I^2}$	$= \frac{E^2}{P}$	
EMF (VOLTS)	E	$= \frac{W}{Q}$	$= I \times R$	$= \frac{P}{I}$	$= \sqrt{(P \times R)}$	

CHARGE *(Q)*. An amount of electricity. A surplus or deficiency of electrons. Practical unit the **coulomb** (C). A negative charge of 1 **coulomb** corresponds to an excess population of approximately six trillion (6×10^{18}) electrons.

CURRENT *(I)*. The movement of electrons or CHARGE. Practical unit the **ampere** or **amp** (A). One **amp** is a flow of 1 coulomb per second.

ENERGY *(W)*. The work done by a flow of electrons, in terms of heat, light, mechanical effort, etc. Practical unit the **joule** *(J)*. One **joule** equals 0·2386 calories, or the work done by a force of 1 newton acting through a distance of 1 metre.

POWER *(P)*. The rate of doing work or delivering ENERGY. Practical unit the **watt** (W). One **watt** is equal to 1 joule per second or 0·00134 horsepower.

RESISTANCE *(R)*. Property of a material to resist or slow down a flow of electrons, and convert their kinetic energy into heat or light. Practical unit the **ohm** (Ω). A resistance of 1 **ohm** will dissipate 1 watt when a current of 1 amp passes through it.

ELECTROMOTIVE FORCE or **E.M.F.** *(E)*, also called **VOLTAGE** and **POTENTIAL** *(V)*. The force which moves electrons. Practical unit the **volt** (V). One **volt** is needed to push a current of 1 amp through a resistance of 1 ohm.

Quite often the practical units used to measure electricity are either too large or too small for the job in hand, and they have to be prefixed for multiples or sub-multiples of one thousand; see Table 1.2.

Table 1.2: UNIT PREFIXES

Prefix	Value
pico—($\mu\mu$ *or* p)	One million millionth (10^{-12})
nano—(n)	One thousand millionth (10^{-9})
micro—(μ)	One millionth (10^{-6})
milli—(m)	One thousandth (10^{-3})
kilo—(k)	One thousand times (10^{3})
mega—(M)	One million times (10^{6})
giga—(G)	One thousand million times (10^{9})
tera—(T)	One million million times (10^{12})

Examples are: picofarad ($\mu\mu$F *or* pF), nanovolt (nV), microamp (μA), millihenry (mH), kilowatt (kW), and megohm (MΩ).

WAY TO ELECTRONICS

FIG. 1.1. RESISTANCE

THE RESISTANCE OF ANY MATERIAL IS PROPORTIONAL TO THE RESISTIVITY FACTOR OF THE MATERIAL AND ITS LENGTH, AND INVERSELY PROPORTIONAL TO ITS CROSS-SECTIONAL AREA

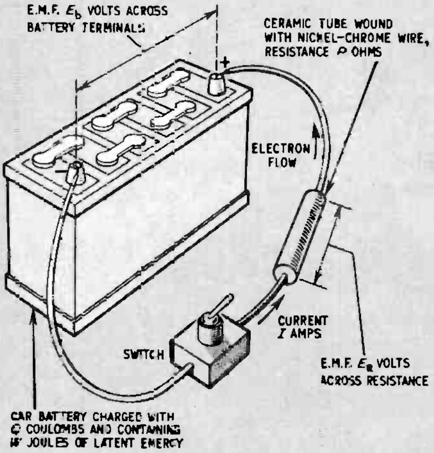


Fig. 1.1a. A heavy duty battery connected in series with a switch and resistor. Electron flow is shown by the arrows. Conventional current flow, based on positively charged particles, is in the opposite direction

Fig. 1.1b. The diagram in Fig. 1.1a can be redrawn in simple terms using a symbol for each component and straight lines for wires. This is called a theoretical circuit diagram. The switch is shown normally open, or "off". The resistor could be replaced by a 12V lamp to show that current flow is heating the filament when the switch is closed

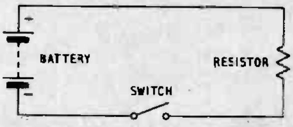


Fig. 1.1c. This graph shows that when the switch is closed the e.m.f. across the resistor increases instantly and remains at almost battery voltage until the switch is opened again

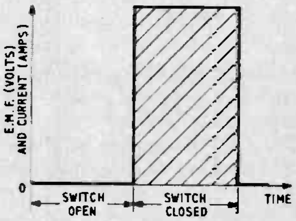
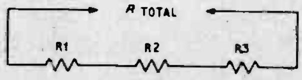


Fig. 1.1d. The total resistance of any number of resistors connected in SERIES is equal to the sum of each resistance added together: $R_{TOTAL} = R_1 + R_2 + R_3$, *etc.*



The total resistance of any number of resistors connected in PARALLEL is

$$R_{TOTAL} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}, \text{ etc.}$$

(All units in ohms)

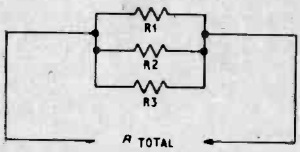


FIG. 1.2. VOLTAGE OR POTENTIAL DIVIDERS

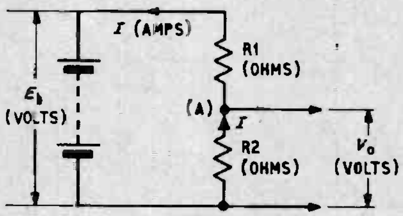


Fig. 1.2a. Potential divider using two fixed value resistors in series. The output voltage available across one of these is $V_0 = I \times R_2$. *The current through the potential divider is* $I = E_b/(R_1 + R_2)$ *(E_b and V_0 are in volts; I in amps; R_1 and R_2 ohms)*

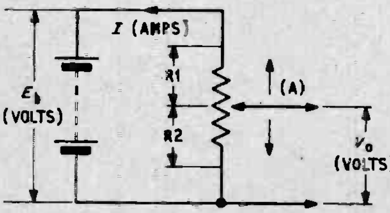


Fig. 1.2b. Potential divider where the two fixed resistors are replaced by one resistor with a movable wiper arm to provide an output voltage V_0 of any amount between zero and the battery voltage. This component is called a potentiometer and is sometimes referred to as a rheostat, volume control, or variable resistor

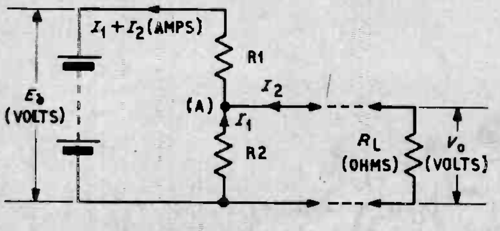


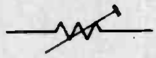
Fig. 1.2c. The output of the above two circuits is usually connected to a load of some kind which can be represented by a resistance R_L. The output voltage V_0 across the load will now be less than it was in Figs. 1.2a and 1.2b because R_L shunts R2.

$$V_0 = I_2 \times R_L = I_1 \times R_2$$

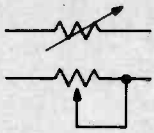
(V_0 is in volts; I_1 and I_2 in amps; R_1, R_2, and R_L in ohms)

CIRCUIT SYMBOLS

VARIABLE RESISTOR

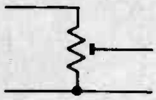


(Preset screwdriver control)

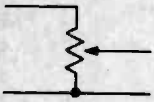


(Knob control)

POTENTIOMETER



(Preset screwdriver control)



(Knob control)

FIG. 1.3. CAPACITANCE

THE CAPACITANCE BETWEEN TWO SETS OF PARALLEL METAL PLATES IS PROPORTIONAL TO THE AREA OF OVERLAP OF EACH PAIR OF PLATES, THE NUMBER OF PAIRS OF OVERLAPPING PLATES, AND THE DIELECTRIC CONSTANT OF THE INSULATING MATERIAL BETWEEN THE PLATES. IT IS INVERSELY PROPORTIONAL TO THE DISTANCE BETWEEN TWO PLATES

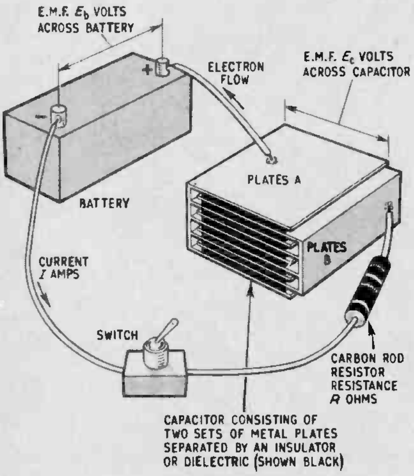


Fig. 1.3a. A battery connected in series with a switch, a current limiting resistor, and a capacitor. For simplicity the capacitor is shown with flat plates interleaved with a dark area of insulating material (or dielectric) between each pair

Fig. 1.3b. The diagram in Fig. 1.3a can be redrawn in simple terms using a symbol for each component. The switch is shown normally "off"

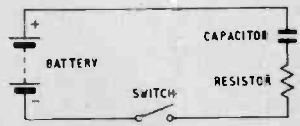


Fig. 1.3c. This graph shows that when the switch is closed the voltage across the capacitor rises exponentially to almost the battery voltage while the current rises instantly and declines exponentially as the voltage rises

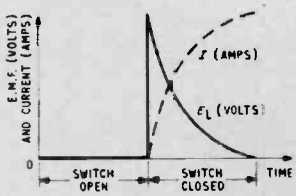
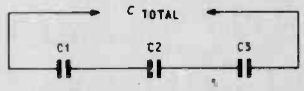


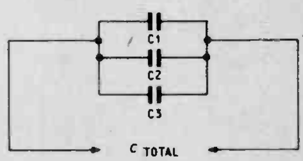
Fig. 1.3d. The total capacitance of any number of capacitors in SERIES is

$$C_{TOTAL} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}, \text{ etc.}$$



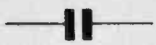
The total capacitance of a number of capacitors in PARALLEL is

$$C_{TOTAL} = C_1 + C_2 + C_3, \text{ etc.}$$



CIRCUIT SYMBOLS

VARIABLE CAPACITOR (Knob control)



FIXED VALUE CAPACITOR

VARIABLE CAPACITOR or TRIMMER (Preset screwdriver control)

POTENTIAL DIVIDER

Apart from series and parallel combinations, there is another important configuration called a potential or voltage divider, see Fig. 1.2. The potential divider is widely used for reducing or dividing voltages or currents by known amounts.

In Fig. 1.2a, the fixed divider network consists of two resistors wired in series across a battery, with an output taken from across one of these resistors. By calculating suitable values for R1 and R2, any voltage between zero and battery volts E_b can be made available.

A continuously variable adjustment between zero and E_b volts can be obtained if the divider has a sliding contact which moves along a resistance track; this arrangement is variously called a potentiometer, volume or gain control, variable resistor and so on, depending on the use to which it is put. The variable divider circuit is given in Fig. 1.2b.

In the examples given in Fig. 1.2a and 1.2b, the dividers reduce the e.m.f. to be supplied to the output (V_0), but until a load is connected, no current flows in the output wires. Current merely flows through R1 and R2 and back to the battery. Most practical dividers usually end up having some sort of load on their outputs, which can be represented by a plain resistance, R_L in Fig. 1.2c.

Even a voltage measuring instrument can take some current, and a heavier load, such as a flashlamp bulb, will place a considerable load on the divider output.

So, the current originally passing through R2 is now divided into I_1 and I_2 through R2 and R_L. The output voltage V_0 is also modified and reduced, because the relationships between electrical quantities in the circuit of Fig. 1.2c must be maintained; refer again to the calculations for voltage, current, and resistance in Table 1.1 and the formulae in Fig. 1.1d.

$$V_0 = I_2 \times R_L = I_1 \times R_2$$

CAPACITANCE

It is appropriate now to add two more electrical quantities to the previous list, namely capacitance and inductance. The basic quantities again being in bold capitals and the measured units in bold small letters.

CAPACITANCE *(C)*. The property of two conductors, separated by an insulator, to store an electric charge. Practical unit the **farad** (F). One **farad** will store 1 coulomb on application of 1 volt.

INDUCTANCE *(L)*. The property of a current carrying conductor to oppose a change of current, due to an associated magnetic field. Practical unit the **henry** (H). The amount of energy stored in the magnetic field associated with 1 **henry** is $\frac{1}{2}$ joule for a current of 1 amp.

FIG. 1.4. INDUCTANCE

THE INDUCTANCE OF ANY COIL OF WIRE IS PROPORTIONAL TO THE SQUARE OF THE NUMBER OF TURNS OF WIRE, THE SQUARE OF THE MEAN DIAMETER OF THE COIL, THE LENGTH OF THE COIL, AND THE MAGNETIC QUALITIES OF THE CORE MATERIAL

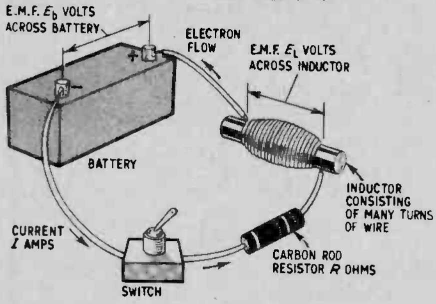


Fig. 1.4a. A battery connected in series with a switch, a resistor, and an inductor (or coil). The inductor usually consists of several turns of thin insulated wire, sometimes with a core of air or ferrous material

Fig. 1.4b. The diagram in Fig. 1.4a using symbols for components

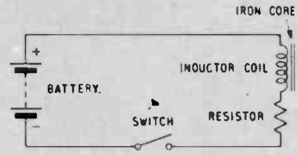
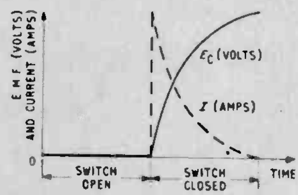


Fig. 1.4c. This graph shows that when the switch is closed the current through the coil rises exponentially, while the voltage rises instantly and declines exponentially as the voltage rises



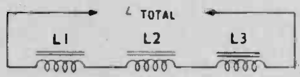
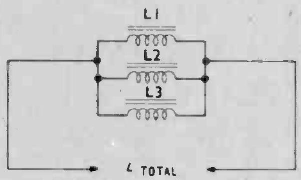


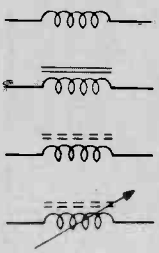
Fig. 1.4d. The total inductance of any number of inductors in SERIES is $L_{TOTAL} = L_1 + L_2 + L_3$*, etc.*

The total inductance of any number of inductors in PARALLEL is

$$L_{TOTAL} = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}, \text{etc.}}$$



CIRCUIT SYMBOLS



FIXED VALUE INDUCTOR

FIXED INDUCTOR WITH IRON CORE

FIXED INDUCTOR WITH CORE OF FERRITE MIXTURE

VARIABLE INDUCTOR WITH ADJUSTABLE CORE

In the circuit in Fig. 1.3a, the capacitor shown consists of two sets of interleaved metal plates A and B, each set being insulated from the other. The presence of an insulator prevents any significant flow of electrons between the two sets of plates, and yet the capacitor seems to conduct a current in certain circumstances.

To see how this can be, we will assume that the switch in Fig. 1.3a is off, leaving the resistor and plates B disconnected from the battery negative terminal. Because plates A are wired directly to the battery positive terminal, they will be deficient in electrons. For the purposes of this exercise we will also assume that plates B have been discharged and are in the same condition as plates A, with an electron deficiency.

