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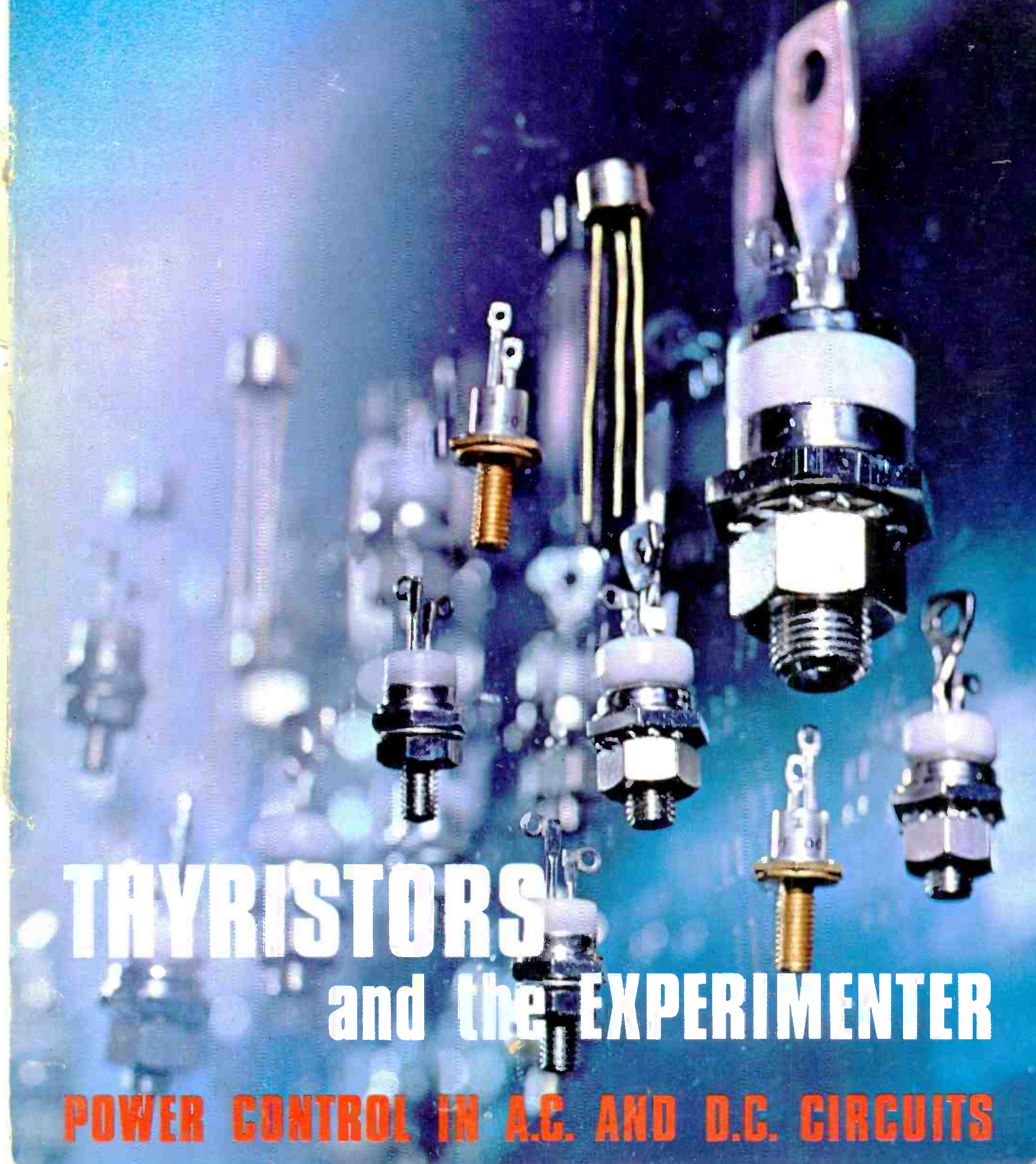

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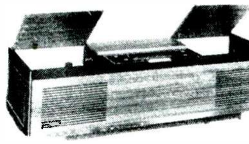

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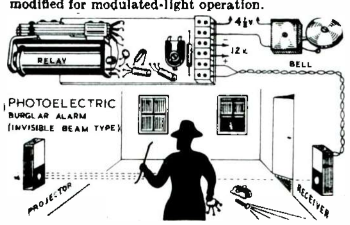

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Everything needed (except plywood) for building: 1 Invisible-Beam Projector and 1 Photocell Receiver (as illustrated). Suitable for all Photoelectric Burglar Alarms, Counters, Door Openers, etc.
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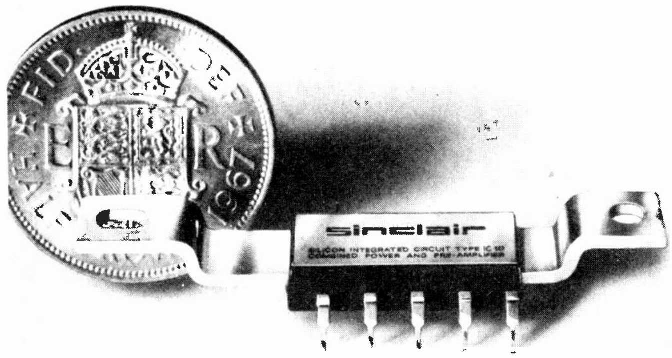
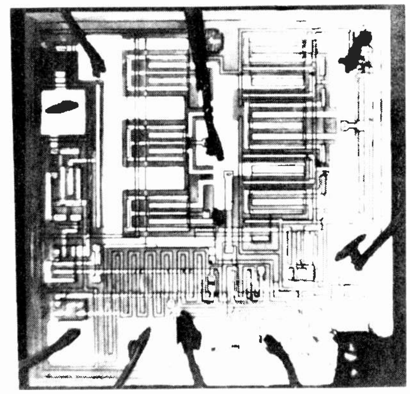
10 WATT MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER AND PRE-AMP





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 zenor 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 for producing monolithic I.Cs are expensive but once made, the circuits can be produced with complete uniformity and at very low cost. It also 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 feed-back 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 and 5 year guarantee* **59/6**

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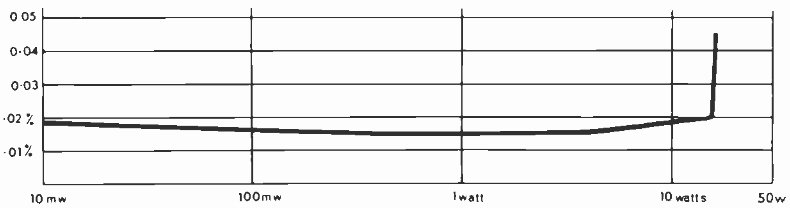
Z.30

THE WORLD'S LOWEST DISTORTION HIGH FIDELITY AMPLIFIER.

For four years, the Sinclair Z.12 dominated the constructor world, being the best selling unit of its kind this side of the Atlantic. Excellent as it was, the new Sinclair Z.30 is still better. Half the size of the Z.12, it has more than twice the power, very much greater gain and a level of distortion 50 times lower. This incredible figure results from using over 60dB of negative feed back with a constant current load to the driver stage obtained by incorporating a two transistor circuit in place of the more usual boot-strapping. 9 silicon epitaxial planar transistors are used to provide enormous power; up to 20 watts RMS sine wave (40 watts peak). The circuitry of this marvellous amplifier allows it to be operated from any voltage from 8 to 35 to perfection. At all output levels, distortion is only 0.02%. This puts true laboratory standards into the hands of every user of a Z.30. Two Z.30s and a new Stereo Sixty will make a stereo assembly of such perfection that it could not be bettered in its class no matter how much you spent. But the Z.30 has an enormous variety of applications, particularly where quality, precision and reliability are essential. It can also be used entirely on its own as an amplifier for an efficient economy record player.

APPLICATIONS

Hi-fi amplifier; car radio amplifier; record player amplifier fed directly from pick-up; inter-com; electronic music and instruments; P.A.; laboratory work, etc. Full details for these and many other applications are given in the manual supplied with the Z.30.



SPECIFICATIONS

Power output—15 watts R.M.S. into 8 ohms using a 35V supply: 20 watts R.M.S. into 3 ohms using a 30V supply.

Output—Class AB.

Frequency response—30 to 300,000 Hz ± 1dB.

Distortion—0·02% total harmonic distortion at full output into 8 ohms and at all lower output levels.

Signal-to-noise ratio—better than 70dB unweighted.

Input sensitivity—250mV into 100kΩ.

Damping factor—>500.

Loudspeaker impedances—3 to 15 ohms.

Power requirements—From 8 to 35V d.c. (The Z.30 will operate ideally from batteries if required.)

Size—$3\frac{1}{2} \times 2\frac{1}{4} \times \frac{1}{2}$ inches.

Built, tested and guaranteed, with circuits and instructions manual

89/6

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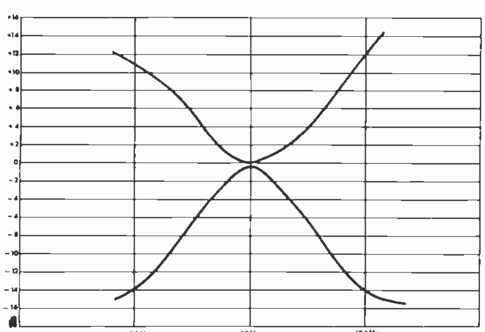
STEREO SIXTY
PRE-AMP & TONE CONTROL UNIT

This attractive and completely new unit is intended for use with two new Z.30 amplifiers to provide the finest possible standards of stereo reproduction. Four press buttons and four rotary controls are used to provide on-off, three input selectors and Volume, Bass cut/boost, Treble cut/boost and Stereo balance. The on-off button also switches the power amplifiers. The front panel in brushed aluminium is flush mounted to the cabinet front, it being necessary only to drill holes to accommodate the controls. Rear adjustable brackets hold the chassis tight to the cabinet. The very latest ganged rotary controls are used to afford compactness and extra long working life free from noise.

The Stereo-60 may also be used with 2 IC-10's or any other high performance amplifiers.