When the switch is closed, electrons will rush through the resistor to the electron starved B plates, consequently power will be dissipated for only an instant in the resistor. The graph in Fig. 1.3c shows that the current rises very rapidly to maximum as the switch is closed, then declines slowly as the concentration of electrons on plates B begins to build up (dotted line).

However, the e.m.f. across the capacitor works the opposite way, rising slowly from zero towards maximum (as shown by the solid line). Note that when the process has been completed, plates A are still deficient in electrons, and there has been no actual flow of electrons through the insulator, but there was a short-lived current through the resistor.

After plates B have been fully charged with electrons, the capacitor is capable of delivering a charge to a resistor which may be connected across A and B. In many ways a capacitor behaves like a small battery.

INDUCTANCE

It has been established that there is a close relationship between electron motion and magnetic attraction. If a current flows through a wire a magnetic field is set up around that wire.

To make this magnetic field of useful magnitude, several wires are placed together and all fed with an e.m.f. The easiest way is to use one wire and wind it several times around a former. The greater the wire thickness and number of turns, the stronger will be the magnetic field and "inductance" of the coil.

A core of iron or other ferrous mixture can be placed inside the coil of wire to increase the inductance. This is shown in Fig. 1.4b.

However, the magnetic field can generate a small opposing current in the wire which will rapidly increase for an instant when the core is removed. The magnetic field collapses and generates an e.m.f. across the coil for a short time. The inductor opposes a change of current, and stores electrical energy.

When the switch is closed in the circuit in Fig. 1.4a, the e.m.f. across the inductor builds up very rapidly to maximum before slowly declining, while current begins a slow growth from zero towards maximum. Clearly, the action of an inductance has points of similarity with that of a capacitance. Current and voltage trends for both can be compared by examining the graphs in Fig. 1.3c and Fig. 1.4c.

Part two next month will deal with the differences between electrical conduction in solids, liquids, and gases, and will also introduce that important semi-conducting device—the diode.

ELECTRONORAMA

VISITS THE B B C NEWS COMPLEX

THE whole "news complex" occupies a six-floor spur built on to the Television Centre at White City.

The News installation includes studios, telecine and video-tape areas, a film processing section, film workshops, cutting rooms, and of course, newsrooms, offices, etc. The basement contains an underground car park for news operational vehicles.

The installation is primarily for the 625-line 50-field PAL colour standard but pictures can be originated on NTSC 525-line 60-field standards directly or via a converter.

Sub-Central Apparatus Room

On the first floor is the sub-central apparatus room in which the many communications facilities required by the News Service are controlled. This room has its own genlocking equipment and pulse generators as well as feeds from the main Television Centre pulse chains. It also supplies all technical areas in the Spur with sound, vision, pulses, and communications facilities, and also co-ordinates the output of news sources in the Spur with other areas in the Television Centre and with the external switching centres of the simultaneous broadcast network. Facilities also exist for remote control of the camera at the Parliamentary Studio. The first photo (*above*) shows the control desk in the sub-central apparatus room.

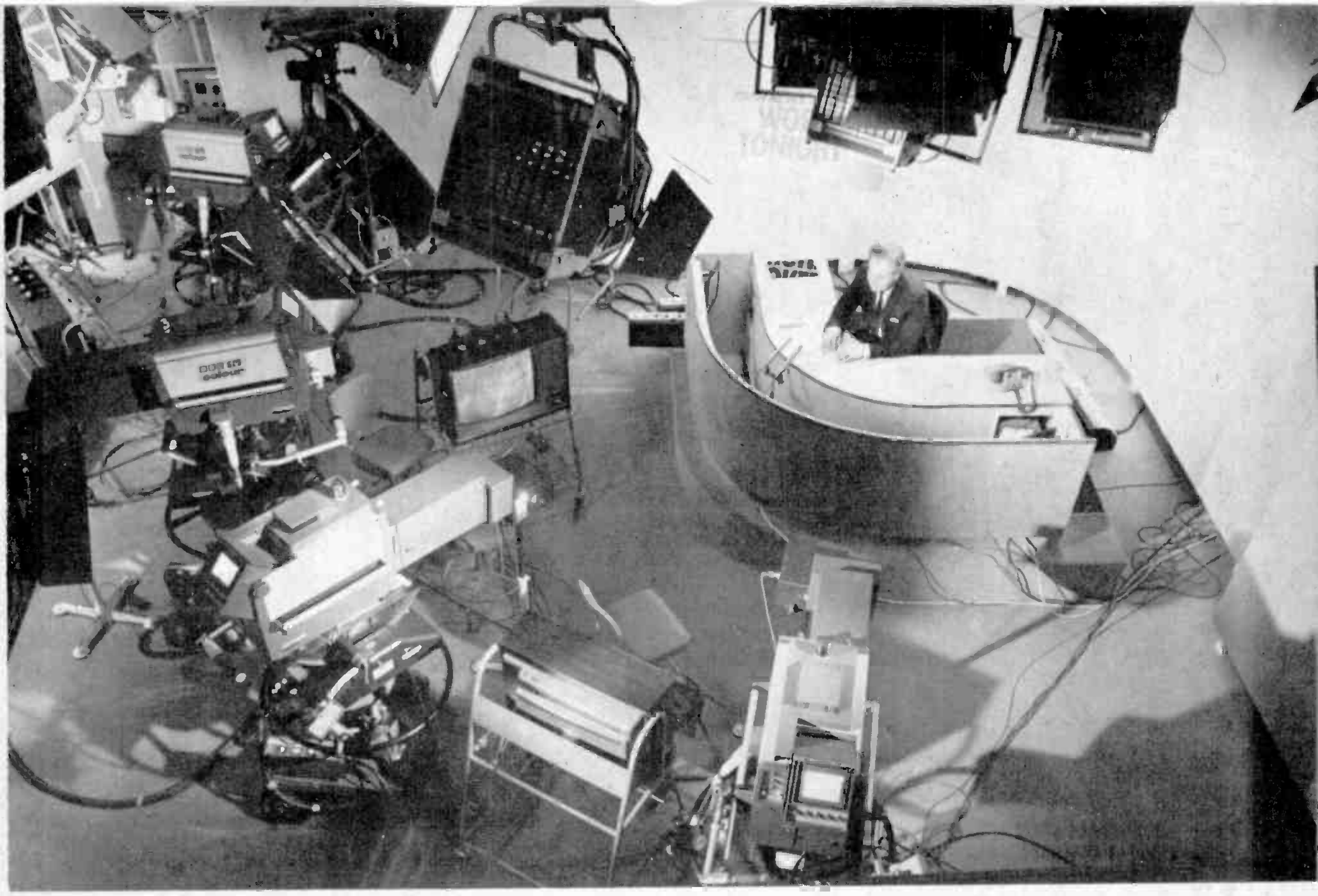
Video-Tape and Film Processing

The third floor contains video-tape and film processing areas and the senior engineering offices.

A large Telecine area is on the fourth floor. This area is equipped with nine 16mm colour machines, two of which are multiplexed to deal with 8mm and super 8mm film. There are also two 16mm monochrome telecines.

One of the two telecine control desks is shown in the photo (*right*).

The electronic method of reviewing film is used.



The Studios

The sixth floor can be described as the output floor. In addition to a large newsroom it has two studios each equipped with four remotely-controlled Marconi colour cameras, see photo (*above*).

There are two large control rooms, one for each of the studios, separated from the studio by a glass partition. The control rooms are divided into raised islands, one of which is for the sound mixer and his disc and tape machines. The island is partially screened by glass which gives some acoustic isolation but enables the sound mixer to keep in touch with control-room operations, an essential requirement in constantly-changing News programmes.

Another island supports the editorial desk and on the floor level is the production section containing vision mixer, productions assistant, senior television engineer, and secretarial positions.

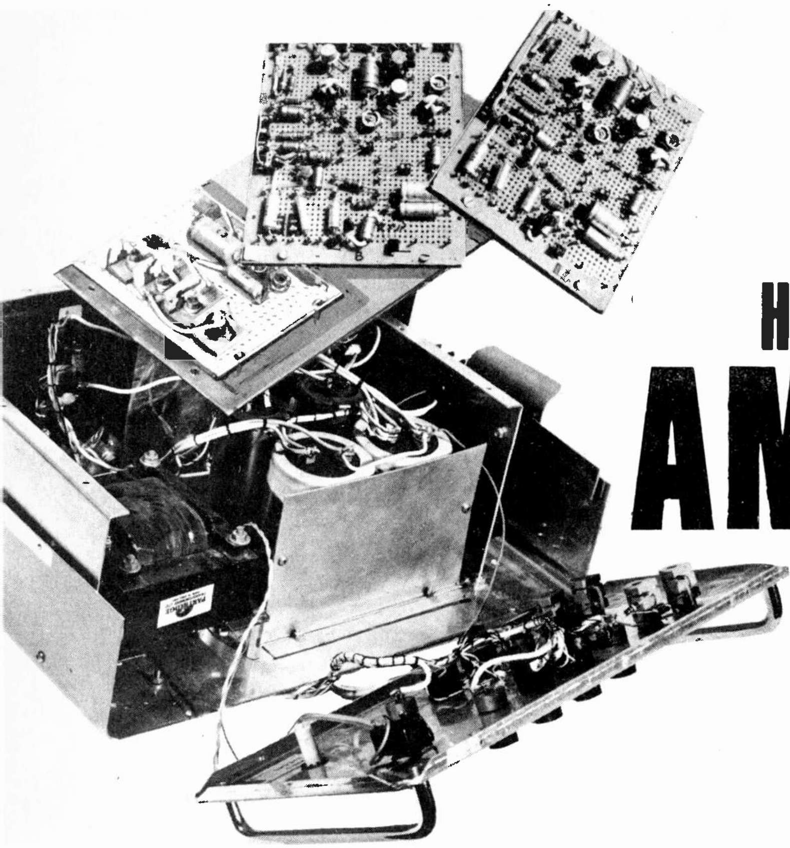
The remaining island houses the vision control and lighting console.

The vision control positions have full remote-control of the studio cameras. There are in each studio four panels each enabling up to 20 pre-set camera shots to be adjusted after which information on these shots can be fed into a ferrite-core memory store in the vision apparatus.

Newsroom

The large Newsroom has communications facilities, teleprinters, and a permanently installed monochrome camera. In addition two colour cameras, one on remote control, can be installed in the Newsroom if required. The photo (*left*) shows newsreader facing vidicon "newsflash" camera.

Captions, either opacity or transparency, are originated in a special control room equipped with a monochrome micro scanner. This is used for inlaying the sub-titles in the "News Review for the Deaf" programme and includes a colour synthesiser enabling a two-tone monochrome caption to be reproduced in two colours.



50 PLUS 50 HIGH POWER AMPLIFIER

By R. D. PALMER

IN LAST month's issue the first part of this article provided design details of the complete amplifier and component assembly and wiring of two amplifier boards.

In this second part the output stage sub-assemblies and power supply unit will be presented, as well as chassis layout and interwiring details.

OUTPUT TRANSISTORS

The output transistors TR13 and TR14 and R44, R45, R46 and C18, for both channels, are mounted on extruded aluminium heatsinks type 10D.

Prior to mounting the components, the heatsinks must be drilled as shown in Fig. 10 making sure that all burrs are removed afterwards. They should then be cleaned and sprayed with an aerosol matt black paint after first having masked the transistor mounting area.

The transistors are then bolted on with the appropriate insulating kits. To ensure a low thermal resistance, silicone grease should be smeared over the insulation washers.

RESISTOR WINDING

Resistors R44 and R45 are made by bifilar winding 25in of 30 s.w.g. or 36in of 28 s.w.g. enamelled copper wire over the body of any 1 watt resistor. This gives the required value of 0·14 ohms $\pm$ 5 per cent.

To secure these windings Araldite should be applied.

The component layout for the heatsinks of both channels is given in Fig. 11. Wiring details of these are given later.

THE POWER SUPPLY

The power supply is of a series regulated type, the circuit of which is shown in Fig. 12. A regulated supply is necessary to maintain the correct working voltage for the two power amplifiers and to prevent excessive intermodulation and hum which would otherwise occur at high output levels.

An added advantage of this circuit is that mains input voltage adjustment by transformer tappings is not necessary over a range of about $\pm$10 per cent of the nominal input voltage.

The specifications of the power supply are as follows:

Output voltage	56 volts
Maximum continuous output current	5 amp
Maximum peak output current	12 amp for duration of 5 milliseconds

The transformer provides a 50 volt output under no load conditions; this being rectified by the bridge D7–D10 and smoothed by C20. The voltage at this point attains 70 volts under no load conditions since C20 charges up to the peak value of the rectified input.

The series regulator transistor TR17, and TR15 are in Darlington pair, emitter follower configuration, biased by R48.

DIFFERENTIAL AMPLIFIER

A differential amplifier, formed by TR16 and the associated components, senses any difference between the voltage on VR7 and the reference voltage across the series diodes D11 and D12. Output changes cause

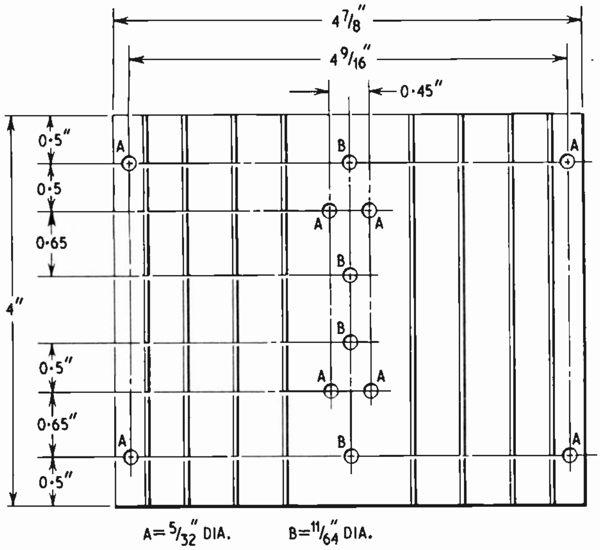


Fig. 10. Drilling details for the type 10D heatsinks, three of which are required

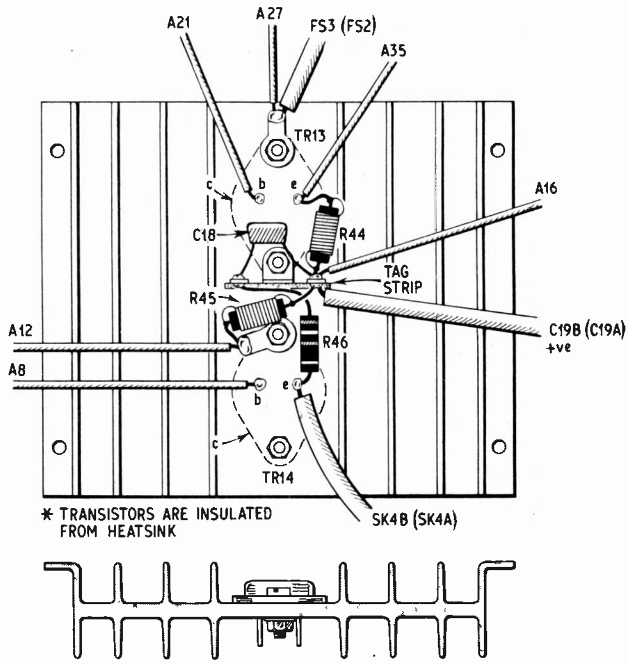


Fig. 11. Component and wiring layout for the heatsink mounted output transistors and associated circuitry of amplifier B. The amplifier A heatsink assembly is identical. For this, thick wire routing is given in parentheses

TR16 to shunt R48 and reduce the voltage at the base of TR15 and hence stabilises the line voltage.