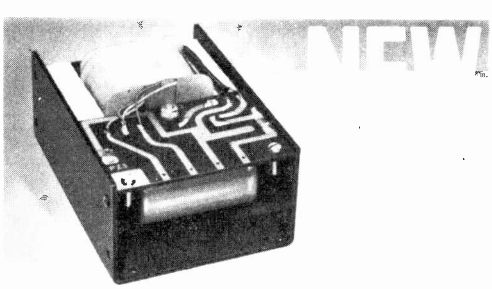


Curves to show bass and treble cut and boost

Ready built, tested and guaranteed with instructions **£9.19.6**

SPECIFICATIONS

- Input sensitivities—Radio—up to 3mV Magnetic Pickup—3mV: correct to R.I.A.A. curve ± 1dB; 20 to 25,000 Hz. Ceramic Pickup—up to 3mV: Auxiliary—up to 3mV.
- Output—1 volt.
- Signal-to-noise ratio—better than 70dB.
- Channel matching—within 1dB.
- Tone Controls—TREBLE 15 to —15dB at 10 KHz: BASS 15 to —15dB at 100 Hz.
- Power consumption 5mA.
- Front panel—brushed aluminium with black knobs and controls.
- Size 8¼ × 1½ × 4 inches.



PZ.5 POWER SUPPLY UNIT

A new heavy duty mains power supply unit designed specially to drive two Z.30s and a Stereo Sixty. New compact design.
For AC Mains, 200-240V/50Hz. **£4.19.6**

USE THIS COUPON FOR Z.30, STEREO 60 AND P.Z.5.

Q.16 LOUDSPEAKER AND MICROMATIC ON NEXT PAGE

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PE 170

Complete stereo system – £29.10.0

The new Duo general-purpose 2-way speaker system is beautifully finished in polished teak veneer, with matching vynair grille. It is ideal for wall or shelf mounting either upright or horizontally.
Type 1 SPECIFICATION:–
Impedance 10 ohms. It incorporates Goodmans high flux 6"×4" speaker and 2¼" tweeter. Teak finish 12"×6¾"×5¾". **4 guineas each.** 7/6d. p. & p.
Type 2 as type 1. Size 17½" × 10¾" × 6¾". Incorporating 10½" × 6¼" bass unit and 2¼" tweeter. 3 ohms impedance **5½ guineas** plus15/-p. & p. 7/6d. p. & p.
Garrard Changers from £7.19.6d. p. & p. 7/6d.
Cover and Teak finish Plinth £4.15.0d. 7/6d. p. & p.

Duetto **Integrated Transistor Stereo Amplifier** **£9.10.0** **plus 7/6d. p. & p.**

The Duetto is a good quality amplifier, attractively styled and finished. It gives superb reproduction previously associated with amplifiers costing far more.
SPECIFICATION:–
R.M.S. power output: 3 watts per channel into 10 ohms speakers.
INPUT SENSITIVITY: Suitable for medium or high output crystal cartridges and tuners. Cross-talk better than 30dB at 1Kc/s.
CONTROLS: 4-position selector switch (2 pos. mono and 2 pos. stereo) dual ganged volume control.
TONE CONTROL: Treble lift and cut. Separate on/off switch. A preset balance control.

These 5 items can be purchased together for £29.10+£1.10 P.&P.

The Classic

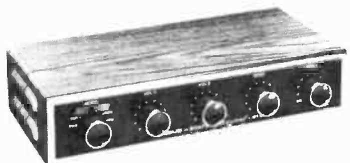
Teak finished case

£9

Plus P. & P. 7/6

SPECIFICATION: Sensitivities for 10 watt output at 1KHz into 3 ohms. Tape Head: 3mV (at 3¾ i.p.s.) Mag. P.U.: 2 mV. Cer.P.U.: 80mV. Tuner: 100mV. Aux. 100mV. Tape/Rec. Output. Equalisation for each input is correct to within +2dB (R.I.A.A.) from 20Hz to 20KHz. *Tone Control Range*: *Bass*: 13dB at 60Hz. *Treble*: ±14dB at 15KHz. *Total Distortion*: (for 10 watt output) < 1·5%. Signal Noise: < –60dB. A.C. Mains 200–250V. Size 12½in long, 4¼in deep, 2¾in high. **Built and tested.**

The Viscount



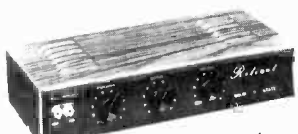
INTEGRATED HIGH FIDELITY TRANSISTOR STEREO AMPLIFER

£14.5.0

Plus P. & P. 7/6

SPECIFICATION: *Output*: 10 watts per channel into 3 to 4 ohms speakers (20 watts monoral). *Input*: 6-position rotary selector switch (3 pos. mono and 3 pos. stereo). P.U., Tuner, Tape and Tape Rec. out. Sensitivities: All inputs 100mV into 1·8M ohm. *Frequency Response*: 40Hz–20KHz ±2dB. *Tone Controls*: Separate bass and treble controls. *Treble* 13dB lift and cut [at 15KHz]. *Bass*: 15dB lift and 25dB cut [at 60Hz]. *Volume Controls*: Separate for each channel. *A.C. Mains Input*: 200–240V, 50–60Hz. *Size*: 12½ × 6in × 2¾in teak-finished case. Built and tested. P. & P. 7/6.
Viscount Mark II for use with magnetic pick ups specification as above. Fully equalised for magnetic pick ups. Suitable for cartridges with minimum outputs of 4mV/cm/sec. at 1kc. Input Impedance 47k. 15 gns. plus 7/6 P. & P.

THE RELIANT Mk. II
SOLID STATE
GENERAL PURPOSE AMPLIFIER



£6.16.0 Plus P. & P. 7/6

In teak finished case

SPECIFICATION: *Output*: 10 watts into a 3 ohms speaker. *Inputs*: (1) for mike (10mV). Input (2) for gram. radio (250mV) individual bass and treble control. *Transistors*: 4 silicon and three germanium. *Mains input*: 220/250 volts. *Size*: 10¼ × 4¾ × 2½in. *Mike to suit (crystal)*: 12/6 plus 1/6 P. & P. 8 × 5in speaker 14/6 plus 3/– P. & P. Mk. I 5½ gns. plus 7/6 P. & P. Less teak finished case.

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Complete stereo systems comprising BALFOUR 4 speed auto player with stereo head, 2 DUO speaker systems size 12 × 6¾ × 5¾in. Plinth (less cover) and the DUETTO stereo amplifier. All above items

£20 Plus P. & P. 20/–

NEW COMPLETE HI-FI STEREO SYSTEM
£39

Comprising SP 25 Garrard Mk. II with diamond stereo cartridge, Viscount amplifier Mk. I, Two type 2 speakers, Plinth and cover. £39 plus £2 P. & P.

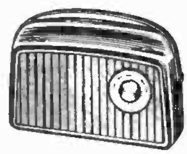
THE ELEGANT SEVEN Mk. III (350mW Output)

7-transistor fully tunable M.W.-L.W. Superhet portable. Set of parts. Complete with all components, including ready etched and drilled printed circuit board—back printed for foolproof construction. **MAINS POWER PACK KIT: 9/6 extra.**

Price £4.9.6 Plus P. & P. 7/6.

Circuit 2/6. Free with parts.

THE DORSET (600mW Output)



7-transistor fully tunable M.W.-L.W. Superhet portable with baby alarm facility. Set of parts. The latest modulated and pre-alignment techniques makes this simple to build. Sizes: 12 × 8 × 3in.
MAINS POWER PACK KIT: 9/6 extra.

Price £5.5.0 Plus P. & P. 7/6.

Circuit 2/6. Free with parts.

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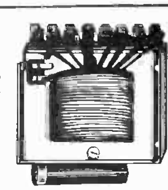

Input 250V OUTPUT (All RMS values) 4 windings of 11·5V connected in series total 46V at 4·5 amps (conservatively rated). The following combinations may be used. 1. 23—0—23V; 2. 46V. Both of these above voltages are commonly used in medium to high powered transistor amplifiers, power supplies, etc.

Price 35/- Plus P. & P. 7/6

Also see opposite page

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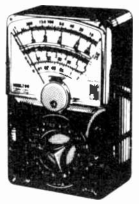
These two meter kits by TMK offer the unique opportunity of building a really first-class precision multimeter at a worthwhile saving in cost. The cabinets are supplied with the meter scale and movement mounted in position; the Model 200 also has the range selector in position. The highest quality in components and 1% tolerance resistors are used throughout. Both offer professional standards of accuracy. Supplied complete with full constructional, circuit and operating instructions.

MODEL 200

20,000 O.P.V. Multimeter. Features 24 measurement ranges with mirror scale. Large 3 × 2in meter. Full scale accuracy: DCV and current: ±2%, ACV: ±3%, resistance ±3%. Special 0·6V DC range for transistor circuit measurements.



SPECIFICATION

● DCV: 0–0·6–6–30–120–600–1,200V at 20K/OPV. ● ACV: 0–6–30–120–600–1,200V at 10K/OPV. ● DC Current: 0–0·6–6–60–600mA. ● Resistance: 0–10K–100K–1M–10M/ohms (58–580–5·8K–58K at mid-scale). ● Capacitance: 0·002–0·2uf (AC 6V range). ● Decibels −20 to +63dB. ● Output: 0·05uf blocking capacitor. Uses two 1·5V (U.7 type) batteries. Black bakelite cabinet—Size 5¼ × 3⅜ × 1⅝in. Complete with test leads.

LASKY'S PRICE 85/- Post 3/6

MODEL 5025

50,000 O.P.V. FEATURING 57 MEASUREMENT RANGES

Uses an entirely new range selection mechanism which permits the use of a really large meter in a more compact cabinet. The range selected is clearly indicated on the actual meter face. High speed rotary range selection knob; also features polarity reversal switch, shielded meter movement with overload protection circuit; Special uA and mA measurement ranges.

SPECIFICATION DCV: 0–0·25–2·5–10–50–250–1,000V at 25K/OPV. 0–0·125–1·25–5·0–25–125–500V at 50K/OPV. ACV: 0–3–10–50–250–1,000V at 2·5K/OPV. 0–1·5–5–25–125–500V at 5K/OPV. DCuA: 0–25uA at 125mA; 0–50uA at 250mA. DCmA: 0–2·5–25–250mA at 125mV; 0–5–50–500mA at 250mV. DC Amps: 0–5A at 125mV; 0–10A at 250mV. Resistance: 0–10M/ohms. Output: Capacitor (0·1uF, 400Vw) in series with ACV ranges. Decibels: −20 to +81·5db. Operates on two 1·5V batts. Black bakelite cabinet, size 5¼ × 6¾ × 2⅜in. Complete with test leads.