The pre-set potentiometer VR7 is used to set this voltage.

TRANSFORMER IMPEDANCE

The series regulator transistor would not be able to handle the high power dissipated if the transformer had a very low output impedance, since the voltage on C20 would maintain its value and produce a very large current. Thus it is necessary that the transformer should have an output impedance not less than 1·5 ohms. If it is less than this, a ballast resistor must be inserted in series with the winding to make up the difference. It should be rated at 25 watts per ohm used.

If in any doubt as to the internal impedance of a particular transformer, the supplier should be consulted or the constructor should measure it for himself.

CAPACITOR RATING

The smoothing and reservoir capacitors C22 and C20, should each have a maximum ripple current rating of not less than 5 amps r.m.s. at 100Hz at 25 degrees centigrade. Again any doubt should be resolved with the supplier.

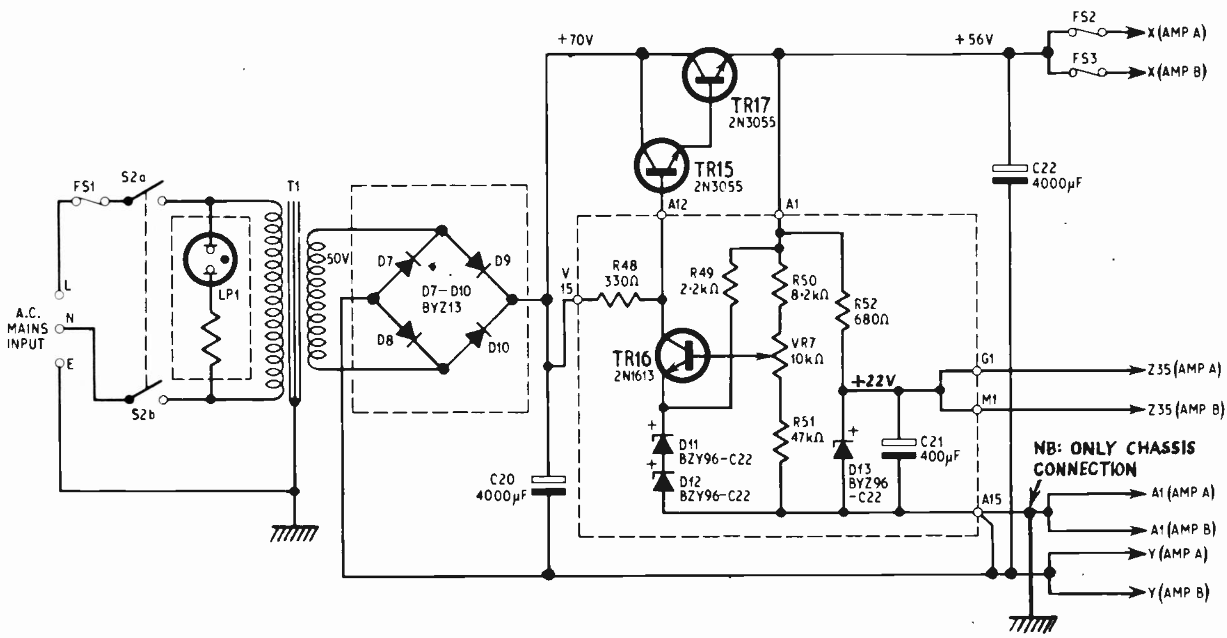
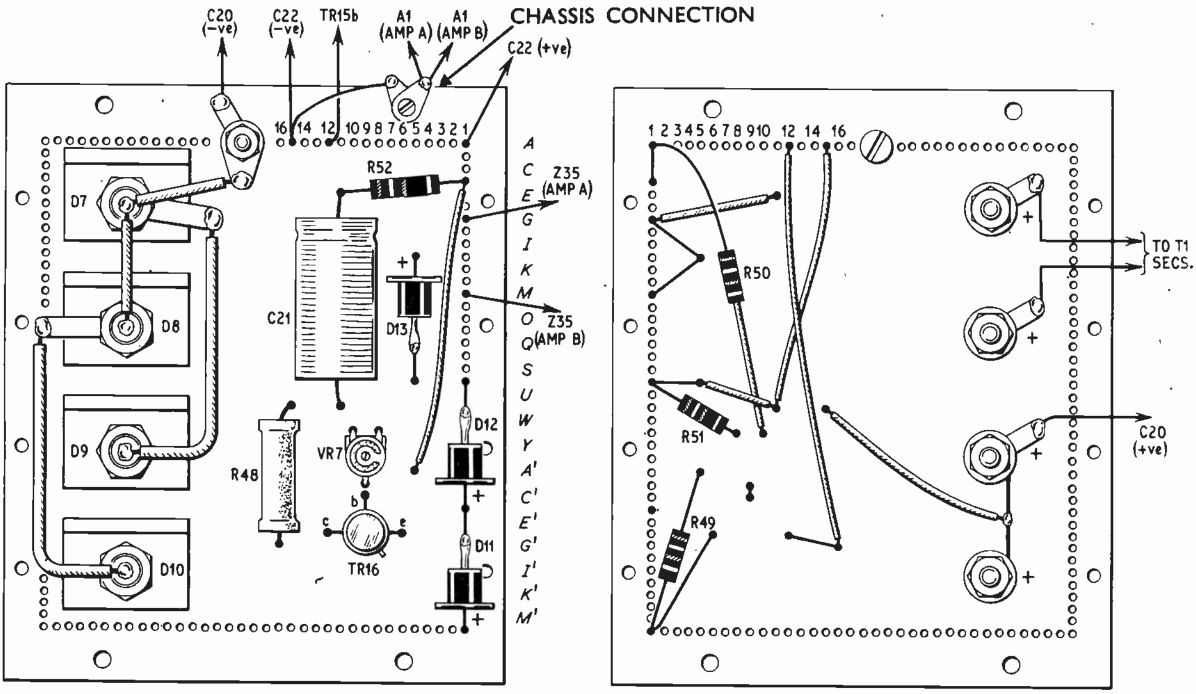


Fig. 12. Circuit diagram of power supply C. Board mounted components are enclosed within dotted lines



✱ RADIAL HEATSINK REQUIRED FOR TR16

Fig. 13. Component and wiring layout for power supply C

COMPONENTS . . .

POWER SUPPLY UNIT

Resistors

R48 330Ω 1W R50 8·2kΩ R52 680Ω 2W
R49 2·2kΩ R51 4·7kΩ
All ½ watt, 10% carbon except where otherwise stated

Capacitors

C20 4,000µF 75V elect. (see text)
C21 400µF 25V elect.
C22 4,000µF 60V elect. (see text)

Transistors

TR15 2N3055 TR16 2N1613 TR17 2N3055

Diodes

D7–D10 BYZ13 (Mullard) (4 off)
D11–D13 BZY96–C22 1·5W Zener diodes (3 off)

Switch

S2 Double pole mains on/off

Transformer

T1 Mains transformer: pri. 0–240V; secondary 50V at 6A. MT107AT (G. W. Smith Ltd.)

Fuses

FS1 3A cartridge fuse and holders
FS2, FS3 3A cartridge fuses (2 off) and twin holder

Miscellaneous

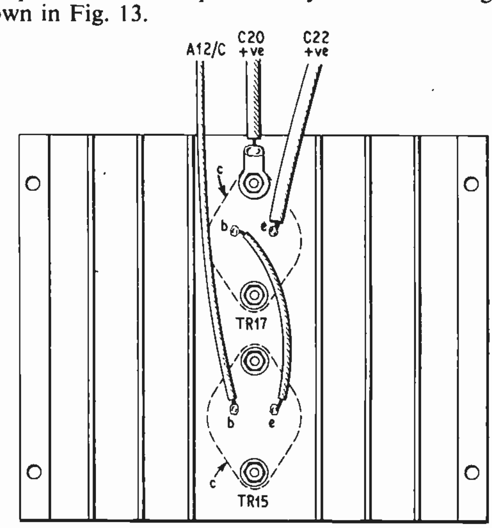
Lektrokit chassis plate No. 4—LK141, 20 wiring pins, type 10D heatsink, TO5 radial heatsink, LP1—mains neon, Aluminium case 15in × 7in × 9in. Type Y (H. L. Smith & Co. Ltd., 287/289 Edgeware Road, London, W.2). Rubber feet, knobs, 6B.A. × ½in hexagon spacers (12 off), 2 chrome handles

Alternative capacitors up to 6,000µF with working voltages up to 150 volts can be used providing they meet the ripple current requirement.

In order to provide the reference voltage a single 43 volt, 5 watt Zener diode may be used instead of the two, 22 volt 1·5 watt Zener diodes D11 and D12.

POWER SUPPLY BOARD

All the components in the power supply circuit except for the two large electrolytics, TR15 and TR17 (and of course the transformer) are mounted on perforated s.r.b.p. board. Component layout and wiring are shown in Fig. 13.



✱ TRANSISTORS ARE CONNECTED DIRECTLY TO HEATSINK

Fig. 14. Component and wiring for power supply transistors. The heatsink MUST be insulated from the chassis. Heatsink drilling details are given in Fig. 10

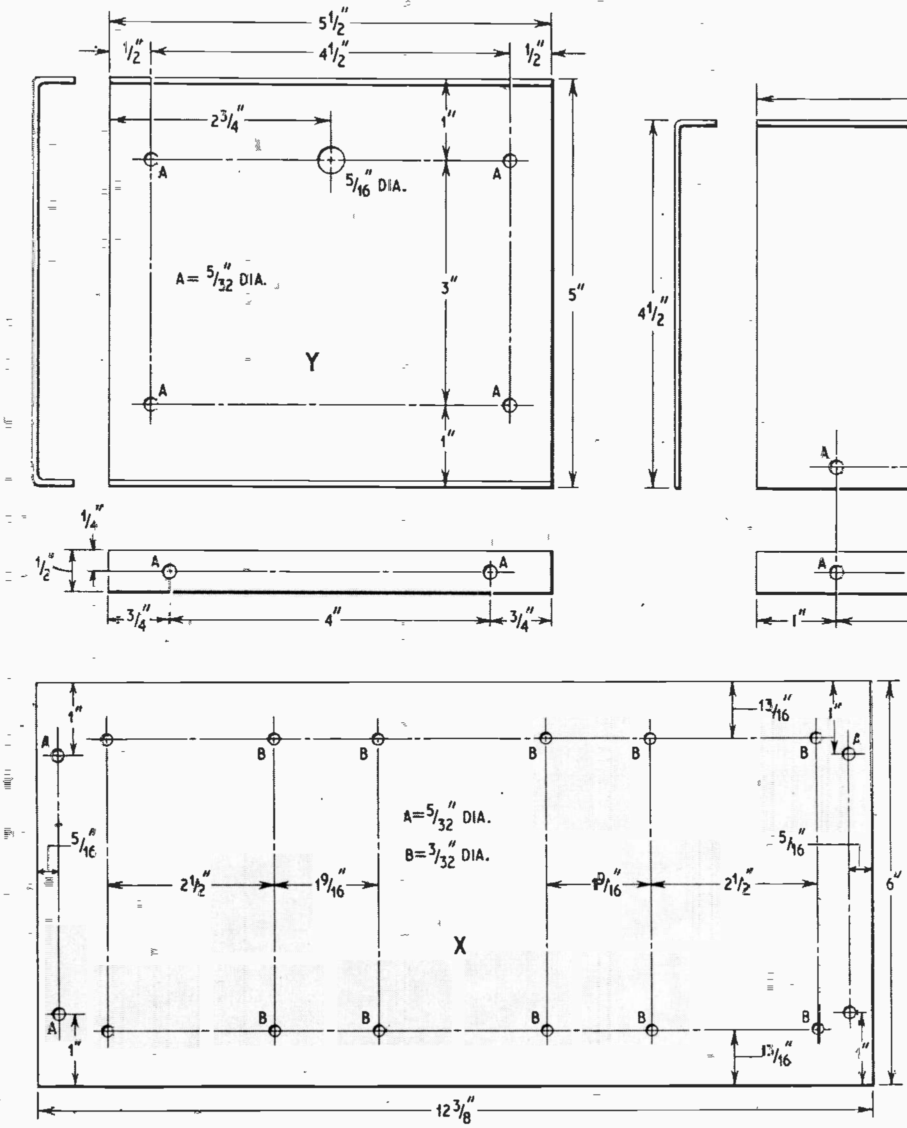
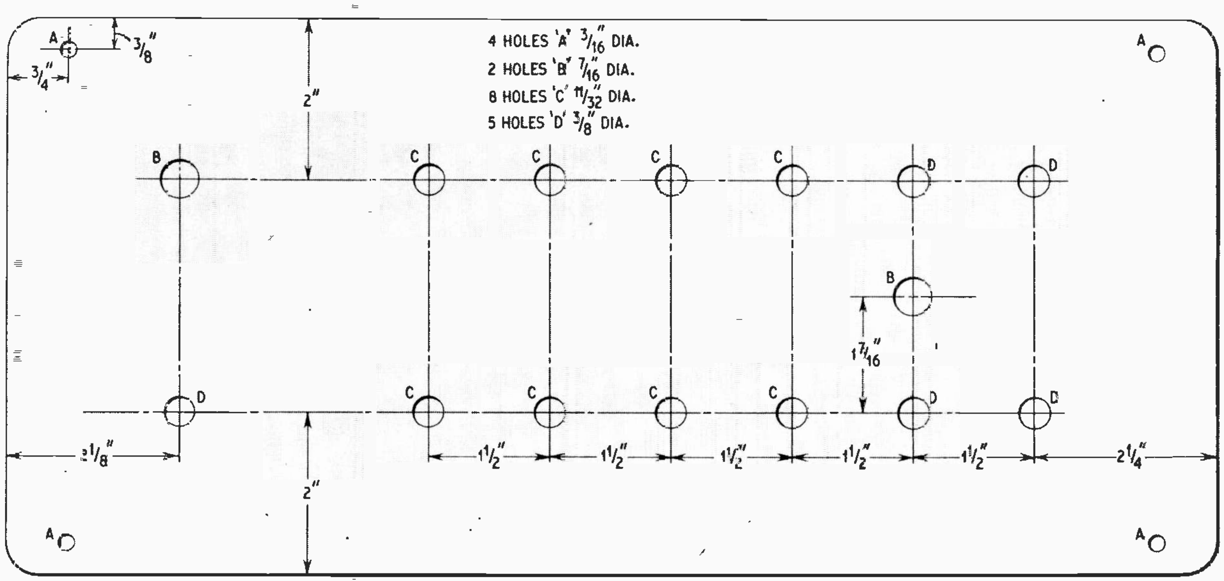
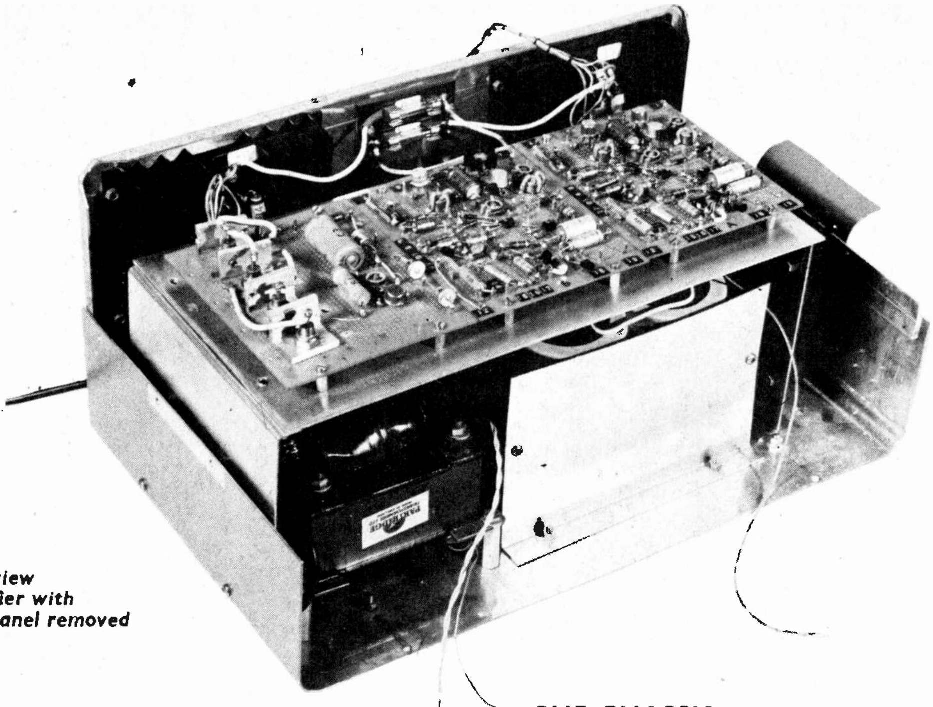


Fig. 15. Drilling details of the 18 s.w.g. aluminium sub-chassis plates X, Y and Z

Fig. 16 (below). Drilling details for control panel





Interior view of amplifier with control panel removed

The board should first be drilled to take the stud rectifiers D7–D10 and the 4B.A. bolt connection for feeding the anodes of D7 and D8 to the negative terminal of C20. The rectifiers can then be bolted on with their individual heatsinks made from $\frac{1}{8}$in. L profile aluminium, $\frac{3}{4}$in by $\frac{3}{4}$in. Connections to the cathodes are made with solder tags.