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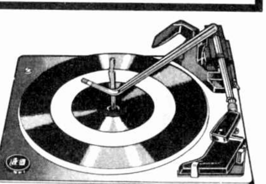
ALSO AVAILABLE READY BUILT AND TESTED £12.10.0. Post 5/-

Garrard

SL.55

4-speed autochanger with stereo cartridge



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Complete with AD76K MAGNETIC CARTRIDGE £16.9.6

AUTOCHANGERS

1025 less cartridge	**£6**	**9**	**6**
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SP.25 Mk.II less cartridge	**£11**	**19**	**6**
SRP22 Mains model less cartridge	**£6**	**12**	**10**
SRP22 Battery model less cartridge	**£7**	**15**	**3**
TRANSCRIPTION DECK 401	**£28**	**10**	**0**

GARRARD BASES:
WB1 £3. 6. 11; WB4 Mk. II **£5. 8. 11; WB5 £5. 8. 11.**

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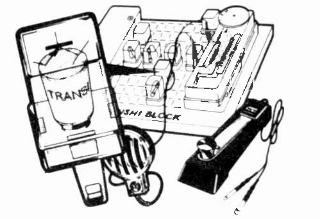
The **DENSHI BOARD** system enables the young experimenter and electronics hobbyist to produce a wide range of transistor circuits of increasing sophistication—without soldering or the use of any tools at all! Basically the system comprises a slotted circuit board into which plug-in components and bridge 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. **DENSHI BOARD KITS comes complete with an 80 page manual of circuits and data. Manuals are available separate at *4/6 post 6d. *Refundable if you purchase kit.**



THESE ARE JUST A FEW OF THE CIRCUITS YOU CAN BUILD IN MINUTES: **VARIOUS RADIO RECEIVERS, AMPLIFIERS, MORSE CODE PRACTICE DEVICE, CONTINUITY TESTER, SIGNAL INJECTOR, SIGNAL TRACER, WIRELESS MICROPHONE, ETC., ETC.**

DENSHI BOARD KIT SR-1A *comprises:*
Base board; tuner block; 4 resistors; choke coil; transformer; 28A transistor for RF; 2 diodes; 3 capacitors; battery block; morse key; antenna lead; crystal earphone; various bridge and connecting pieces **This kit permits the building of 16 basic circuits.**

LASKY'S PRICE £4.19.6 Post 3/6

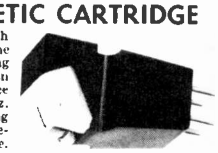
DENSHI KIT SR-2A *as SR-1A with these additional parts:*
28B transistor for AF; 2 resistors; 1 capacitor; crystal microphone; test probes; electrode; additional connecting pieces; 9V battery. **This kit permits the building of 30 circuits**

LASKY'S PRICE £7.2.6 Post 3/6

SPECIAL HI-FI OFFER

AD-86K STEREO MAGNETIC CARTRIDGE

The famous AUDIO DEVELOPMENT AD-86K high compliance stereo magnetic cartridge now at our "all time low" special price offers you the opportunity of obtaining magnetic pickup quality for your hi-fi at a price you can afford. Brief Spec: Diamond L.P. stylus Compliance 10×10^{-6}cm/dyne. Frequency response 20-20KHz. Channel separation 25dB. Output 5mV. Tracking pressure 3gm ± 0·5gm. Standard ½in mounting. (Replacement stylus available.) Don't miss this great chance. **List Price £6.2.6.**



SPECIAL PRICE 69/6 Post 2/6

Replacement diamond stylus EN30S **39/6.**

SKYROVER MK II

COMMUNICATION RECEIVER

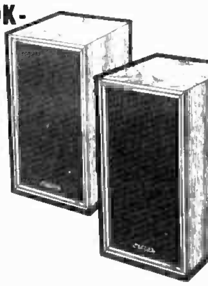
A short wave receiver, exclusive to Lasky's, at a real economy price. Four valve line up using one each 6BE6, 6BA6, 6AV6 and 6AR5 valves, gives highly sensitive reception and powerful gain. Switch selected SW frequency range cover: 1·5 to 30Mc/s in three separate bandspread ranges and full AM medium waveband cover in one range 550-1,600Kc/s. Reduction drive tuning with hair line cursor. Controls include volume on/off BFO, Band selector. Power on indicator lamp. External antenna connections and mains fuse at rear. Internal speaker plus standard 5mm jack socket for phones on front. For 220/240V a.c. mains operation. Strong metal cabinet finished in grey crackle with anodised silver front panel. Size 9½ × 5¾ × 5¼in. Complete with mains lead and full instructions.

LASKY'S PRICE £13.13.0 Post 5/-

Lasky's

NEW FOSTER "Criterion" Mk II

2 SPEAKER TWO WAY BOOK-SHELF SPEAKER SYSTEM

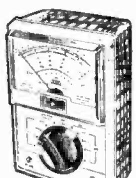


Another high quality sub-miniature book-shelf system from Foster. The "Criterion" Mk II is a sealed infinite baffle type enclosure using 5½in bass/mid-range woofer with rolled cloth edge and a 2¼in HF cone type tweeter. The compact cabinet is constructed ¾in laminate with handsome oiled walnut veneer finish and black woven acoustic gauze front panel with satin chrome edge insert. SPEC: Frequency range 90-20,000Hz. Power handling 10 watts. Impedance 8 ohms. HF crossover. Screw tag connections at rear. Size 12¼ × 7¾ × 6¾in. The performance of the "Criterion" is superior to many larger and more expensive units and at Lasky's exclusive price offers absolutely unbeatable value.

Post 1—7/6 2—12/6

LASKY'S PRICE £9.10/- or 2 for £17.10/-

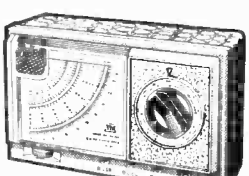
TTC MODEL C-1000



A really tiny 1,000 O.P.V. pocket multi-tester with "big" meter performance. Precision 2 jewel meter movement. Hand calibrated to ±3% accuracy on full scale of DC ranges, 4% on AC ranges. 2¼in square meter. SPECIFICATIONS AC/V ranges: 0-10, 50, 250 100V at 1K/O.P.V. DC currents: 0·1-100mA. Resistance: 0-150K ohms (3,000 ohms centre scale). Decibels: −10 to +22dB. Operated on one penlight cell. Two colour buff/green case—size only 3¼ × 2¼ × 1in. Click stop range selection switch. Ohms zero adjustment. Complete with test leads, battery and instructions with circuit data.

LASKY'S PRICE 39/6 Post 2/6

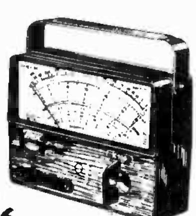
TTC MODEL C-1051



20,000 O.P.V. pocket multimeter with mirror scale and built in thermal protection circuit. Exceptionally large easy to read meter with D'Arsonval movement. Colour coded scales. Single positive click-in, recessed selection switch for all ranges. Ohms zero adjustment. Range spec. A.C. volts: 0-6-30-300-1200V at 10/K/ohms/V. D.C. volts: 0-3-15-150-300-1·2KV at 20K/ohms/V. Resistance: 0-60K-6megs. D.C. current: 0-60μA-300mA. Decibels: −20dB to +17dB. Hand calibration gives extremely high standard of accuracy on all ranges. Uses one 1½V penlight battery. Strong impact resistant plastic cabinet—size only 4¾ × 3¼ × 1¼in. Two colour buff/green finish. Complete with test leads and battery. **Original list price 5gns.**

LASKY'S PRICE 75/- Post 2/6

TMK PL-436



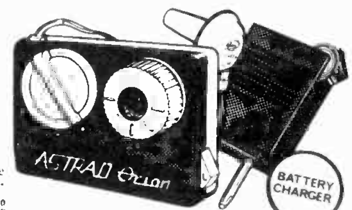
20,000 O.P.V. Multitester for the amateur or professional. Features mirror scale and wood grain finish front panel. Spec.: D.C./V ranges: 0·6, 3, 12, 30, 120, 600V at 20K/O.P.V. A.C./V ranges: 3, 30, 120, 600V at 8K/O.P.V. D.C. current: 50μA, 0·6, 60, 600mA. Resistance: 10K, 100K, 1M and 10M ohms end scale (65, 650, 6·5K and 65K ohms centre scale). Decibels: −20 to +57dB in four ranges. Operates on 2 × 1·5V U7 type batteries. Size: 5¾ × 4¼ × 2¾in. Complete with test leads, batteries and instructions.

LASKY'S PRICE £6.19.6 Post 5/-

SCOOP! THE WORLD'S SMALLEST

6 TRANSISTOR TWO WAVEBAND RADIO RECEIVER

THE Astrad ORION



Made to the highest space-age standards — this remarkable micro-size set measures only 1 11/16 × 1 3/16 × 5/16in. yet it contains 6 transistors and other components combined in a photo etched circuit, only ¾ × ½in.: tuning capacitor, ferrite rod aerial, battery, wave band selection switch etc. Output to a high impedance crystal earpiece, giving ample volume (automatically adjusted) and clear tone. Brief tech. spec.: Waveband coverage—Medium wave 525 to 160 kc/s, Long wave 150 kc/s to 408 kc/s. Sensitivity: 35MV max. Selectivity—10dB (at 30 kc/s de-tuning). Power source: 1 × 1·4V Mercury battery.

The Orion is supplied fully built and tested complete with battery, left and right fitting earphone supports and attractive black and ivory plastic presentation/carrying case (matching the Orion). Never miss your favourite music, sport, news—the Orion is an ideal gift for all, providing a constant source of enjoyment without disturbing others.

LASKY'S PRICE* ONLY 39/6 Post 2/6 Extra rechargeable battery 3/6

***NOTE: The battery we supply with the Orion is a rechargeable type. Charger units are available enabling you to re-charge the battery from AC Mains 220/240V supply.**

PRICE 19/6 extra. Post free with radio—otherwise 2/-

MIDLAND Model 10-502 VHF AIRCRAFT BAND CONVERTER

An entirely new item for the radio enthusiast bringing instant reception of the ground-to-air, air-to-ground waveband. For use with any standard AM or FM radio covering 535 to 1605Kc/s, 88 to 108Mc/s respectively—with no electrical conversion or connection required. The Model 10-502 self powered by one 9V (PP3 type) battery is merely placed close to the receiving set and then tuned over 110 to 135Mc/s which covers the whole aircraft communications band. Volume and reception effectiveness is adjusted by moving both sets to the most favourable position and balancing the vol. controls of each accordingly. The Model 10-502 has a smartly designed black plastic cabinet with brushed metal front panel and 18in. chrome telescopic antenna, size only 4 × 2¾ × 2¾in. (inc. knobs). Complete with battery and full instructions.

LASKY'S PRICE 79/6 Post Free

NEW INTERNATIONAL TAPE

FAMOUS AMERICAN MADE BRAND TAPE at RECORD LOW PRICES

3in	Message tape, 150ft	2 6
3in	Message tape, 225ft	3 9
3in	Message tape, 300ft	7 6
3¼in	Triple play, 600ft Mylar	10 0
4in	Triple play, 900ft Mylar	17 6
5in	Double play, 1,200ft Mylar	15 0
5in	Long play, 900ft Acetate	10 0
5in	Standard play, 600ft PVC	8 6
5in	Triple play, 1,800ft Mylar	35 0
5¾in	Double play, 1,800ft Mylar	22 6
5¾in	Long play, 1,200ft Acetate	12 6
5¾in	Standard play, 850ft PVC	11 6
5¾in	Long play, 1,200ft Mylar	15 0
5¾in	Triple play, 2,400ft Mylar	45 0
7in	Standard play, 1,200ft Acetate	12 6
7in	Standard play, 1,200ft Mylar	12 6
7in	Long play, 1,800ft Mylar	19 6
7in	Double play, 2,400ft Mylar	25 0
7in	Long play, 1,800ft Acetate	15 0
7in	Triple play, 3,600ft Mylar	50 0

P. & P. 1/- extra per reel. 4 reels and over Post Free. **Special quotes for quantities.**

NEW BUDGET PRICED CASSETTES from the U.S.A.

C.60—7/6 (6—42/6) C.90—12/6 (6—70/-) C.120—17/6

Post 1/- each. 4 and over Post Free. **Special quotes for quantities.**

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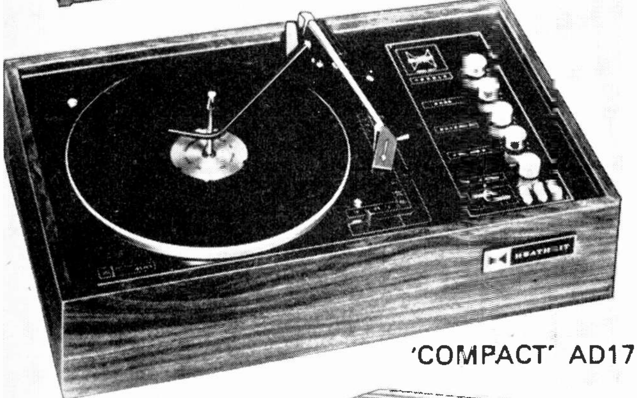
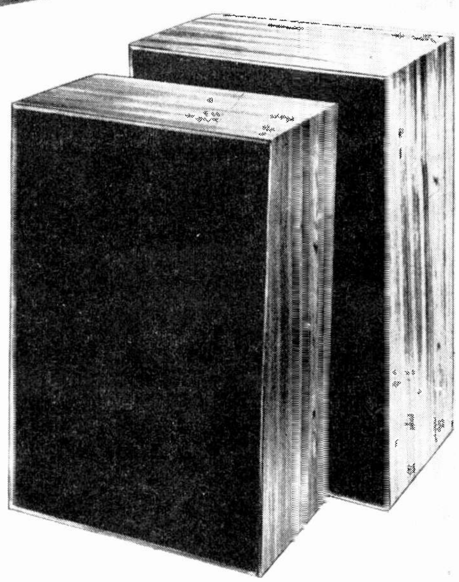
LASKY'S RADIO ESTABLISHED OVER 36 YEARS

ALL MAIL ORDERS AND CORRESPONDENCE TO: 3-15 CAVELL STREET, TOWER HAMLETS, LONDON, E.1 Tel.: 01-790 4821

'COMPACT' AD27

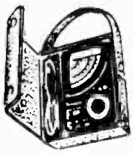


'COMPACT' AD17

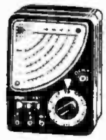


AMBASSADOR SPEAKERS

LIND-AIR OPTRONICS LTD

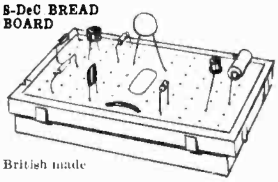


TTC.C1001 MULTITESTER in leather case. Overload protection. 20,000 opv. AC volts 10, 50, 250, 1,000V. DC volts 5-25, 125, 500, 2,500V. D.C. Current 0-50μA, 0-250mA Resistance 0-60K, 0-6 Megohm. Decibels −20 to +22dB. Size of meter 4½ × 3½ × 1in. **85/-**. P. & P. 3/6.



SHIRA 62D MULTI-TESTER 20,000 o.p.v. DC voltage: 5-25-50-250-500-2·5K (20,000 ohms per volt). AC Voltage: 10-50-100-500 1000 volts (10,000 ohms per volt). DC Current: 0-50μA, 0-2·5mA, 0-250mA. Resistance: 0-6K, 0-6Mg (300 ohm and 30K at centre scale). Capacitance: 10pf. to ·001 mfd, ·001μf to ·1μF. Decibels: −20 to +22dB. Size 4½ × 3½ × 1in. Complete with case **77/-**. P. & P. 3/6.

S-DeC BREAD BOARD



British made

Solderless breadboard panels, for fast reliable component connections.
Single DeCs. One S-DeC with Control Panel, Jig and Accessories for solderless connections to controls, etc., with booklet "Projects on S-DeC" giving construction details for a variety of circuits. **29/6**. P. & P. 2/6.
4-DeC KIT. Four S-DeCs with two Control Panels, Jigs and Accessories and the booklet "Projects on S-DeC" all contained in a strong attractive plastic case. Ideal for the professional user. **£5.17.6**. P. & P. 3/6.

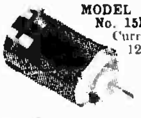
GARRARD DECKS

SRP22 less cartridge	**£5. 9.6**
1025 Stereo/Mono with cart.	**£6.19.6**
2025 Stereo/Mono with cart.	**£7.19.6**
3000S Stereo/Mono with cart.	**£9.19.6**
3000D Stereo/Mono with cart.	**£10.19.6**
SP25 less cartridge	**£11.19.6**
SP25 with Decca Deram cart.	**£17. 4.6**
SL55 less cartridge	**£11.19.6**
SL55 with Decca Deram cart.	**£17. 4.6**
SL65 less cartridge	**£14. 9.6**
Covers for above	**£2.19.6**
Bases for above	**£2.10.0**
AP75 less cartridge	**£18.18.0**
SL75 less cartridge	**£28. 7.0**
SL95 less cartridge	**£38.19.6**
Bases for above	**£4.19.6**

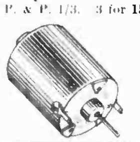
SPECIAL OFFER!
SP25 less cart., with base **£13.10.0**
P. & P. Decks 12/6, Cover 4/6, Base 4/6.
P. & P. Deck/Cover/Base 17/-.

SPECIAL OFFER!

Sonotone 9TAHC Stereo Cartridge with diamond styli. Normal retail price 4gns. **Our Price 55/-**. P. & P. 1/6. Suitable for use with all Garrard Decks.

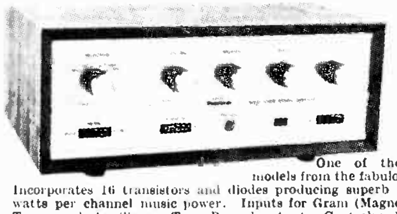


MODEL MAKER'S MOTOR No. 15RN. Voltage 11·5V. Current 400mA. Torque 12g.cm. Body size 1⅞" × long × ⅞" dia. Shaft ³⁄₁₆" long × ³⁄₃₂" dia. Ideal for small models and toys. **5/6** each. P. & P. 1/3. 3 for **15/-**. P. & P. 2/6.



9V d.c. Gram deck replacement motor. 2in × 1½in dia. Shaft ½in long 3/32in. **17/6**. P. & P. 2/-. Two for **30/-** P. & P. 2/-.

SPECIAL LIND-AIR OFFER!



TELETON SAQ203 TRANSISTOR STEREO AMPLIFIER

One of the most popular models from the fabulous Teleton range. Incorporates 16 transistors and diodes producing superb quality hi-fi. 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. 12/6

TRANSFORMERS

AUTO WOUND TRANSFORMERS

All winding voltage ratings and tappings 0–115–200–220–240V, except MT113 0–115–210–240V

		Size	Weight	Price
MT113	20W	2⅞ × 1¹¹⁄₁₆ × 1¾in	11oz	**12/6** (P. & P. 2/6)
MT64	75W	2¾ × 2½ × 2⅜in	1lb 14oz	**21/9** (P. & P. 4/6)
MT4	150W	3½ × 2¾ × 3in	3lb	**33/-** (P. & P. 6/-)
MT65	200W	3½ × 4½ × 4in	4lb	**39/6** (P. & P. 6/-)
MT66	300W	4 × 4 × 3¾in	6lb 7oz	**59/4** (P. & P. 9/-)
MT110	400W	4¾ × 4½ × 4in	11lb	**85/-** (P. & P. 10/-)
MT67	500W	5½ × 4 × 4½in	12lb 8oz	**89/-** (P. & P. 10/6)
MT83	750W	4½ × 5½ × 5½in	13lb 4oz	**95/7** (P. & P. 10/6)
MT84	1000W	4⅝ × 5½ × 5½in	16lb	**142/2** (Carr. extra)
MT93	1500W	5⁵⁄₁₆ × 5⅞ × 6¾in	28lb 9oz	**170/6** (Carr. extra)
MT94	1750W	5⁵⁄₁₆ × 6⅜ × 6½in	31lb	**195/-** (Carr. extra)
MT95	2000W	7 × 6½ × 8½in	40lb	**211/2** (Carr. extra)
MT73	3000W	6⅞ × 7⅛ × 8⅜in	45lb 8oz	**300/-** (Carr. extra)