The resistors R48 and R52 get quite hot in use and should be mounted out of contact with the board.

POWER TRANSISTOR MOUNTING

The two power transistors TR15 and TR17 are both directly bolted onto a type 10D heatsink. This ensures a low thermal resistance but means that the heatsink *must* be insulated from the chassis.

Heatsink drilling details are identical to those given in Fig. 10.

Transistor layout is given in Fig. 14. Wiring of these will be referred to later.

SUB-CHASSIS

The amplifier and power supply boards are mounted on an 18 s.w.g. aluminium plate using 6B.A., $\frac{1}{2}$in hexagon spacers and bolts as seen in the photograph. Drilling details for this plate, marked X, are given in Fig. 15 together with the supporting end plates Y and Z.

MAIN CHASSIS ASSEMBLY

Before the main chassis assembly is commenced the control panel of the 15in by 7in by 9in aluminium case (see components list) should be drilled as shown in Fig. 16. When this is done the components are mounted according to Fig. 18.

With this completed, the sub-chassis end plates are attached to the main chassis. Next the transformer and four large electrolytic capacitors are mounted.

It is important that the cases of these capacitors are insulated from the chassis; they are normally fitted with plastic sleeves which are sufficient.

In the prototype an aluminium plate and strap were used to retain C20 and C22.

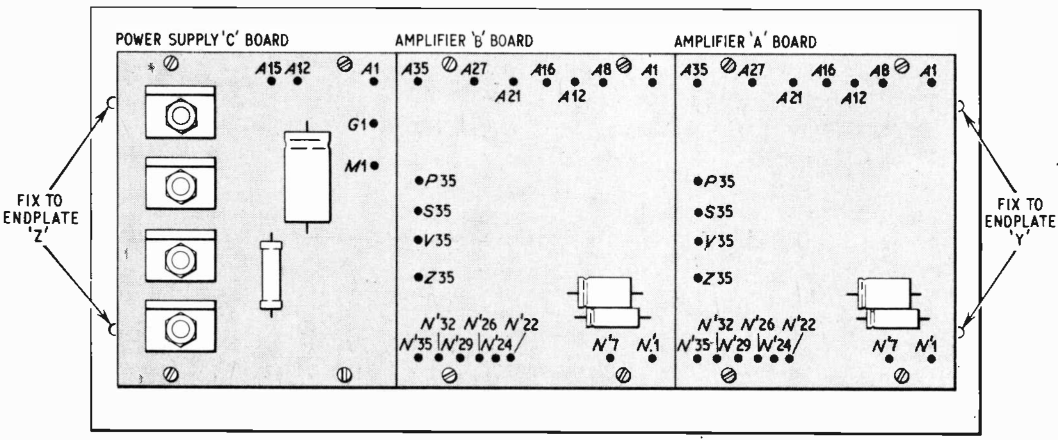


Fig. 17. Sub-chassis plate X with sub-assemblies mounted. This must be attached to the end plates of Fig. 18 as indicated in the photograph above

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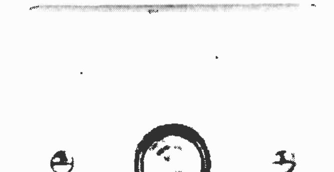

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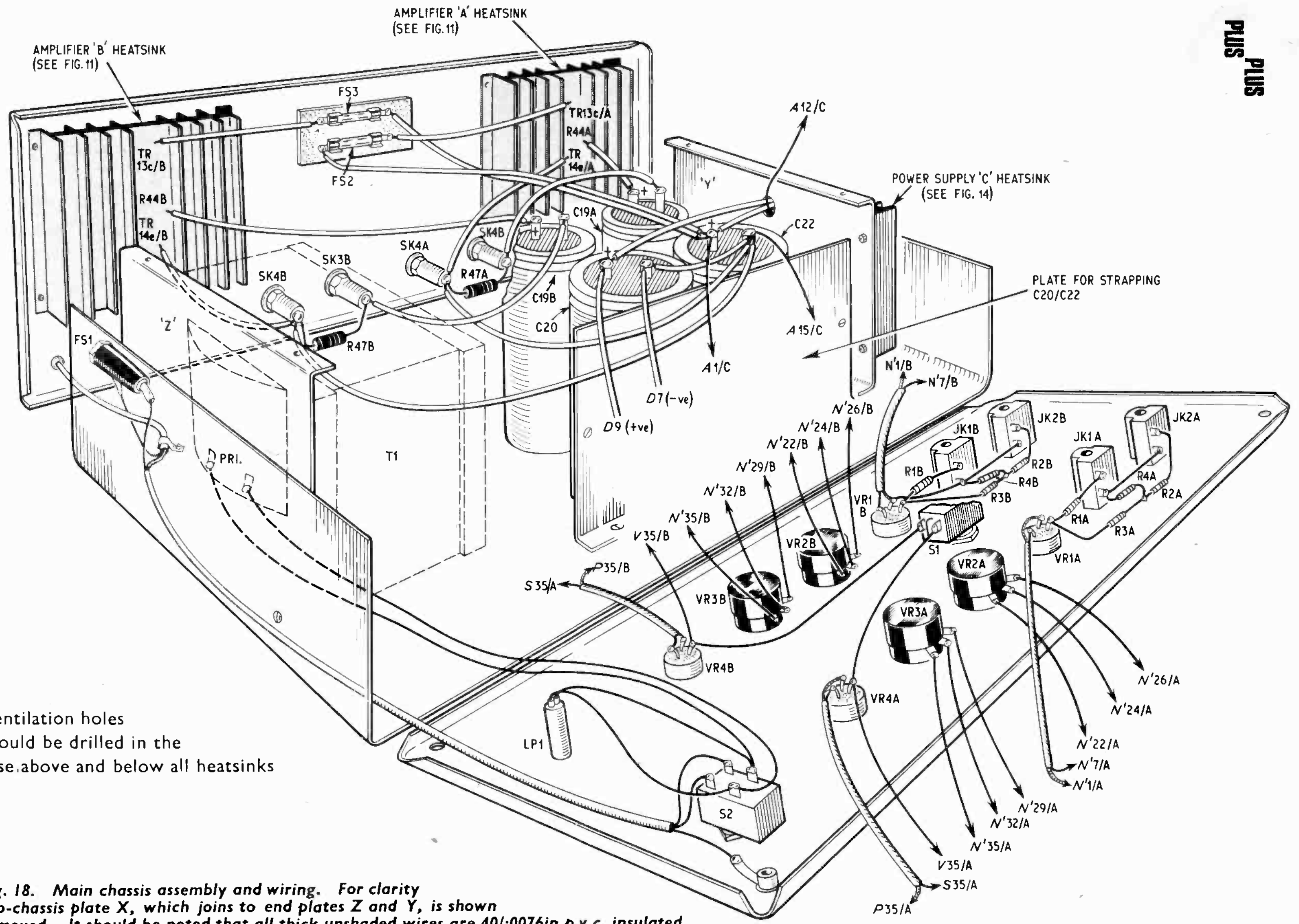
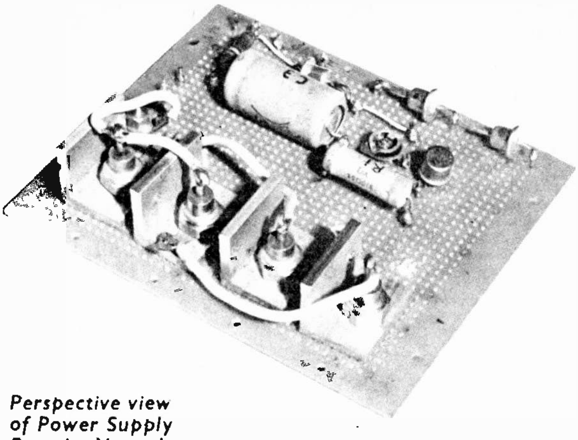


Ventilation holes should be drilled in the case above and below all heatsinks

Fig. 18. Main chassis assembly and wiring. For clarity sub-chassis plate X, which joins to end plates Z and Y, is shown removed. It should be noted that all thick unshaded wires are 40/·0076in p.v.c. insulated



Perspective view of Power Supply Board. Note the diode heatsinks

MOUNTING THE HEATSINKS

The amplifier heatsinks are mounted inside the back panel. Since the transistors are insulated they are connected directly.

Before mounting the power supply heatsink, flying leads should be attached as shown in Fig. 13. These leads are drawn through the centre hole of end plate Y and the heatsink attached using 4B.A. nylon bolts and insulating washers.

The small components of the main chassis back panel should now be attached and the underside rubber feet bolted on.

WIRING UP

Initial wiring should be carried out according to Fig. 18. It should be noted that all thick unshaded wires are 40/·0076in p.v.c. insulated which are necessary for carrying the high output circuit.

Flying leads from the front control panel should be 9in long as they will all terminate at the upper plate of the sub-chassis. The power supply and amplifier boards mounted on this plate are shown in outline in Fig. 17.

The plate should now be connected to plates X and Y in the sense indicated and wires attached to the pins as shown. With soldering completed the wiring should be tidied up by tying in cableforms with nylon cord. This will ensure reliability.

TEST AND SETTING UP PROCEDURE

Extreme care should be taken when making tests as an accidental short circuit across the power supply will result in the instantaneous destruction of TR17. A short elsewhere might cause even more expensive damage to the amplifier circuitry.

First remove FS2 and FS3, then proceed as follows:

(1) Switch on and measure the potential at the collector of TR17 collector; this should be about +70 volts.

(2) Set the voltage on pin A1 of the power supply board to +56 volts by adjusting potentiometer VR7.

(3) Check the +22 volt output at either pins G1 or M1.

(4) Switch off and connect a 100 ohm, 5 per cent, 5 watt resistor across the terminals of FS2 fuse socket. Across this connect the multimeter set to a high voltage range. Now check that the volume and quiescent current controls of amplifier A are turned fully anti-clockwise.

(5) Switch on and wait a few minutes for the coupling capacitors to charge. Set the multimeter to a lower range after the voltage drops to zero, then set VR6 for a reading of 1·5 volts.

This represents a quiescent current through the output transistors of about 12mA.

(6) Switch off and remove test resistor from FS2 socket, and replace fuse.

Switch on and set the centre coil voltage, measured at pin A16 on amplifier A board, to 28 volts, by adjusting the pre-set potentiometer VR5.

(7) Repeat operations (4), (5) and (6) for amplifier B.

With the satisfactory completion of these tests, the amplifier is now ready for use.

LOUDSPEAKER ARRANGEMENTS

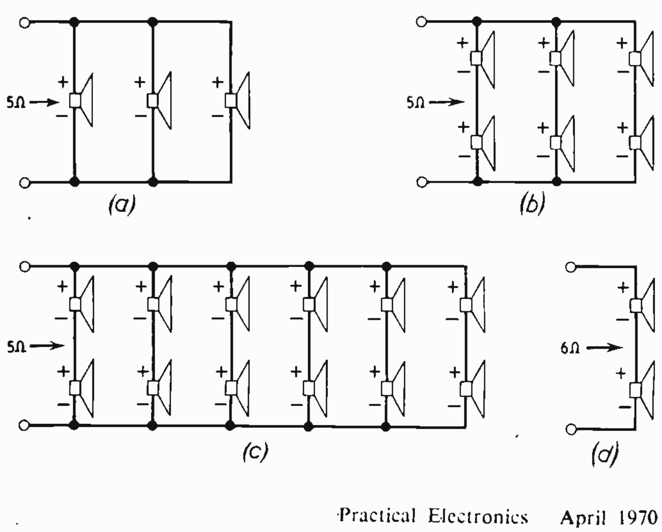
In order to obtain the maximum power it is necessary that the amplifier be correctly loaded. This can be done by using parallel and series arrangements of loudspeakers as shown in Fig. 19, or a suitably rated matching transformer to obtain the required load impedance of 5 ohms.