LOW VOLTAGE 12V RANGE

Primary 200–250V; secondary 12V

MT111	0·5A	3 × 2¼ × 1¾in	12oz	**15/3** (P. & P. 2/6)
MT71	2A	2¾ × 2½ × 2¼in	1lb	**19/-** (P. & P. 3/9)
MT69	4A	3½ × 2¾ × 2¾in	2lb 4oz	**28/-** (P. & P. 6/-)
MT70	6A	4 × 3 × 3⅜in	3lb 12oz	**39/-** (P. & P. 6/-)
MT72	10A	3⅛ × 4½ × 4in	6lb 3oz	**51/-** (P. & P. 9/-)
MT115	20A	4¾ × 4⅝ × 4in	11lb 13oz	**95/-** (P. & P. 9/-)
MT187	30A	5½ × 4¾ × 4¾in	16lb 12oz	**180/-** (P. & P. 13/6)

LOW VOLTAGE 24V RANGE

Primary 200/250V; secondary 24V

MT58	1A	2¾ × 2⅜ × 2¼	1lb 7oz	**23/9** (P. & P. 4/6)
MT114	3A	2½ × 3 × 3in	3lb 6oz	**38/-** (P. & P. 6/-)
MT72	5A	4 × 3¾ × 3⅜in	5lb 12oz	**53/10** (P. & P. 6/-)
MT17	8A	4¾ × 3¾ × 4in	7lb 8oz	**72/7** (P. & P. 9/-)
MT115	10A	4¾ × 4½ × 4in	11lb 13oz	**95/-** (P. & P. 11/-)

LOW VOLTAGE 30V RANGE

Primary 200/250V; secondary tapped 12–15–20–24–30V

MT112	0·5A	3½ × 2⁷⁄₁₆ × 1⁵⁄₁₆in	1lb 4oz	**17/4** (P. & P. 3/9)
MT79	1A	2¾ × 2½ × 2⅜in	2lb	**23/-** (P. & P. 6/-)
MT20	3A	4 × 3½ × 3⅜in	4lb 6oz	**46/2** (P. & P. 6/-)
MT51	5A	4¾ × 3½ × 4in	6lb 8oz	**60/9** (P. & P. 9/-)
MT88	8A	5½ × 3¾ × 4½in	9lb 6oz	**92/4** (P. & P. 11/-)
MT89	10A	5½ × 4 × 4½in	12lb 2oz	**103/6** (P. & P. 11/-)

LOW VOLTAGE 50V RANGE

Primary 200–250V; secondary tapped 19–25–33–40–50V

MT102	0·5A	2¾ × 2¾ × 2¼in	1lb 11oz	**21/3** (P. & P. 6/-)
MT104	2A	4 × 3½ × 3⅜in	5lb	**45/8** (P. & P. 6/-)
MT106	4A	4¾ × 4½ × 4	9lb 4oz	**77/-** (P. & P. 9/-)
MT118	8A	5½ × 5½ × 4¾in	18lb 9oz	**132/-** (P. & P. 13/6)
MT119	10A	6⅛ × 4½ × 6¼in	19lb 12oz	**165/-** (P. & P. 15/6)

LOW VOLTAGE 60V RANGE

Primary 200/250V; secondary tapped 24–30–40–48–60V

MT124	0·5A	3½ × 2¾ × 2⅝in	2lb 4oz	**24/-** (P. & P. 6/-)
MT127	2A	4 × 3½ × 3⅜in	5lb 6oz	**52/10** (P. & P. 6/-)
MT123	4A	4½ × 3¾ × 4½in	10lb 6oz	**99/-** (P. & P. 11/-)
MT122	10A	6½ × 5 × 6¼in	23lb 2oz	**152/-** (Carr. extra)

MAINS H.T. RANGE

				Size	Price	P&P
MT1AT	250–0–250V	80MA	6·3V 3·5A 5/6·3V 1A	3½ × 3 × 3in	33/-	6/-
MT6AT	250–0–250V	100MA	6·3V 3·5A 5/6·3V 1A	4 × 3½ × 3½in	38/3	6/-
MT110	250–0–250V	120MA	6·3V 3·5A 5/6·3V 1A	4 × 4 × 3½in	44/9	6/-
MT11AT	300–0–300V	100MA	6·3V 3·5A 5/6·3V 1A	4 × 3½ × 3⅜in	37/9	6/-
MT12AT	300–0–300V	120MA	6·3V 4A 5/6·3V 1A	4 × 3¾ × 3⅜in	46/2	9/-
MT33AT	300–0–300V	150	6·3V 4A 5/6·3V 1A	4 × 4 × 3½in	59/4	9/-
MT2AT	350–0–350V	80	6·3V 3·5A 5/6V 1A	4 × 3½ × 3⅜in	38/6	6/-
MT7	350–0–350V	100	6·3V 3·5A 5/6·3V 1A	4 × 3½ × 3⅜in	42/4	6/-
MT8	350–0–350V	120	6·3V 3·5A 5/6·3V 1A	4 × 3¾ × 3⅜in	50/-	6/-

BATTERY CHARGER TYPES

Primary voltage 200–250V; secondary 6–12V (Rectifier not included)

MT77	1A	2¾ × 2½ × 2⅜in	1lb 6oz	**15/-** (P. & P. 4/6)
MT45	1·5A	2¾ × 2⅜ × 2⅜in	1lb 9oz	**21/9** (P. & P. 4/6)
MT46	2A	3½ × 2½ × 2⅜in	2lb 4oz	**25/4** (P. & P. 6/-)
MT47	3A	4 × 3 × 3⅜in	3lb 8oz	**28/4** (P. & P. 6/-)
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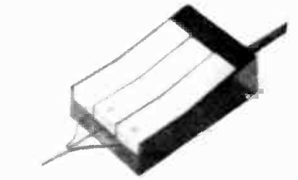

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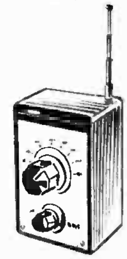

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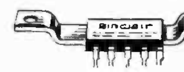

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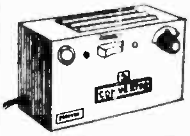

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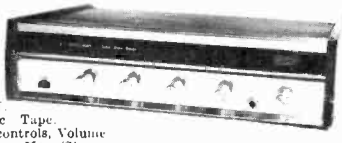

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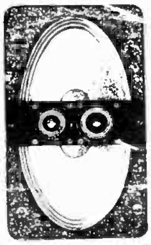

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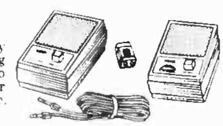

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VOL. 6 No. 1
January 1970

PRACTICAL ELECTRONICS

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DISPELLING THE MYSTIQUE

CURRENT affairs commentators make free with colourful phrases concerning "this age of electronics." These evocative declamations are apt, and correct. Yet there are signs that some of the original lustre has worn off the image this well exposed branch of contemporary technology conjures up in the public's mind. While without a doubt a mystical aura still surrounds the subject, following upon many demonstrations of its efficiency and versatility in providing all manner of services in everyday life, electronics seems to have become accepted as the modern marvel—with an answer to most of the problems encountered in this increasingly complicated and highly organised world. News of further striking technical advances tends to be received passively, as though the public has been conditioned to expect these as perfectly natural happenings—though the manner in which they are achieved is not understood. The wonderment of the early days has given way to quiet respect.

This general deference to a rather mysterious power contrasts with the easy familiarity which has been developed by technically inclined individuals towards electronics. To the uninitiated it may seem hard to believe, but without question electronics is an ideal and convenient subject for private study and experimentation. It is certainly *not* a subject to shrink from in fear and bewilderment—despite its formidable attributes. The swing over to solid state and the ensuing miniaturisation are, of course, factors of immense practical advantage and have been quickly recognised by enthusiasts from all walks of life. The component supply situation, apart from occasional difficulties with particular "special" items, is good and many of the latest circuit devices soon emerge onto the retail market.

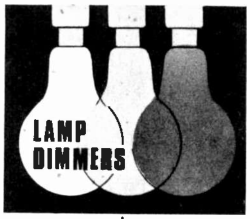
Thus while electronics has been making phenomenal progress and extending its influence into all areas of modern life, the know-how has not remained a closed book to all except the professionals. It is open for any private person to explore and so experience at first hand much of the evolution in components and circuit design which is a continuing process in the industry.

From active home work develops a new and fuller appreciation of the potentialities of electronics. The informed amateur is not likely to be bamboozled by mere words and phrases. He knows the universality of electronics and sees the future even more dominated by this technology. But with knowledge based upon personal involvement he can also cut the "monster" down to size; to flip-flops, gates, linear amplifiers, phase inverters, and all—the very circuit "bricks" he makes and uses himself.

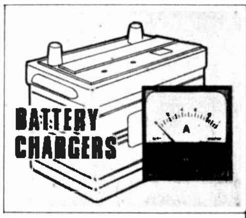
F.E.B.

THIS MONTH

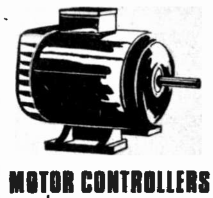
Our February issue will be published on Thursday, January 15



THYRISTORS AND THE EXPERIMENTER



By J. N. WATT



Of all the semiconductor devices which have become generally available to the home experimenter, surely the silicon controlled rectifier (s.c.r.), or thyristor, is one of the most useful, and, at the same time, least appreciated. Transistors of course have wide application, but what follows will show that thyristors are capable of a multitude of uses, often at currents and voltages—and hence power levels—well out of reach of transistor circuitry.

FIRST a mention of how one of the names for these devices, the *thyristor,* is derived. It comes from THYRatron transISTOR, and those readers who are familiar with the thyratron or gas filled valve will recognise much of the properties of the thyristor. A proper understanding of these properties is vital to a full appreciation of the circuits which follow, and it is worthwhile to set down here three basic characteristics.

BASIC CHARACTERISTICS

1. A thyristor will conduct in only one direction, and when doing so behaves very much as an ordinary silicon diode; that is, it exhibits a low resistance and hence dissipates little power.