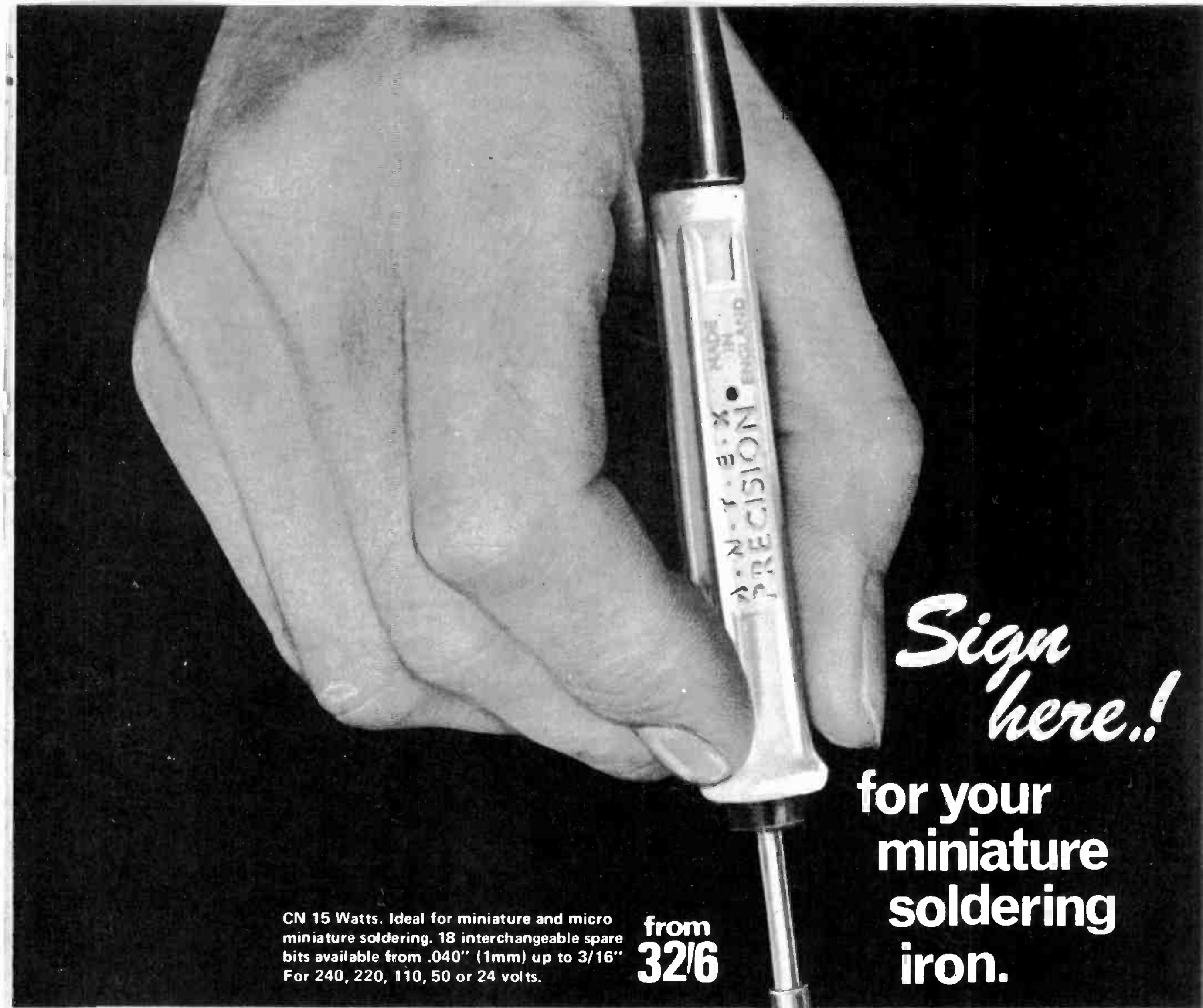
When using horn type speakers, the bass control must be turned down to restrict the bandwidth at low frequencies. If this is not done, damage may be caused to the pressure units.

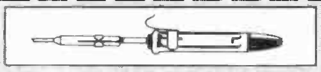
The concluding article will include a voltage table and a fault finding schedule.

Fig. 19. Some possible loudspeaker arrangements for each channel.
Impedances "looking in" are indicated:
- *(a) 3 speakers, each of 15 ohms and rated at 20 or 25W.*
- *(b) 6 speakers, each of 7·5–8 ohms and rated at 10 or 12W.*
- *(c) 12 speakers, each of 15 ohms and rated at 5–6W.*
- *(d) 2 speakers, each of 3 ohms and rated at 20–25W.*

The speakers should be phased as shown by the positive and negative signs







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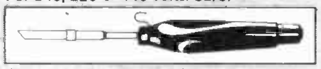

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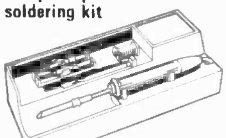

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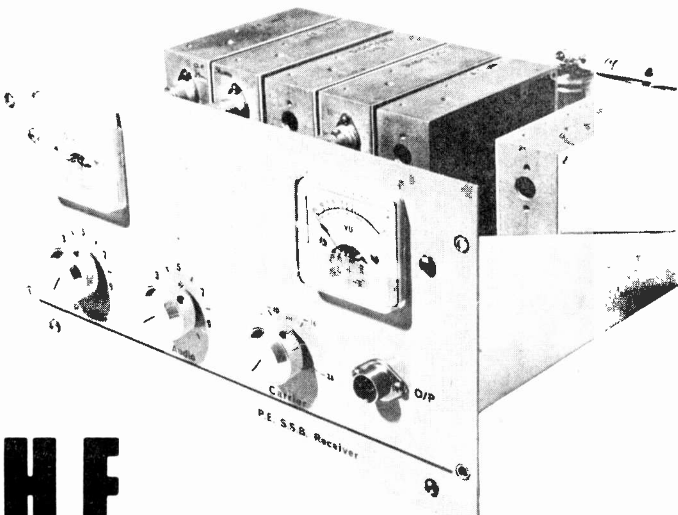
(b) The First I.F. Module
(c) The Sideband Filter Module
(d) The Second Oscillator Module (36MHz)
(e) The A.F. Module
(f) The Third Oscillator Module (2MHz)
(g) The Power Supply Unit
(h) The Power Supply Board
(i) The R.F. Attenuator



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CONTROLS

There are three manual controls which alter the gain of the various portions of the overall receiver. The "R.F. Gain" (VR1) controls the level of the input signal which is fed to the R.F. Unit and applies a d.c. voltage to the R.F. Attenuator. This d.c. voltage varies in level depending upon the setting of the control.

The "Audio" control (VR2) controls the audio output level at the output socket. The final control marked "Carrier" (VR3) controls the gain of two stages in the i.f. amplifiers. All three of these controls *reduce* the sensitivity of the receiver when they are set in the fully anti-clockwise position.

MECHANICAL ASSEMBLY

The main chassis unit consists of an Imhoff BC 511 chassis and a 1690C cabinet and front panel. Holes are drilled in the chassis and front panel as indicated in the appropriate diagrams (Figs. 7.1 and 7.2). The meters and controls can then be mounted on the front panel and the panel bolted to the main chassis. The Power Supply Unit and the Power Supply Board should be fixed to the main chassis and all the front panel wiring put in at this stage (Fig. 7.3 is the interconnection circuit diagram for the main chassis), otherwise it will be difficult to wire up the controls once the modules have been mounted. A wiring diagram for components mounted on the front panel is shown in Fig. 7.4.

At this stage the R.F. Attenuator and the separate smoothing capacitor C114 should be fitted, both of which are located underneath the main chassis. The Main Chassis Assembly is now ready to receive the modules each of which is held in position with two screws accessible from underneath the chassis. Individual earth tags should be mounted under one of these fixing screws to ensure that the units are earthed at these points. The earth pin of the modules are connected to their respective earth tag. A wiring diagram for the module interconnection is shown in Fig. 7.5. *An important point to note is that in the case of the A.F. Module, the screened lead going to the output socket should under no circumstances be earthed, as this carries the supply for the A.F. Module.*

WIRING

All the connecting leads should be kept as short as possible, and where the chokes L12 and L13 are fitted (Fig. 7.5.) they should be placed as close as possible to the a.g.c. pins of the first and second units. These chokes in conjunction with C130 and C131 give further decoupling to the d.c. control line which adjusts the basic gain of the receiver.

It may well be, if the wiring of the modules and receiver has departed from the specified layout, prudent to run two separate leads from the slider of the "Carrier" control VR3, one to the R.F. Module and the other to the First I.F. Module, using screened lead and thus avoiding any stray pickup. This point to the receiver is very sensitive and is prone to picking up any strong R.F. signal that may be floating around the set,

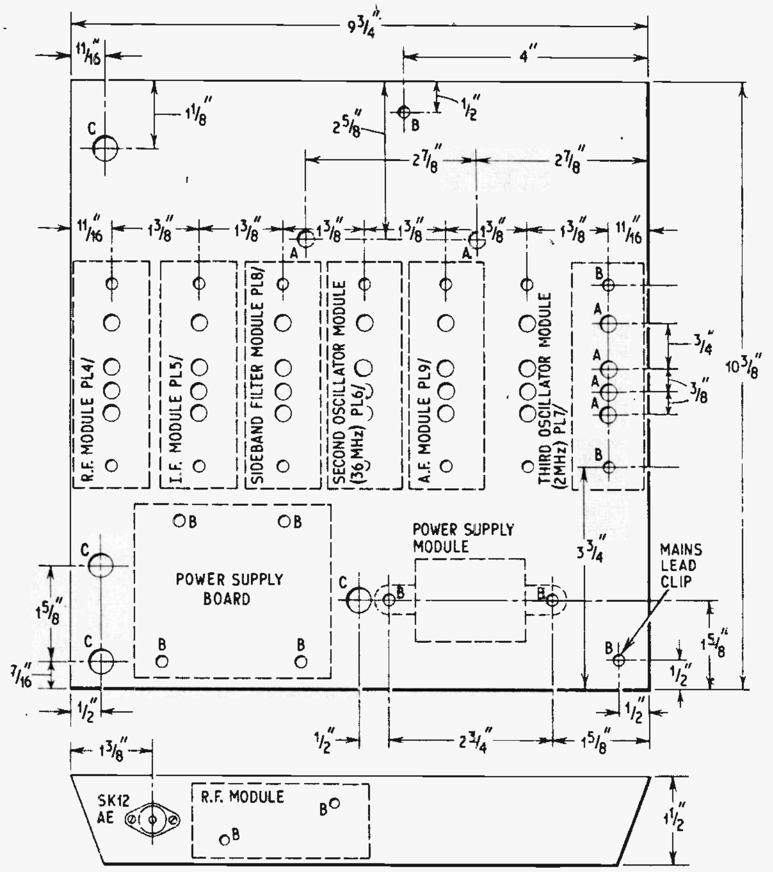


Fig. 7.1. Chassis drilling details. Positions for holes not dimensioned must be taken from the relevant components

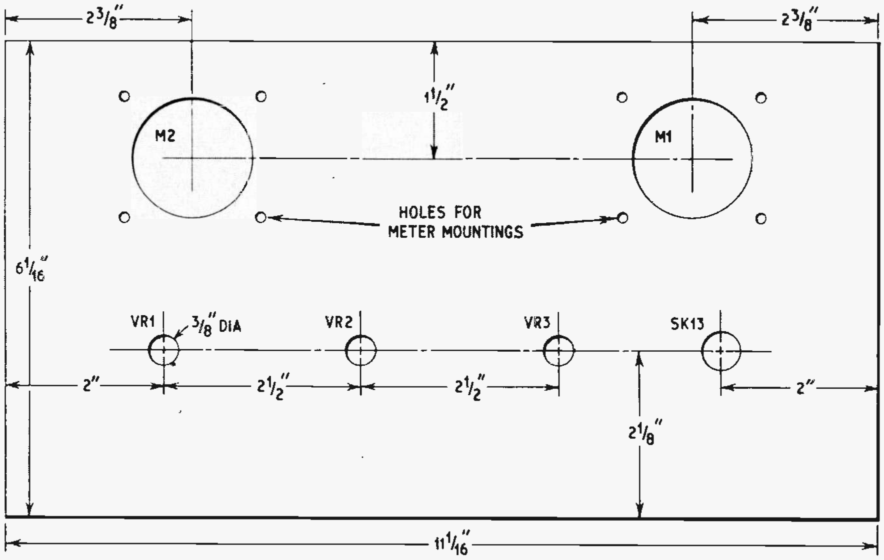
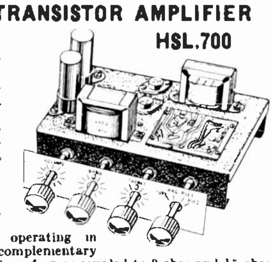


Fig. 7.2. Front panel drilling details

MONO TRANSISTOR AMPLIFIER



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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 30c/s–18Kc/s: Continuously variable tone controls: Bass, +8db to −12db at 100c/s. Treble, +10db to −10db at 10Kc/s.

The HSL.700 has been designed for true high fidelity reproduction from radio tuner, gramophone deck and tape recorder preamp. Supplied ready built and tested, 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.

OUR SPECIAL PRICE £7.19.6. P. & P. 7/6.

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5in 3 ohm **16/-**, P. & P. 3/-. 7 × 4in 3 ohm **21/-**, P. & P. 4/-. 10 × 6in 3 ohm **27/6**, P. & P. **6/-**. E.M.I. 8 × 5in 3 ohm with high flux magnet **26/-**, P. & P. 4/-. E.M.I. 13½ × 8in 3 ohm with high flux ceramic magnet **42/-**, (15 ohm **45/-**), P. & P. 6/-. E.M.I. 13 × 8in, 3 or 15 ohm with two inbuilt tweeters and crossover network **4 gns**, P. & P. 6/-.

BRAND NEW. 12in 15w H/D Speakers, 3 or 15 ohm. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly **£5.10.0**, P. & P. 7/6. Guitar models: 25w **£6.0.0**. 35w **£8.0.0**.

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10 watts peak handling. 3 or 15 ohm, **37/6**, P. & P. 6/-.

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HIGH IMPEDANCE CRYSTAL STICK MIKES. OUR PRICE **21/-**. P. & P. 1/6.
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BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240V. Secondary combinations: 0-5-10-15-20-25-30-35-40-60V half wave at 1 amp or 10-0-10, 20-0-20, 30-0-30V. at 2 amps full wave. Size 3inL × 3½inW × 3inD. Price **32/6**. P. & P. 6/-.

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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. 20-20,000c/s. Bass boost approx. to +12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 25V at 0·6 amp.

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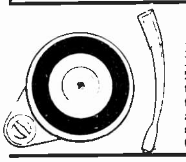

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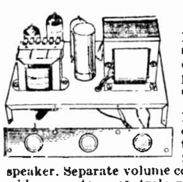
Uncut motor board size 14½ × 12in., clearance 2in. below, 5½in. above. Will take above amplifier and any B.S.R. or GARRARD changer or Single Player (except AT60 and SP25). Size 18 × 15 × 8in. PRICE **79/6**. P. & P. 9/6.



3-VALVE AUDIO AMPLIFIER HA34 MK II
Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in w. × 4in. d. × 4½in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. 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 **£4.15.0**. P. & P. 6/-.

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VYNAIR AND REXINE SPEAKERS AND CABINET FABRICS app. 54in. wide. Usually 35/- yd., our price **15/-** yd. length. P. & P. 2/6 (min. 1 yd.). S.A.E. for samples.

POWERFUL COMPACT MOTOR for 6-9v. Battery operation approx. 25mA. Made originally for "Staar" and "Greencoat" record player decks. Built in constant speed device. Ideal for models, etc. Overall size approx. 1¾" × 1¼". **7/6** each. P. & P. 1/6. (3 or more Post Free).

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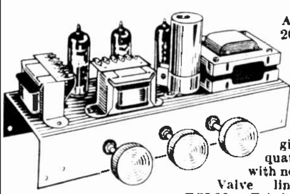

A.c. mains 200-240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:—2 × ECL86 Triode Pentodes, 1 EZ80 as full wave rectifier. Two dual potentiometers are provided for bass and treble control, giving bass 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 11in. w × 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. **Price 8 gns.** P. & P. 8/-.

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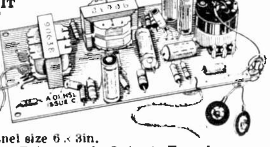
LATEST GARRARD MODELS. All types available 1025, 2025, SP25, 3000, AT60 etc. Send S.A.E. for Latest Prices!
PLINTH UNITS cut out for Garrard Models 1025, 2025, 2000, 3000, AT60, SP25. With transparent plastic cover. OUR PRICE **5 gns.** complete. P. & P. 8/6.

SONOTONE 9TAHC compatible Stereo Cartridge with diamond stylus **50/-**. P. & P. 2/-.
LATEST RONETTE T/O Stereo Compatible Cartridge for EP/LP/Stereo/78. **32/6**. P. & P. 2/-.
LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono or stereo records on mono equipment. **30/-**. P. & P. 2/-.

HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT
Type TA1



- Peak output in excess of 1½ watts.
- All standard British components.
- Built on printed circuit panel size 6 × 3in.
- Generous size Driver and Output Transformers.
- Output transformer tapped for 3 ohm and 15 ohm speakers.
- Transistors (GET114 or 81 Mullard AC 128D and matched pair of AC128 o/p).
- 9 volt operation.
- Everything supplied, wire, battery clips, solder, etc.
- Comprehensive easy to follow instructions and circuit diagram **2/6** (Free with Kit). All parts sold separately.

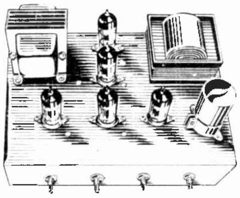
SPECIAL PRICE 45/-. P. & P. 3/-. Also ready built and tested, **52/6**. P. & P. 3/-.

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 7in. wide × 3in. deep × 6in. high overall. AC mains 200/240V. Supplied absolutely Brand New completely wired and tested with valves and good quality output transformer. FEW ONLY.

OUR ROCK BOTTOM BARGAIN PRICE 55/- P. & P. 6/-

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet **2/6** (Free with parts). **All parts sold separately.** ONLY **£7.9.6**. P. & P. 8/6. Also available ready built and tested complete with std. input sockets, **£9.5.0**. P. & P. 8/6.

Open all day Saturday
Early closing Wed. 1 p.m.
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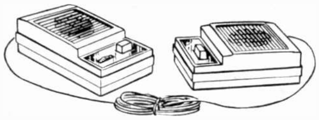

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Suitable for: Room-to-room, office-to-office and an excellent baby alarm. Is complete with ample connecting wire and battery.

65/- Plus 3/6 P. & P.

STEREO HEADSET

8 ohm impedance, complete with plug and 5ft lead. A very comfortable phone set. Listen to stereo without noise interrupting the pleasure.

Wonderful value **59/6** Plus 4/- P. & P.

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For stereo amplifiers without stereo jack socket.

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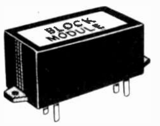

SOLID STATE BLOCK MODULES

Phono pre-amp E1311: input, 100K; gain, 28db; max. out, 3-volt; max. in, 50M/V: power, 9V.
Tape pre-amp E1312, as above.
Mic. pre-amp E1313, as above.
Power amplifier E1314: input, 1,000 ohms; gain, 20db, 300M/W: power, 9-volt d.c.
Electronic organ, tone osc. E1315: tone freq., 200-1kHz; output, 80M/W; power, 9V; current, 15M/A.
Dual flasher E1318: flasher time, 1/4 secs; power, 6V; current, 150M/A; lamp, 6V 150M/A.
We also stock the morse code practice modules in this range.

ALL AT **25/-** Plus 2/- P. & P.

I.C. MODULE TYPE BP1010

3 watts r.m.s. power amplifier and pre-amp. Complete with data sheet. Fully guaranteed. **25/-** P. & P. 1/6 each

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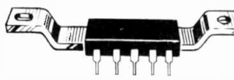

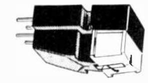

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Stereo with diamond styli. This ever popular cartridge now at economy price: Diamond Stylus, ·7 mil; Frequency, 20-20kHz; Separation, 20db at 10kHz.

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SONOTONE 9TAHC

Ceramic cartridge diamond stylus.

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EMI LOUDSPEAKER 450

10 watts. 13in × 8in + two 2·2½in tweeters and crossover. All wired and ready for use. This ever-popular 450. In 3–8–15 ohm imp.

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20 watts. 20-20 k/c. 8 and 15 ohms.

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Designed to clean the heads on all cassette machines.

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A now famous brand of tape. 7in 2,400ft, 25/-; 7in 1,800ft, 21/-; 7in 1,200ft, 13/6; 5¾in 1,200ft, 15/-; 5¾in 1,800ft, 22/6; 5in 600ft 9/9; 5in 900ft, 12/6; 5in 1,200ft, 16/-. Please note the postage and packing is FREE.

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Emitape 3in 175ft in EMI case **5/-** EACH

EMI SET 850

A complete speaker system IN KIT FORM. We supply a modern styled teak finish cabinet with black front. Overall dimensions: 14in × 9in × 9in. Made to a very high standard. A 6½in EMI woofer. A 3in tweeter. A crossover network. Acoustic wadding. Output terminals, wire and fixing hardware. Specification: Max. power, 10 watts: frequency, 65-20kHz: imp 3-8-15 ohms.

Kit price **9 Gns.** Plus 7/6 P. & P.

COMPONENTS CORNER (Please inc. postage with order)

8in × 6in. One sided printed circuit board	2/- each
BY100 type rectifiers 800 p.i.v. 750 M/A	3/3 each
4 pin transistor holders	6d each
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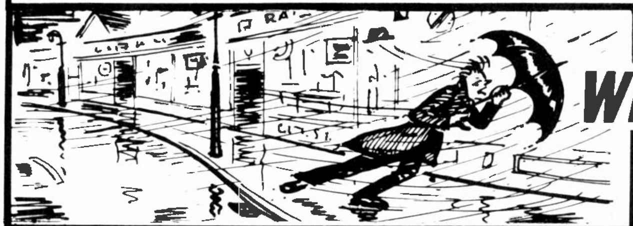

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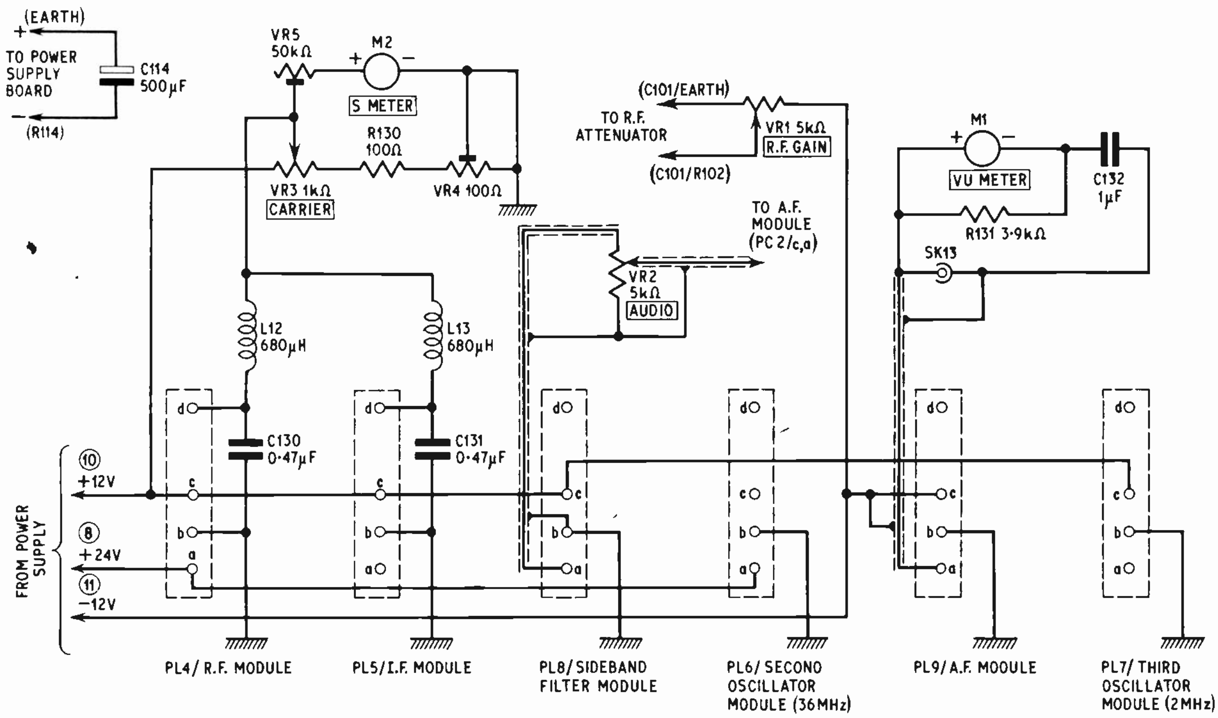


Fig. 7.3. Module and control interconnection circuit for the receiver main chassis

so care should be taken in keeping any leads that may be associated with the Seond and Third Oscillator Modules well away from this area. Interconnections between the various sockets on the modules are shown in Fig. 7.6.

SETTING UP INSTRUCTIONS

Equipment required

(a) **Multimeter**

(b) **Signal Generator** with an output of 2MHz to 30MHz and a stability of better than 2 parts in 10^6 giving an output of at least 1 millivolt into 50 ohms.

(c) **Signal Generator** *or* **Single Spot Oscillator** having a range of 36MHz to 64MHz with a stability of better than 1 part in 10^6 giving an output of at least 0·7 volts into 50 ohms.

PROCEDURE

Before switching on the main chassis of the receiver, check all connections to see that they are correct. Once assured that the receiver is wired up correctly, switch on and check the d.c. levels at the appropriate

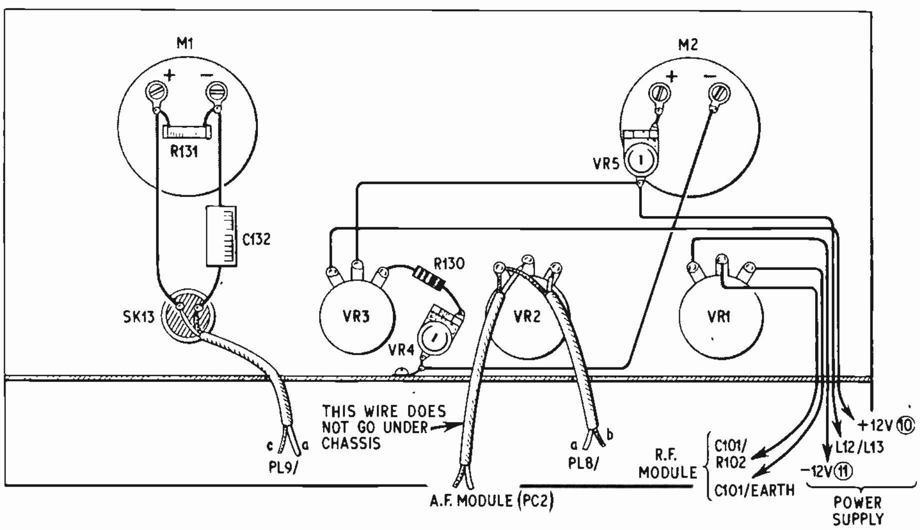


Fig. 7.4. Control and meter wiring diagram

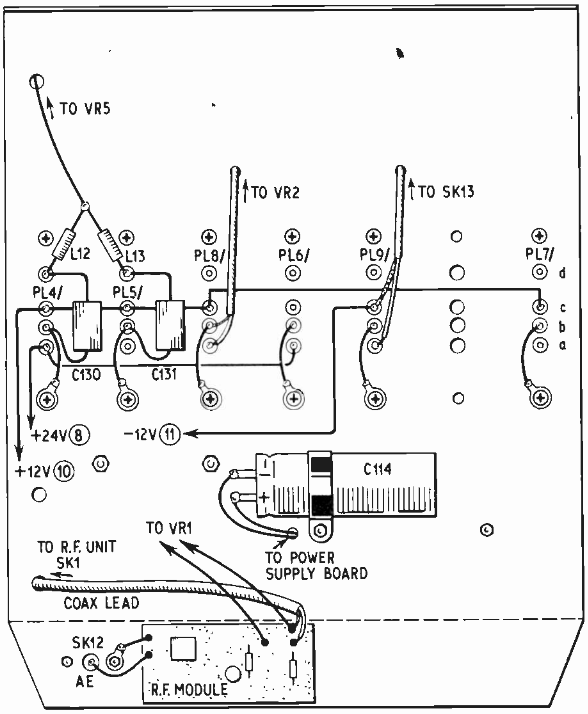


Fig. 7.5. Module wiring diagram

points to see that they correspond with those given in Table 7.1. Once these are correct proceed as follows:

Set the "Audio" control to 6 and the "R.F. Gain" and "Carrier" controls to maximum sensitivity condition (i.e. fully clockwise). Apply the local oscillator signal set to 36MHz, at a level of 0·7 volts, to SK2 on the R.F. Module. Inject a signal into the aerial socket SK1 at a level of 1 millivolt; with the frequency at 2·001MHz a 1kHz tone should be heard at the output. *Both the generators should be set to within 10Hz of the specified frequency.* If some warbling is heard it

Table 7.1.
MAIN CHASSIS D.C. VOLTAGES

Connection	Voltage	Connection	Voltage
PL4 (a)	+24V	PL7 (a)	0V
(b)	Earth	(b)	Earth
(c)	+12V	(c)	+12V
(d)	Variable	(d)	0V
PL5 (a)	0V	PL8 (a)	Audio
(b)	Earth	(b)	Earth
(c)	+12V	(c)	+12V
(d)	Variable	(d)	0V
PL6 (a)	+24V	PL9 (a)	Audio
(b)	Earth	(b)	Earth
(c)	0V	(c)	−12V
(d)	0V	(d)	0V

could well be that the generators are not stable enough or have not had time to warm up to their correct operating characteristics.

Reduce the level of the 2·001MHz signal to 10 microvolts and adjust VR4 for maximum audio gain as indicated on the front panel V.U. meter (M1). It may be necessary to reduce the "Audio" control during this operation to keep the pointer within the confines of the scale. Having adjusted VR4, set the "Audio" control back to 6 and increase the 2·001MHz aerial input signal level to 100 microvolts. Adjust VR5 so that the S meter (M2) reads 9dB. *These last two adjustments must be made with the "Carrier" control in it's fully clockwise condition.*

Connect SK1 to the R.F. Attenuator unit and put the input signal at a level of 10 microvolts into SK12, with the signal set at 2·001MHz. The audio output should not be less than −6dB on the V.U. meter. To produce 1 milliwatt in the earphones when the V.U. meter reads 0dB, the earphones should be 1 kilohm impedance; under no circumstances should a load of less than 15 ohms be placed across the output socket SK13.

Next month: First Oscillator Unit

COMPONENTS . . .