2. However, in order to conduct it is not sufficient that the anode be made positive. For conduction to take place, a third electrode, the "gate" (corresponding to the grid of a thyratron) must be made slightly positive with respect to the cathode. The power needed to do this is only a small fraction, a *very* small fraction, of the power it is possible to control, and it is this property that can be exploited so well in thyristor circuitry.

3. Even with this positive voltage removed from the gate, the thyristor continues to pass current (as mentioned in 1 above) provided the value of this current does not fall below a certain, small, value, known as the holding current. A typical holding current for a 3A thyristor is 30mA. Should this fall in current take place, the thyristor will "block", the current will fall to zero and the re-application of a positive gate voltage will be required for conduction to start again.

PHYSICAL DETAILS

Thyristors are available with voltage ratings up to 1,200 volts and current ratings up to 250A—although it is not suggested that home experimenters should use such high power types! Devices of 400V rating will be suitable for mains use and lower voltage ratings such as 50V to 100V are satisfactory for battery driven equipment.

The physical construction of a thyristor varies of course with the voltage and current it is able to handle, and the more usual outlines and connections are as shown in Fig. 1. Also depicted is the circuit symbol for this device.

Construction (a) is used for lower current devices, say up to 2A, while higher ratings usually employ one of the other forms. Most popular is perhaps stud mounting (b), since it requires only a single hole to be made; (d) is of more recent origin, with thyristors of plastic encapsulation now being made.

TWO MAIN GROUPS OF CIRCUITS

The three important properties mentioned earlier lead to an abundance of thyristor circuits, and it will be convenient to classify these circuits into two broad groups:

1. Circuits using d.c. supplies, such as a solid state relay, flashers, and battery chargers.
2. Circuits using a.c. supplies, such as lamp dimmers, motor speed controllers (already described in PRACTICAL ELECTRONICS), temperature control, and mains lamp flashers.

In all the circuits which follow component values given are not necessarily optimum, but have been selected to show the principles involved.

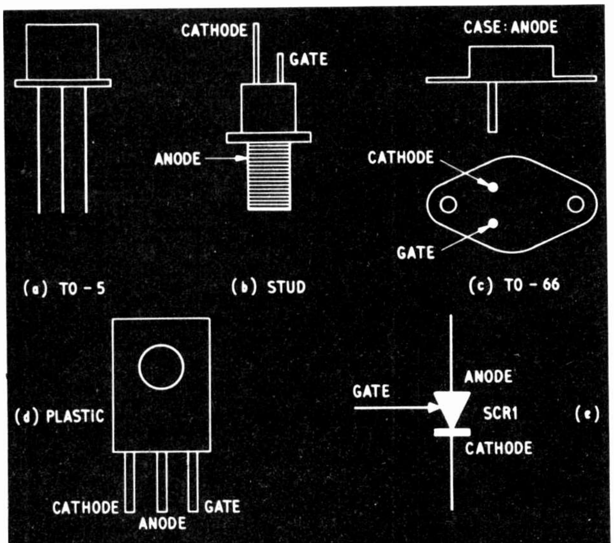


Fig. 1. (a-d) Outlines of typical thyristors; (e) symbol for thyristor and component reference used in circuit diagrams

Thyristors have large spreads in their detailed characteristics, notably gate current required for turn on, which varies with temperature, and it may be found that slight alterations in some resistor values will be required.

However, unmarked devices, advertised in PRACTICAL ELECTRONICS, as well as manufacturers' type numbered products should all work well and experimenters can proceed with confidence. Thyristors are tolerant devices (provided ratings are not exceeded of course) and will be found to be easy to use in the circuits to be given.

A SIMPLE THYRISTOR CIRCUIT

The simplest circuit which finds practical use is shown in Fig. 2. The load can be a lamp or a relay; nothing sophisticated is needed for the positive pulse shown at the gate, indeed a resistor momentarily connected to the positive supply will switch on the thyristor.

Uses for this simplest of all circuits are remote operation of a lamp where switch-on at a distance is needed and voltage drop in the lamp cable could be troublesome, for only the small gate current will be required to flow to the remote switching point, and then

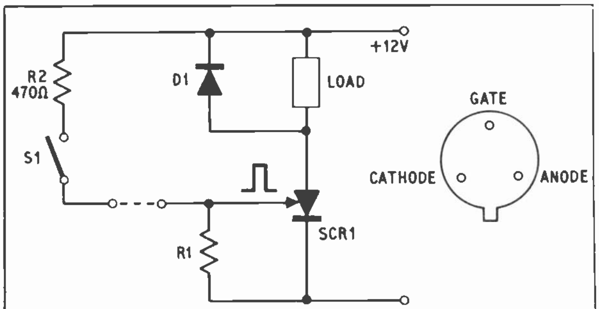


Fig. 2. Simple load switching circuit

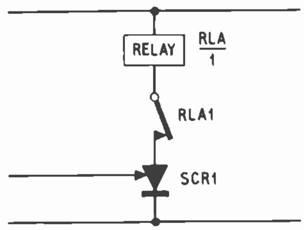
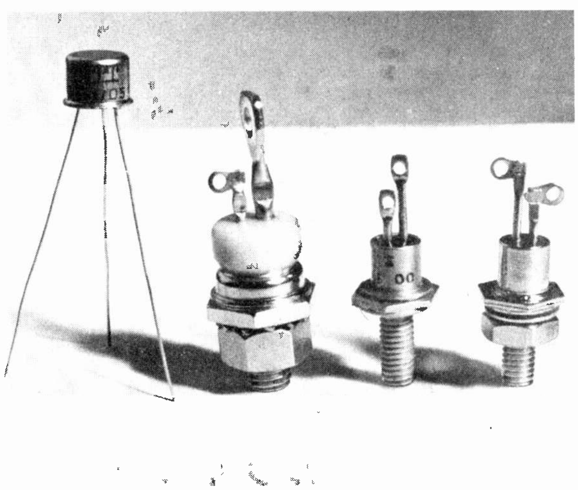


Fig. 3. Use of a relay in lieu of a buzzer

only for a few milliseconds or less. The resistor R1, which should be about 1 kilohm, is required to ensure that the thyristor does not switch on spuriously, especially at higher temperatures.

Typical connections for a 100V thyristor are as shown, and almost any device of that rating capable of carrying 1A will work well, controlling, say, a 12 watt lamp. The diode D1 across the load removes any high voltage transients present when the current changes, which could damage the thyristor.

The load in Fig. 2 could be a buzzer or bell, and the self-interrupted nature of the current through it will ensure that when the gate circuit is opened, buzzer operation ceases. Should operation of a buzzer be required from a distance, this will enable a lighter gauge cable to be used to the operating push or switch, so recouping the cost of the thyristor. If desired, a relay with a normally closed contact wired as shown in Fig. 3 can be substituted for the buzzer.



SWITCHING OFF ARRANGEMENT

To switch off the current in the load of Fig. 2 it is easiest to break the supply; however a useful alternative is given in Fig. 4. With the thyristor conducting and hence with its anode at only a volt or so positive, C1 charges to almost 12 volts. Closure of the switch earths the right-hand side of C1, and since the charge on C1 is unable to change instantaneously, the left-hand side of C1, and hence the thyristor anode, will be at about. −11V; this switches off the thyristor.

A drawback of this circuit is that if the switch is left closed, C1 charges through the load with the opposite polarity, and hence an ordinary electrolytic cannot be used.

It is possible to use a second thyristor in place of the switch, and since it is called upon to pass only the current through R3 it can be a low current rating device, which will be both more sensitive and cheaper.

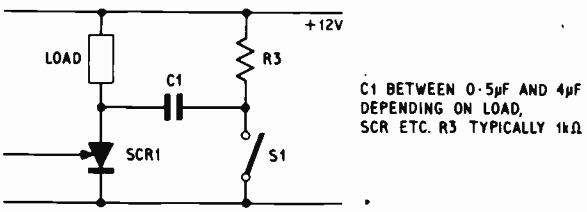


Fig. 4. A method of switching off a thyristor

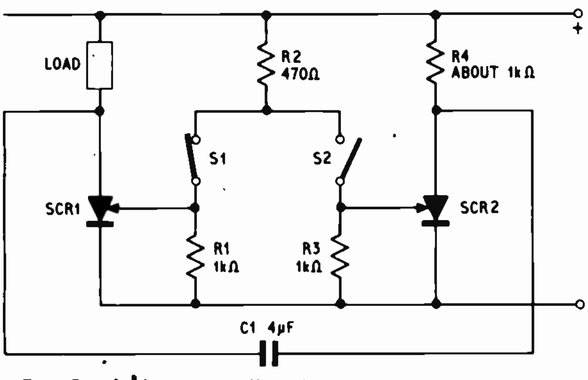


Fig. 5. A d.c. controller developed from the basic circuit of Fig. 2

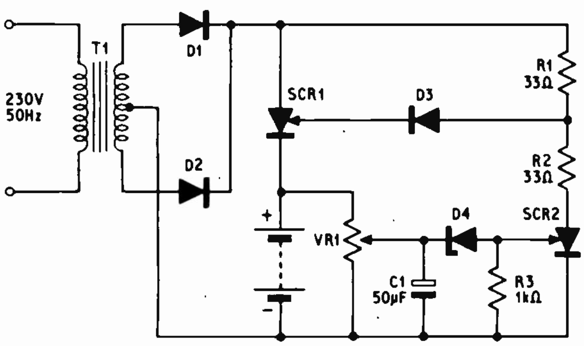


Fig. 6. Controlled battery charging

EFFICIENT MOTOR CONTROLLER

An application of this circuit which should be of interest to model control enthusiasts is given in Fig. 5.

The load is energised when S1 is closed and S2 opened, and de-energised when S1 is opened and S2 closed. If S1 and S2 are the contacts of a pair of reed relays in the collectors of a multivibrator running at, say, 200Hz, variation of the mark-space ratio will alter the mean current in the load, which could be a drive motor.

This is a very efficient controller for d.c. to run motors, lamps, etc.—there is little power wasted in dropper resistors and the use of lightly loaded reed relays ensures long life and reliability.

The control of high current d.c. supplies is thus possible where the use of a series transistor would be difficult or expensive. This circuit forms the basis of control used in fork lift trucks and in experimental electric cars.

BATTERY CHARGERS

The very name "silicon controlled rectifiers" would lead one to believe that such units as battery chargers could have their charging rate controlled, and such is the case. It is possible to arrange for the charger to be cut-off when a pre-set battery voltage is reached, so that over-charging is impossible. A typical circuit is given in Fig. 6, and is admittedly somewhat complex in appearance, although straightforward in operation.

With a discharged battery, each half-cycle of mains input delivers current to the battery via SCR1 since it is turned on at its gate via R1 and the diode. As charging proceeds, battery voltage rises until the potential at VR1 slider exceeds the Zener voltage of D4, so causing it to conduct. Its anode therefore goes positive, so switching on SCR2 (this latter thyristor is not required to carry charging current and can thus have a low current rating, which implies that its gate triggering will be more sensitive—an advantage here as it was in connection with the circuit of Fig. 4.)

Further charging, giving rising battery voltage, means that the point in the half-cycle at which SCR2 conducts will become earlier and earlier, until eventually it takes place *before* SCR1 has had a chance to turn on. With SCR2 conducting, the junction R1/R2 is only just above earth, so that SCR1 is unable to switch on; thus charging ceases. The battery voltage at which this occurs is set by VR1.

Should battery voltage fall, charging will re-start, so making the circuit suitable for those uses where a battery is called upon to provide high rate, intermittent, short discharges and is left across the charger continuously. Use of the circuit of Fig. 6 will permit a smaller battery to be employed (overcharging would be more harmful to a small battery).

CONTROL OF A.C. SUPPLIES

All the circuits mentioned up to this point have controlled d.c. supplies, but it is in the field of a.c. control that thyristors are perhaps most attractive.

There are two different methods for operating a thyristor in a.c. circuits, these are known as "phase shift" and "burst fire" operation.

In phase shift the thyristor conducts for a certain period during every positive half cycle. The point on the positive-going waveform at which conduction commences is the controllable factor, and the amount of power passed through the load is varied accordingly.

In burst-fire control the thyristor switching cycle is longer, and trains of "whole" pulses are passed. The mark-space ratio determines the length of these trains of pulses, and so the amount of power consumed in the load.

Phase shift is the easier method so far as the circuitry is concerned; it does, however, have certain disadvantages, as will be pointed out in due course. Its use is therefore best confined to low power functions, such as light control.

LAMP DIMMING

Starting with domestic lamp dimming; perhaps the only advantage of the gaslight of former decades over present electric lamps was the ease with which the intensity could be readily adjusted! Now, the availability of cheap thyristors has changed the picture dramatically.

If only slight dimming of, say, a 100 watt lamp to the equivalent of a 60 watt lamp is required, then the circuit could hardly be simpler—see Fig. 7.

HALF WAVE CONTROL

When the line is more negative than the neutral, diode D1 conducts and supplies current to the lamp. On the other half-cycle, with line more positive than neutral, the thyristor conducts, starting at a time depending on the setting of VR1. This resistor and capacitor C1 give a retarded phase shift to the gate voltage, so that as VR1 increases, the shift increases, so delaying turn on of SCR1 in alternate half-cycles. The diode D2 prevents the thyristor gate from going more negative than the cathode during the half-cycles when D1 conducts. As the waveforms in Fig. 8 show, delayed turn on of the thyristor gives reduced power in the load.

The circuit is not critical of the type of thyristors and diodes used. Unmarked devices of 400V rating as well as Mullard BTY 79-400R have worked well; D1 should be rated at 400V p.i.v. and be capable of carrying 0·5A for lamps up to 200 watts, though D2 need only be of 100V working and of lower current capacity, say 100mA.

With the circuit shown a useful reduction in light output is obtained with VR1 at maximum resistance, but of course no more than a 90 degree phase shift can be provided by a simple RC network. If D1 is switched out, control down to lower lamp brilliance is possible, but since only alternate half-cycles of the 50Hz mains are thereby being used, there is an annoying flicker from the lamp.

FULL WAVE CONTROL

With slightly more complexity and expense, full smooth control from full brilliance down to zero output is possible and two circuits for this are given. Each shows a different approach to the problem, which is not perhaps surprising since one circuit is that due to Messrs. SGS UK Ltd. while the other originated with S.T.C. Ltd.

Basically, what is required is a means of controlling both half-cycles of the 50Hz mains together, in one

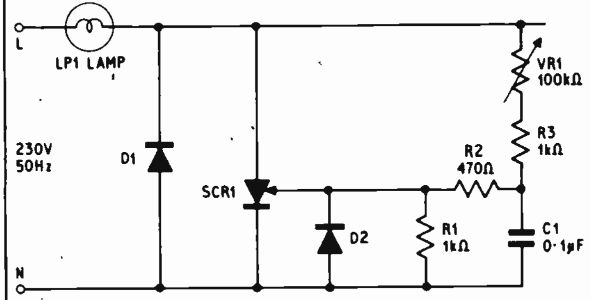


Fig. 7. Simple lamp dimmer—half wave control

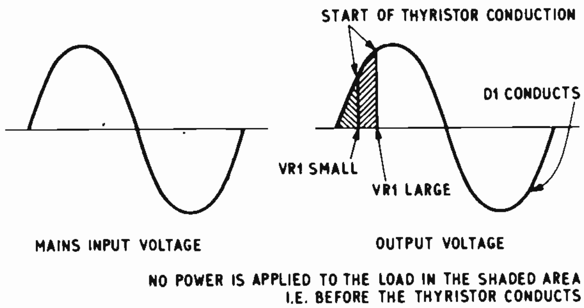
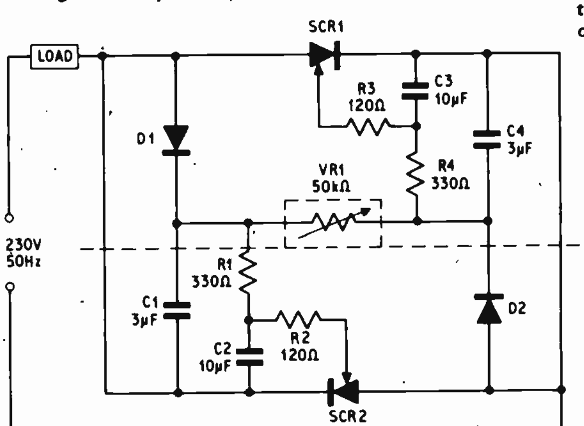
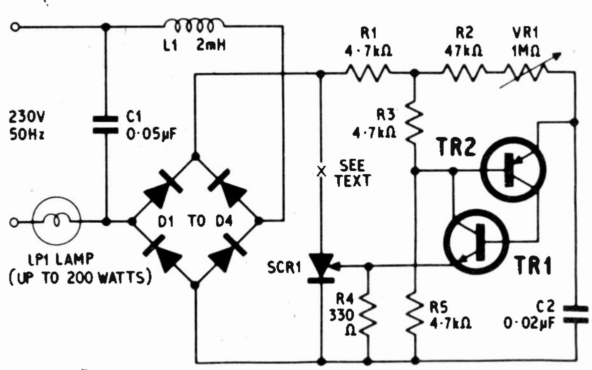


Fig. 8. These waveforms show how the thyristor controls the power in the load with the phase-shift method of operation



SCR1, SCR2 BTX60 OR SIMILAR (400V 3A SUITABLE)
D1, D2 EC402 OR SIMILAR (50V 100mA SUITABLE)

Fig. 9. Lamp dimmer—full wave control (SGS UK Ltd.)



SCR CRS30/40AF OR SIMILAR (400V 3A SUITABLE)
D1-D4 400V 1A EACH TR1, TR2 SEE TEXT

Fig. 10. Lamp dimmer—full wave control (S.T.C. Ltd.)

smooth operation. This is done in one case by using two thyristors, each exercising control on alternate half-cycles, while in the other a full wave bridge rectifier is used to enable one thyristor to control both half-cycles.

Circuits are given in Fig. 9 and Fig. 10.

TWO-THYRISTOR CIRCUIT

Dealing with the SGS circuit first, consider that part above the dotted line and including the variable resistor VR1. Positive going half-cycles at D1 anode are shifted in phase by VR1 and C4, but here extra phase shift is added by R4 and C3, so giving control of SCR1 gate firing over the whole half-cycle instead of a maximum of 90 degrees as previously described.

On the other half-cycle the remainder of the circuit behaves in a similar manner, using VR1 as phase shift control, and smooth variation of lamp brilliance is given from full brilliance to zero output.

SINGLE-THYRISTOR CIRCUIT

Turning now to the circuit from S.T.C. (Fig. 10), it will be seen that only one thyristor is used, together with a full wave bridge rectifier to supply only positive voltages to the anode.

If we imagine the thyristor already to be conducting, the output of the bridge will be short circuited, but with the lamp in series with the mains input it will drop nearly all the applied voltage and be at full brilliance. Variable delay of thyristor conduction in each half-cycle will give control of lamp brilliance; this control is achieved by charging C2 through R2 and VR1.

When the voltage across C2 and hence at TR2 emitter exceeds that at its base by more than about 0·6V, TR2 conducts, so passing current to TR1 base and this complementary pair of transistors rapidly turns to a state of conduction. Thus the positive voltage on C2 is suddenly applied to the thyristor gate, so switching it on. The point in the half-cycle at which it does so is set by the time taken for C2 to charge to the required voltage, through VR1. Once again, very smooth control of lamp brilliance is given.

DUPLICATE CIRCUITS

A variation of this particular circuit (Fig. 10) is to put the lamp at X, in the anode of the thyristor and apply the mains direct to the bridge. This will give d.c. in the lamp, but this is of no consequence. However, what is interesting is that duplicate thyristors, each with their own control circuits, can be run from the same bridge rectifier, each thyristor having a lamp (or other load) in its anode circuit.

By this means a multitude of lamps, for theatrical work, shop window displays and so on can very easily be controlled, *independently*. The bridge must of course be of adequate rating, that is, be capable of carrying the total lamp current with all lamps at maximum brilliance.

Besides the thyristors quoted in the circuits, unmarked devices have proved successful in both cases, although some slight adjustment of resistor or capacitor values may be called for to obtain full control.

The transistors used should be silicon for low leakage, and a variety of types will function well—BSY95A, 2N929, 2N3704, BSY27 for the *npn*; the OC200 series and 2N3702 for the *pnp* have all proved suitable.