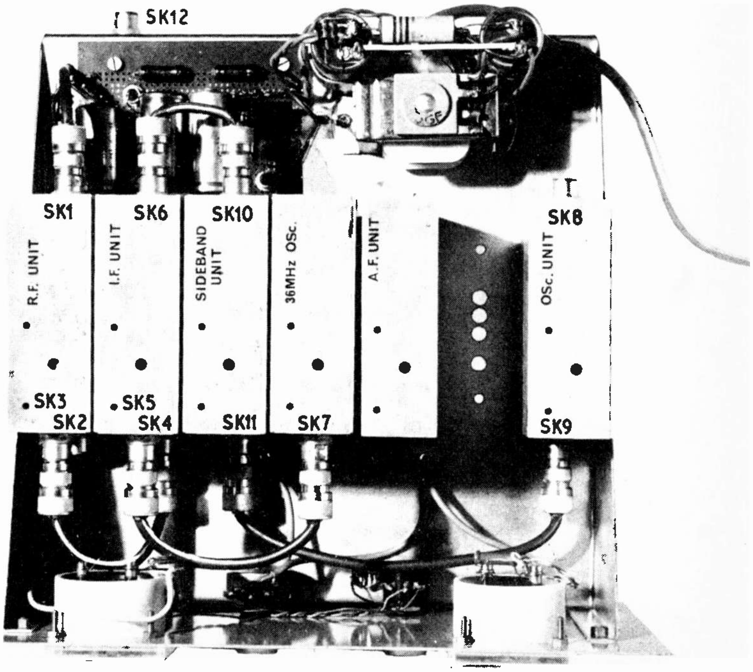
Resistors
- R130 100Ω ¼W carbon
- R131 3·9kΩ 1W wirewound

Capacitors
- C130 0·47μF polyester
- C131 0·47μF polyester
- C132 1μF polyester

Variable Resistors
- VR2 5kΩ linear
- VR3 1kΩ linear
- VR4 100Ω skeleton preset
- VR5 50kΩ skeleton preset

Miscellaneous
- L12, 13 680μH choke (Painton 2 off)
- M1 VU meter MR45P (−20/0+3 VU)
- M2 S meter MR45P (50−9+40dB)
- SK12 coaxial aerial socket
- SK13 socket to suit earphones
- Main chassis, Imhoff BC 511
- Cabinet and front panel, Imhoff 1690C
- 3 knobs
- Coaxial wire
- Coaxial plugs (12 off)
- Earth tags and fixings

Fig. 7.6. Interconnection of coaxial sockets on the modules



ELECTROVALUE

Everything brand new and to specification • Large stocks • Good service

RESISTORS

Code	Power	Tolerance	Range	Values available	1 to 9	10 to 99	100 up
C	$\frac{1}{20}$W	5%	100 Ω–220k Ω	E12	**18d**	**16d**	**15d**
C	$\frac{1}{8}$W	5%	4·7 Ω–330k Ω	E24	**2·5d**	**2d**	**1·75d**
C	$\frac{1}{4}$W	10%	4·7 Ω–10M Ω	E12	**2·5d**	**2d**	**1·75d**
C	$\frac{1}{2}$W	5%	4·7 Ω–10M Ω	E24	**3d**	**2·5d**	**2·25d**
MO	$\frac{1}{2}$W	2%	18 Ω–1M Ω	E24	**9d**	**8d**	**7d**
C	1W	10%	4·7 Ω–10M Ω	E12	**6d**	**5d**	**4d**
WW	1W	10% ±$\frac{1}{20}$ Ω	0·22 Ω–3·3 Ω	E12	**15d** all quantities		
WW	3W	5%	12 Ω–10k Ω	E12	**15d** all quantities		
WW	7W	5%	12 Ω–10k Ω	E12	**15d** all quantities		

CODES: C = carbon film, high stability, low noise. MO = metal oxide, Electrosil TR5, ultra low noise. WW = wire wound, Plessey.
VALUES: E12 denotes series: 1, 1·2, 1·5, 1·8, 2·2, 2·7, 3·3, 3·9, 4·7, 5·6, 6·8, 8·2 and their decades. E24 denotes series: as E12 plus 1·1, 1·3, 1·6, 2, 2·4, 3, 3·6, 4·3, 5·1, 6·2, 7·5, 9·1 and their decades.
Prices are in pence each for quantities of same ohmic value and power rating, not mixed values. (Ignore fractions of one penny on total resistor order.)

COLVERN 3 watt wire-wound potentiometers: 10 Ω, 15 Ω, 25 Ω, 50 Ω, 100 Ω, 150 Ω, 250 Ω, 500 Ω, 1k Ω, 1·5k Ω, 2·5k Ω, 5k Ω, 10k Ω, 15k Ω, 25k Ω, 50k Ω. Price only **5/6** each.

CARBON TRACK POTENTIOMETERS: Double wiper ensures minimum noise level Long plastic spindles.

	each
Single gang linear: 220 Ω, 470 Ω, 1k Ω, etc. to 2·2M Ω	**2/6**
Single gang log: 4k Ω, 10k Ω, 22k Ω, etc. to 2·2M Ω	**2/6**
Any type with $\frac{1}{2}$ amp double pole mains switch: extra	**2/3**
Dual gang linear: 4k Ω, 10k Ω, 22k Ω, etc. to 1M Ω	**8/6**
Dual gang log: 4k Ω, 10k Ω, 22k Ω, etc. to 2M2 Ω	**8/6**
Log/Anti-log: 10k Ω, 47k Ω, 1M Ω only	**8/6**
Dual anti-log: 10k Ω only	**8/6**

FETS n-channel. Low cost general purpose 2N5163, 25V, only **5/–** each. Audio/r.f., Texas 2N3819 **8/6**, Motorola 2N5459 (MPF105) **9/9** each.

NEW PLESSEY INTEGRATED CIRCUIT POWER AMPLIFIER, Type SL403A. Only **48/-** nett. Operates with 18V power supply. Sensitivity 20MV into 20M Ω, 3W into 7.5 Ω Application data with two or more. P.E., Nov. 69. Stereo Amplifier kit less metalwork **£11.18.2** net complete.

30 WATT BAILEY AMPLIFIER COMPONENTS
Transistors for one channel **£7.5.6.** list, with 10% discount only **£6.11.0.** Transistors for two channels **£14.17.6.** list, with 15% discount **£12.7.5.** Capacitors and/resistors for one channel list **£2.** Printed circuit board free with each transistor set. Complete unregulated power supply kit **£4.17.6.** mono or stereo, subject to discount. Complete regulated power supply kit **£9.5.** subject to discount. Further details on application.

SINCLAIR IC10 Integrated Circuit Amplifier and Pre-amplifier. This remarkable monolithic integrated circuit amplifier and pre-amp is now available from stock. The equivalent of 13 transistor/18 resistor circuit plus 3 diodes and the first of its kind ever. It is d.c. coupled and applicable to an unusually wide range of uses as detailed in the manual provided with it. As advertised, post free **59/6** net.

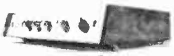
CARBON SKELETON PRE-SETS. Small high quality, type PR: Linear only, 100 Ω, 220 Ω, 470 Ω, 1k Ω, 2k Ω, 4k Ω, 10k Ω, 22k Ω, 47k Ω, 100k Ω, 220k Ω, 470k Ω, 1M Ω, 2M Ω, 5M Ω, 10M Ω vertical or horizontal mounting, **1/–** each.

S-DeC's put an end to "birdsnesting". Components just plug in. Saves valuable time. Use components again and again. S-DeC only **30/6** post free. Compact T-DeC, increased capacity, may be temperature-cycled. T-DeC only **50/–** post free. Full range stocked.

LARGE CAPACITORS. All new stock. High ripple current types: 2,000μF 25V **7/4**; 2,000μF 50V **11/4**; 5,000μF 25V **12/6**; 5,000μF 50V **21/11**; 1,000μF 100V **16/3**; 2,000μF 100V **28/9**; 5,000μF 70V **36/–**; 5,000μF 100V **58/3**; 1,000μF 50V **8/2**; 2,500μF 64V **15/5**; 2,500μF 70V **19/6**.

MEDIUM ELECTROLYTICS. Axial leads: Values (μF/V): 50/50 **2/–**; 100/25 **2/–**; 100/50 **2/6**; 250/25 **2/6**; 250/50 **3/9**; 500/25 **3/9**; 1,000/10 **3/–**; 500/50 **4/6**; 1,000/25 **4/6**; 1,000/50 **6/–**; 2,000/25 **6/–**. Small electrolytics, axial leads: 5/10, 10/10, 25/10, 50/10, **1/–** each; 25/25, 47/25, 100/10, 220/10, **1/3** each.

PEAK SOUND ENGLEFIELD KITS



Build it 12 + 12 or 25 + 25. Brilliant new styling and available in two forms: **STEREO 15 WATTS PER CHANNEL.** In kit form with complete amplifier and pre-amplifier modules and power supply. Output per channel into 15 Ω –12W R.M.S. Price **£38.9.0.** net. **STEREO 25 WATTS PER CHANNEL.** As above but output per channel into 15 Ω –25W R.M.S. Price **£58.15.0.** net. Brief specification: Total harmonic distortion 0·1%.
Inputs: Magnetic, Ceramic, Tape, Radio, Signal to noise ratios: Better than 60dB all inputs.
O/Load factor 28dB all channels.
ENGLEFIELD CABINET to house either above assemblies (as illustrated) **£5.0.0.** net. *Other peak sound products as advertised.*

MULLARD SUB-MIN ELECTROLYTICS C426 RANGE. Price **1/3** each. Axial leads, Values (μF/V): 0·64/64; 1/40; 1·6/25; 2·5/16; 2·5/64; 4/10; 4/40; 5/64; 6·4/6·4; 6·4/25; 8/4; 8/40; 10/2·5; 10/16; 10/64; 12·5/25; 16/40; 20/16; 20/64; 25/6·4; 25/25; 32/4; 32/10; 32/40; 32/64; 40/16; 40/2·5; 50/6·4; 50/25; 50/40; 64/4; 64/10; 80/2·5; 80/16; 80/25; 100/6·4; 125/4; 125/10; 125/16; 160/2·5; 200/6·4; 200/10; 250/4; 320/2·5; 320/6·4; 400/4; 500/2·5.

WAVECHANGE SWITCHES: 1P 12W; 2P 6W; 3P 4W; 4P 3W long spindles, **4/9** each. Slider switches, double pole double throw, **3/–** each.

BARGAINS IN NEW TRANSISTORS

All power types supplied with free insulating sets

2N696	**5/6**	2N5192	**25/–**
2N697	**5/6**	2N5195	**29/3**
2N706	**2/9**	40361	**12/6**
2N1132	**9/9**	403612	**16/–**
2N1302	**4/–**	AC126	**6/6**
2N1303	**4/–**	AC127	**6/–**
2N1304	**4/6**	AC128	**6/–**
2N1305	**4/6**	AC176	**11/–**
2N1306	**6/9**	ACY22	**3/9**
2N1307	**6/9**	ACY40	**4/–**
2N1308	**8/9**	AD140	**19/–**
2N1309	**8/9**	AD149	**17/6**
2N1613	**6/–**	AD161 }	**16/–pr.**
2N1711	**7/4**	AD162 }	
2N2218	**10/6**	AF118	**16/6**
2N2147	**18/9**	AF124	**7/6**
2N2369A	**6/9**	AF127	**7/–**
2N2646	**10/9**	BA102	**9/–**
2N2924	**4/3**	BC107	**2/9**
2N2925	**5/3**	BC108	**2/6**
2N2926R	**2/6**	BC109	**2/9**
2N2926O	**2/3**	BC147	**4/3**
2N2926Y	**2/3**	BC148	**3/3**
2N2926G	**2/3**	BC149	**4/3**
2N3053	**5/6**	BC153	**10/–**
2N3054	**14/3**	BC154	**11/–**
2N3055	**16/6**	BC157	**3/9**
		BC158	**3/6**
2N3391A	**5/6**	BC159	**3/9**
2N3702	**3/6**	BC167	**2/6**
2N3703	**3/3**	BC168	**2/3**
2N3704	**3/9**	BC169	**2/6**
2N3705	**3/5**	BC177	**6/3**
2N3706	**3/3**	BC178	**5/8**
2N3707	**4/–**	BC179	**6/–**
2N3708	**3/–**	BD121	**18/–**
2N3709	**3/–**	BD123	**24/3**
2N3710	**3/3**	BF178	**10/6**
2N3711	**3/11**	BFX29	**10/9**
2N3904	**7/6**	BFX85	**8/3**
2N39086	**7/6**	BFX88	**7/9**
2N3731	**23/–**	BFY50	**4/6**
2N4058	**5/3**	BFY51	**4/3**
2N3325	**10/9**	BSX20	**3/9**
2N3794	**3/3**	MJ480	**21/–**
2N4286	**3/3**	MJ481	**27/–**
2N4289	**3/3**	MJ491	**30/–**
2N4291	**3/3**	P346A	**5/9**
2N4292	**3/3**	IN4001	**4/2**
2N4410	**4/9**	IN4005	**8/–**

MAIN LINE AMPLIFIER KITS, as advertised. Prices net. Authorised dealer.

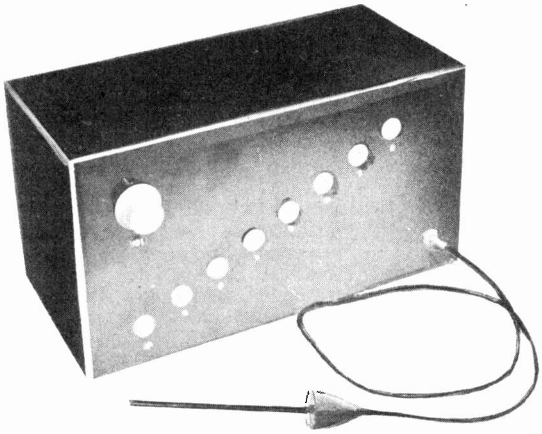
COMPONENTS DISCOUNTS
10% on orders for components for £5 or more.
15% on orders for components for £15 or more.
No discount on net items.

POSTAGE AND PACKING
Free on orders over **£2.**
Please add 1/6 if under.
Overseas orders welcome: carriage charged at cost.

ELECTROVALUE

Dept. PE4, 28 ST. JUDES ROAD, ENGLEFIELD GREEN, EGHAM, SURREY
Opening Hours: 9—5.30; Sat. 9 a.m. to 1 p.m. Tel.: Egham 5533 (STD 0784-3)

THE MERRY MONTH OF MAY!

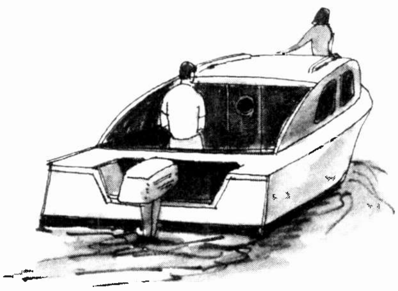


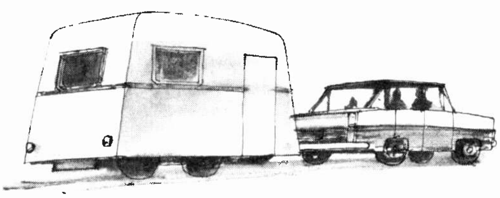
MUSICAL STAVE

A novelty single octave electronic musical instrument for learning rudimentary tonic sol-fa. This compact melody maker is self-contained and is simple to play using a touch probe. An instrument that will appeal to young and old both for novelty and some serious applications.

MARINE TACHOMETER

A tachometer for the boat enthusiast. This instrument has been designed for 2 stroke outboard motors and will accurately indicate the r.p.m. of the outboard. Its use will prevent "cavitation"—saving petrol—and safeguard the engine.





CAR CONVERSION FOR TOWING

This article describes the electrical conversion of a car for towing and gives constructional details of an electronic device to repeat indicator signals on the tow. A warning light system is also given and the two units can be used on any 12V car system.

Plus—of course **PART 2 "THIS WAY TO ELECTRONICS"**

PRACTICAL ELECTRONICS — **MAY ISSUE ON SALE APRIL 13**

Readout—
A SELECTION FROM OUR POSTBAG

Correspondents wishing to have a reply must enclose a stamped addressed envelope. We regret we are unable to guarantee a reply on matters not relating to articles published in the magazine. Technical queries cannot be dealt with on the telephone.

Unqualified success . . .

Sir—I was most interested in the letter from Mr E. A. Bromfield (P.E. February 1970) headed "Academic Barrier".

I have been in various branches of the Electronics Industry since the year 1920 and have four inventions to my credit. Two were applicable only to the guided weapons work upon which I was engaged and were put on the secret list. They were manufactured and used by my employers. The other two, the Fairey Safety Ohmmeter and the Fairey Voltage Detection Meter have been used widely all over the World and in respect of which Royal Letters Patent were granted.

In view of this, I certainly consider that I am entitled to be classed as an engineer even though I do not hold a degree.

It would be most interesting to hear Mr Bromfield's opinion on this matter.

J. C. Baker,
Bristol.

. . . of trained engineers

Sir—Your editorial on the "Non-Registered Engineer" and your reply to Mr Bromfield's letter on this subject, tempt me to make a few observations of my own.

The main theme of your argument is, that the fairly large body of non-qualified engineers make a really worthwhile contribution in the sphere of original invention. In the first place, how many people in the engineering industry are required to be technical innovators? Not many.

Also, if the record of inventions of the non-qualified engineers are placed alongside those of the qualified research workers, I fail to see how anyone can describe the contribution of the former as significant.

I share your concern that it is grossly unfair to attempt to dismiss the existing non-qualified engineer who is probably doing exactly all that is required of him at present. But at some future date, I cannot see why all engineers shouldn't be expected to be qualified.

After all, an academic qualification has no destructive properties, but leaves the inventive mind still inventive but with a useful grasp of analytical methods with which to probe and prove the limitations inherent in any idea. This is usually noticeably lacking in semi-professional inventions.

As for your point of view that some people do not wish to be, or cannot attempt to become qualified, I have very little sympathy. In the case of personal hardships involved in becoming qualified, I would put my own record against anyones, and I have as little sympathy for someone who doesn't wish to become qualified as I do for an athlete who doesn't wish to train.

In any field of human endeavour the introduction of a basic training programme has always improved performance, not diminished it. Did England win the Jules Rimet trophy by simply "having a bash?"

M. A. Stewart,
Dundee.

Bad taste!

Sir—It is with reluctance that I feel obliged to write to an excellent magazine with a complaint.

In the February 1970 issue the critic of Roland Worcester's book "Electronics" displays remarkably bad taste by questioning the validity of the claim that this author is an authority in the field of electronics. Could it be that the critic feels he is a greater authority? Strangely, he does not add his full name after the critique but merely the initials "M.K."—a pseudonym. Using M.K.'s own argument, one is led to wonder whether he is in fact qualified to make criticisms of the book. A book which, though it doubtless has its faults, is excellent value for money and attempts to cover a much wider field than any comparable work.

Stephen J. Waller,
Belvedere,
Kent.

Your Throw

Sir—After I built my Stockmarket game, I constructed a very simple, relatively inexpensive electronic die. Perhaps your readers would be interested in the circuit.

I used a Raytheon CK8754 Datavue numerical indicator tube ($5.60) operated by a simple half-wave power supply and a 24 position rotary switch. Incidentally, a Burroughs B5440 or a National NL840 tube could have been used just as well; they are all about the same. I am sure that there are comparable readout tubes available in England.

I removed the detent (click-stop) mechanism from the rotary switch so that it rotates continuously with little friction. On the shaft of the switch I installed a tuner type flywheel to provide coasting inertia. A suitable flywheel is available from Electroniques, Edinburgh Way, Harlow, Essex, catalogue number 4522. The switch shaft is also fitted with a large knob.

Every four contacts on the 24 position switch are connected to one of the cathodes of the numeral indicator tube. For example, the first four switch contacts go to the number 1 cathode. The next four switch contacts are wired to the number 2 cathode on the tube, and so on.

To use this electric die, all I do is spin the switch shaft and the flywheel causes the switch to spin to a random stop after a few rotations. The result is that a number from 1 to 6 is illuminated in the readout tube. The number is random of course, depending on how fast the switch is spun, etc. The switch should be the shorting (make-before-break) type. This type of switch results in a more positive change.

I mounted the whole thing in a 5 × 3 × 2in metal box. This electro-mechanical approach is the cheapest way to have an electronic die. Using the driver-decoder circuits made for these readout tubes was out of the question because of their cost and complexity.

Ken Greenberg,
Chicago,
U.S.A.

Since the Electronic Stockmarket Game was published many ideas for a dice (or "die" as some prefer to call it) have been received. Some, like the example described above, are semi-electronic, and others are entirely electronic. We hope shorly to publish full details of a few of these all electronic dice designs.

Although it is not possible to publish all ideas submitted, (a certain amount of similarity or duplication inevitably occurs) we do thank all those who sent in their ideas on this subject.—Ed.

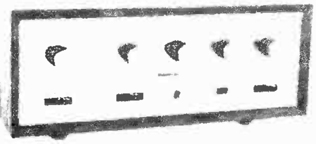
COMPLETE STEREO SYSTEM

FOR ONLY 39 GNS

CARRIAGE 35/-

The Premier Stereo System "ONE" consists of an all transistor stereo amplifier, Garrard 2025T/C auto/manual record player unit fitted stereo/mono cartridge and mounted in teak finish plinth with perspex cover and two matching teak finish loudspeaker systems. Absolutely complete and supplied ready to plug in and play. The 10 transistor Amplifier has an output of 5 watts per channel with inputs for pick-up, tape and tuner also tape output socket. Controls: Bass, Treble, Volume, Balance, Selector. Power on/off, stereo/mono switch. Brushed aluminium front panel. Black metal case with teakwood ends: Size 12" × 5½" × 3½" high (Amplifier available separately if required **£14.19.6.** Carr. 7/6).

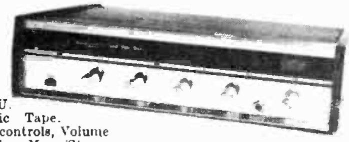
TELETON SA0203E STEREO AMPLIFIER



A small but powerful amplifier designed for stereo hi-fi reproduction. Incorporates 16 transistors and diodes. 10 watts per channel music power. Inputs for Gram (Magnetic and Crystal), Tuner and Auxiliary. Tape Record output. Controls: Volume, Balance, Bass, Treble. Stereo/Mono slide switch. Stereo headphone socket. Attractive oiled walnut cabinet with brushed aluminium front panel. List Price £28.7.0

OUR PRICE 22 GNS. P. & P. 10/-

"NOVA" 505 TRANSISTOR STEREO AMPLIFIER



A superb stereo amplifier offering every facility for the hi-fi enthusiast. Output 6 watts per channel. Frequency response 40–20,000Hz ± 3dB. Inputs for Radio, P.U. Ceramic, P.U. Magnetic Tape. Separate bass and treble controls, Volume and Balance Controls. Mono/Stereo Switch. Also features headphone socket and tape output. Teak case with attractive illuminated front panel. Size 14½ 9½ × 3¼in., a.c. 200/250V.

WONDERFUL VALUE AT ONLY 18 gns. Carr. 10/-.

PREMIER STEREO SYSTEM "FOUR"

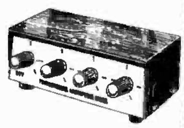
Teleton SAQ203E Amplifier (as above)	£23.2.0
Garrard SP25	£11.19.6
Shure M3D	£6.19.6
Teak base and cover	£5.10.0
Pair of 3-Unit Hi-Fi Enclosures fitted E.M.I. Speakers	£26.5.0
Total cost if purchased separately	£73.16.0

PREMIER PRICE 65 GNS. Carr. 35/-

PREMIER STEREO SYSTEM "TWO"

As system 'ONE' above but with Garrard SP25. Carriage 35/-. **45 GNS.**

VERITAS V-149 MIXER



Battery operated 4-channel audio mixer providing four separate inputs. Size 6 × 3 × 2in. suitable for crystal microphone, low impedance microphone with transformer, radio, tape, etc. Max. input 1·5V, max. output 2·5V, gain 6dB. Standard jack plug socket inputs, phonoplugs output. Attractive teak wood grain finish case.

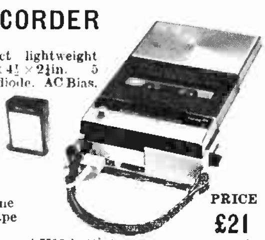
Mono Model 59/6 **Stereo Model 69/6** P. & P. 2/6.

PREMIER STEREO SYSTEM "THREE"

Nova 505 Amplifier (as above)	£18.18.0
Garrard SP25	£11.19.6
Sonotone 9TAHCD	£2.15.0
Teak base and cover	£5.10.0
Pair of 3-Unit Hi-Fi Enclosures fitted E.M.I. Speakers	£26.5.0
Total cost if purchased separately	£65.7.6

PREMIER PRICE 55 GNS. Carr. 35/-

SANYO M48M CASSETTE TAPE RECORDER



A truly compact lightweight recorder size 8 × 4½ × 2¼in. 5 transistors and 1 diode. AC Bias. 2½ in. speaker. Record level indicator. Earphone socket. Complete with carrying strap, remote control microphone with pouch and tape cassette. Output 300mW. Operates on 4 U11 batteries.

PRICE £21 P. & P. 7/6

'VERITAS' V-313 TAPE HEAD DEFLUXER

A must for all tape users! Tape heads become permanently magnetized with constant use; this leads to background noise that prevents perfect recordings. Simply applied to recording head the V313 leaves head free of magnetism. Cleans any tape head in seconds.

34/6 P. & P. 1/6

E.M.I. 13 × 8in HI-FI SPEAKERS

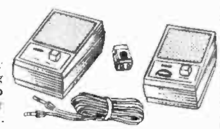
Fitted two 2½in tweeters and crossover network. Impedance 3 & 15 ohms. Handling capacity 10W. Brand new.

99/6 P. & P. 7/6

Also available without tweeters.

49/6 P. & P. 7/6

TWO STATION TRANSISTOR INTERCOMS.



Complete with battery and 50ft connecting wire. Compact size, two way call system. Ideal for home, office, factory, etc.

65/- P. & P. 4/-.

FOUR STATION INTERCOM. Master unit and 3 slaves. Ideal for office and home. Complete with battery and connecting wire **£7.19.6.** P. & P. 5/6.

"VERITONE" RECORDING TAPE

SPECIALLY MANUFACTURED IN U.S.A. FROM EXTRA STRONG PRE-STRETCHED MATERIAL. THE QUALITY IS UNEQUALLED.

TENSILISED to ensure the most permanent base. Highly resistant to breakage, moisture, heat, cold or humidity. High polished splice free finish. Smooth output throughout the entire audio range. Double wrapped—attractively boxed.

LP3	3"	250'	P.V.C.	5/6	
TT3	3"	450'	POLYESTER	7/6	
DT3	3¼"	600'	POLYESTER	11/6	
SP5	5"	600'	P.V.C.	8/6	
LP5	5"	900'	P.V.C.	10/-	
DT5	5"	1200'	POLYESTER	15/-	
LP6	5¾"	1200'	P.V.C.	12/6	
DT6	5¾"	1800'	POLYESTER	22/6	
TT6	5¾"	2400'	POLYESTER	37/6	
SP7	7"	1200'	P.V.C.	12/6	
DT7	7"	2400'	POLYESTER	25/-	
TT7	7"	3600'	POLYESTER	50/-	

TAPE SPOOLS 3" 1/-, 5", 5¾", 7" 1/9. TAPE CASES 5", 7" 2/6.

Post and Packing 3" 1/-, 5", 5¾" 1/6, 7" 2/-. (3 reels and over Post Free.)

TAPE CASSETTES

C60	(60 min.)	7/6
THREE FOR 21/-		
C90	(90 min.)	12/6
THREE FOR 36/-		
C120	(120 min.)	17/6
THREE FOR 51/-		

P. & P. 1/-.

CASSETTE HEAD CLEANER

Removes unwanted deposits from delicate tape heads. Fits all cassette recorders.

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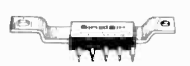


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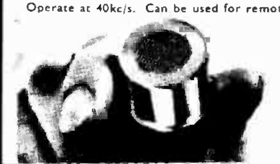

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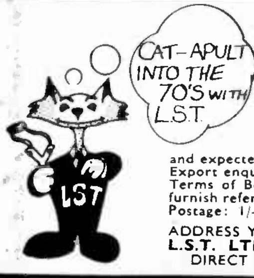

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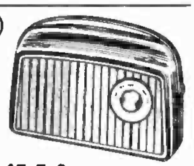

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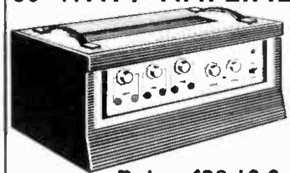

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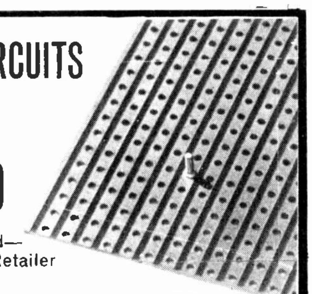

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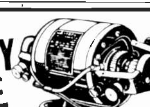

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4000 MFD 72V } 7/6 each. P & P. 1/6.
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250 MIXED RESISTORS 12/6
¼ and ½ watt.

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100 CFM 2800 r.p.m. 4½in × 4½in × 2in. Ideal for kitchen extraction, instrument cooling, etc., etc. 50/- each. P. & P. 5/-.

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160 bits £1. P. & P. 2/-.
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10000 bits £8. P. & P. 8/-.
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(continued)

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All 3/- each or 8 for 20/- With Pin Connections. Post Paid

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Printed circuit biscuit, 4 trans. 6 diodes 9V with full instructions **£3.19.6**

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Horn type Hi-Fi

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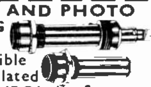

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New SIEMENS, PLESSEY, etc. miniature relays at COMPETITIVE PRICES

Coil Ω	Working d.c. Volts	Contacts		Price
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170	9-12	3 c/o + I H.D. c/o		12/6
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280	6-12	2 c/o	I.B	14/6
700	12-24	2 c/o	I.B	12/6
700	16-24	4 c/o	I.B	15/6
700	16-24	4M 2B	I.B	12/6
2500	30-50	2 c/o H.D.	I.B	12/6
9000	40-70	2 c/o	I.B	10/-

H.D. Heavy Duty. POST PAID
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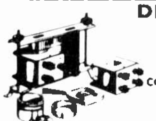
(STENZYL TYPE)



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7	6, 12, 20V at 20A	£6.17.6	7/6
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9	4, 6, 24, 32V at 12A	£7.3.0	6/6

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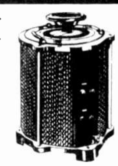

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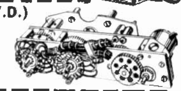

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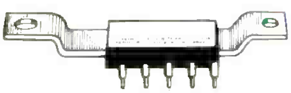

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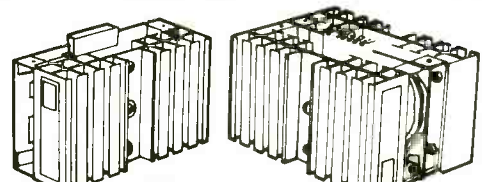

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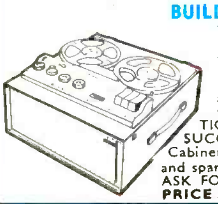

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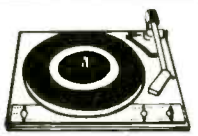

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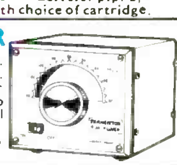

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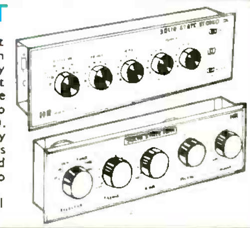

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