RADIO INTERFERENCE

One important point which should be mentioned here is the question of radio interference. Since thyristors by their very nature switch on rapidly, many harmonics are produced and these may give rise to interference, especially if a controller is run from the same mains socket outlet as a television or radio, on which a pronounced 50 or 100Hz buzz will be heard.

Some form of suppression is required, and that depicted in Fig. 10 is typical, where L1 and C1 act as a filter, is an example of what could be used.

The construction of controllers and similar devices using circuits such as described here is best carried out in metal boxes which can be earthed, thereby reducing the radiation of interference, as well as giving greater safety.

AUTOMATIC LIGHTING CONTROL

Continuous control of lamp output has a multitude of uses—porch lights can be run dimmed, to be turned up when needed, lights can be turned down for watching television, or for parties, and photographers will be able to control studio lighting and enlarger lamps. Extra lamp life is a useful by-product of under running of course.

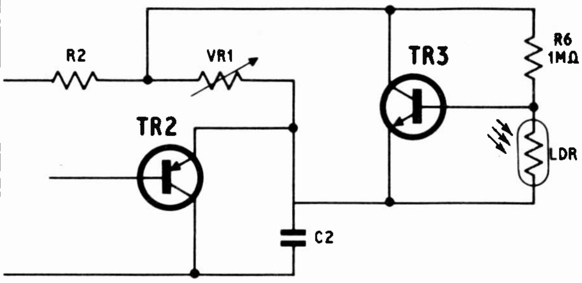


Fig. 11. Automatic Light control modification to circuit given in Fig. 10

Automatic control of lamp brilliance, depending on the level of ambient lighting, so that lights come on at dusk for example, is a desirable feature, and a modification to the circuit of Fig. 10 to carry this out is given in Fig. 11.

With VR1 set for low light output and the light dependent resistor (LDR) at minimum resistance, say 10 kilohm, the transistor TR3 will be cut off, that is it will present a high resistance between collector and emitter and hence it will hardly shunt VR1. As the LDR resistance increases up to about 300 kilohm or more with reduction in light level, the transistor conducts and shunts VR1, hence switching on the thyristor earlier in each half-cycle and turning up the lights. A suitable LDR would be cadmium sulphide (CdS) type; the transistor can be any ordinary silicon *npn* type, such as a BSY 95A.

Circuits for switching on lights as the ambient light level falls have appeared in PRACTICAL ELECTRONICS before, but that given above has the twin advantages of gradual turn on as daylight falls and of being contactless—previous circuits have usually used relays.

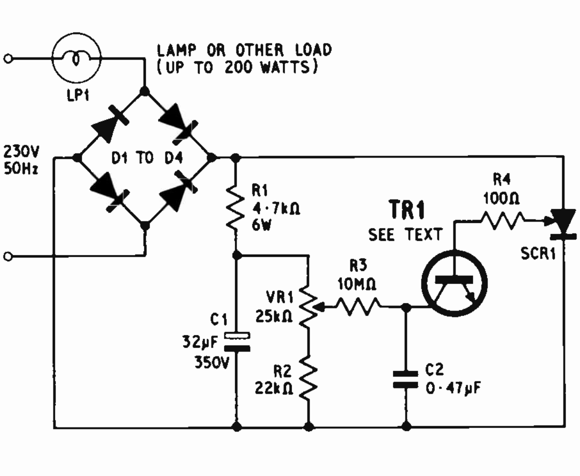


Fig. 12. Lamp flasher circuit using the burst-fire method of control

HEATING CONTROL

Similarly, the LDR could be replaced by a temperature dependent resistor, or thermistor; the temperature of aquaria, chemical solutions and so on will then be governed very efficiently. With a suitable thyristor and diodes, control of electric room heating is possible.

Remember that each kilowatt to be controlled will pass just over 4A through the thyristor and half that amount through each bridge diode; adequate surge rating is called for when switching on cold heating elements. The higher power thyristors, say 10A and upwards, may require larger gate currents than that given by the circuits here.

The circuits so far described use the "phase-shift" method of thyristor operation. The next circuit introduces a form of "burst-fire" control.

FLASHING CIRCUITS

Continuing with a.c. circuits, that of Fig. 12 will provide flashes lasting about a quarter of a second, with a repetition rate determined by the setting of the 25kΩ potentiometer VR1. With the values and thyristor shown, this can be varied from one flash every second to one every five seconds. A lower value for R3, say 4·7 megohms will quicken the rate of flashing; an increase in the value of C2, say to 1μF, will slow the rate to about one flash every nine seconds.

Flashes lasting longer than the quarter-second noted above will be obtained if C1 is increased, say to 64μF. With the potentiometer slider at the lower end a flash of about 0·6 second alternating with a space of 0·5 second gives an effective display, useful for warning lights and so on.

The use of a transistor TR1 in the gate lead of the thyristor is worthy of a mention. Connected as shown (Fig. 12), with its emitter left disconnected, very little current, certainly less than 10μA, will flow to the thyristor gate as long as the voltage across the collector-base junction is fairly small. This low level of current is insufficient to switch on the thyristor.

As C2 charges, this collector-base voltage rises until avalanche breakdown occurs, at around an applied voltage of 30 to 35 volts, when the transistor conducts suddenly and connects C2, charged to that potential, to the thyristor gate. The thyristor immediately conducts, discharging C2 for the cycle to repeat. The 100 ohm resistor R4 limits the current through the transistor.

No damage or change of important characteristic has been noted in this transistor, which may, in any case, be an inexpensive silicon *npn* such as a BSY 95A. The thyristor quoted is a BTY 79400R; an unmarked 400V 3A device worked also but various samples gave slightly varying repetition rates.

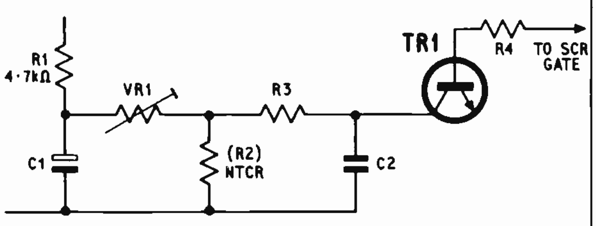


Fig. 13. Flasher circuit adapted for temperature control

TEMPERATURE CONTROL

A use for this circuit, besides the obvious one of a flashing light for display purposes and so on—without moving parts and exposed contacts of course—is the possibility of close temperature control; see Fig. 13.

Replace the 22 kilohm (R2) resistor by a suitable negative temperature coefficient resistor, placed in the environment to be controlled, say an aquarium. With the water cold, the NTC resistor will have a large resistance, and the repetition rate of the thyristor firing will be high. The thyristor load is, of course, the aquarium heater. As the water warms, the NTC resistor will decrease in value and the repetition rate will accordingly fall, so passing, averaged over some seconds, less heat to the water.

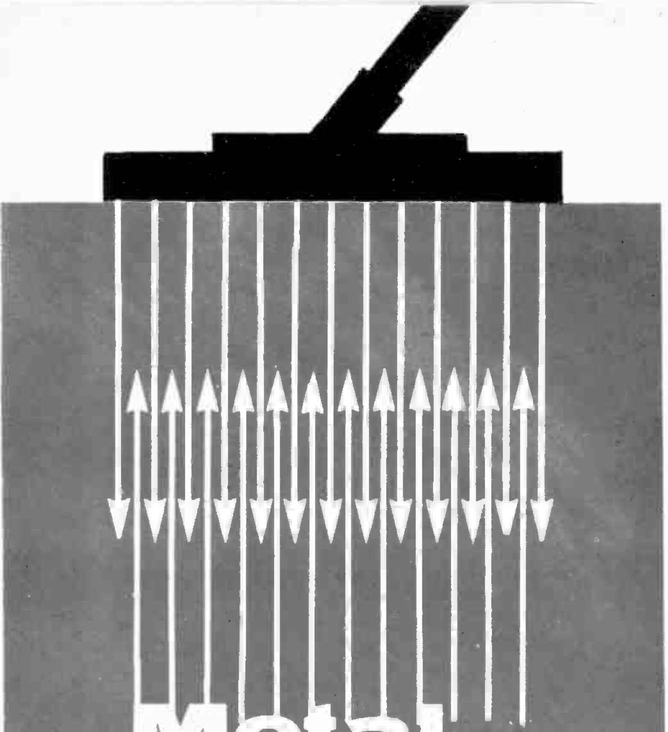
Control of water temperature is thus close and perhaps more important, rapid, since the set-up responds to NTC resistor changes immediately and continuous control is maintained. These are important improvements over an ordinary on-off thermostat, in aquaria, plating baths, photographic processing solutions and so on.

A disadvantage is that since the duty cycle of heating is no greater than say, 50 per cent, even at maximum heat output, a larger heating element is needed. In the author's opinion, it is worth while to gain the advantages mentioned; a by-pass switch could put continuous heating on if required for rapid warm up from cold.

PHASE-SHIFT v. BURST-FIRE

The phase-shift method, as described in connection with circuits for lamp dimming, can give a certain amount of r.f. interference due to the rapid turn on of the thyristor sometime during each half-cycle of mains input, that is, at a rate of 100Hz. The steps necessary

continued on page 31



Metal Detector

By F. G. RAYER

THE device described in this article can help to locate concealed metal, under paving or the earth, under floors, or behind walls. The search coil and detector are attached to a wooden handle, so can be moved about over the ground. The maximum distance to which a metal object can be located depends on the adjustment of the circuit, and also circumstances, such as the presence of other metal objects, size of the metal to be located, and to some extent on materials which may lie between the metal and search coil.

RANGE

The range at which detection could be secured was up to about 6in from a small metal item such as a coin, extending to about 1ft 6in for a metal object having an area of about ½ sq ft or larger. Long items of small width, such as small pipes or wires, can only be detected at short range. The kind of metal, and the ability of the user to note a small change in tone, also influences the maximum possible range.

Moving the search coil near a large mass of wet earth changes the tone, but a manual control allows adjustment for this. In such circumstances the search coil should be moved at a uniform distance from the ground, or regularly in contact with it.

DETECTOR CIRCUIT

Two r.f. transistors are used in a heterodyne circuit (Fig. 1) with a further transistor as an audio amplifier. L1 is the search coil, with collector and base tappings, and tuned by the fixed capacitor C4.

The second oscillator is built around a cored coil L2. The frequency is initially set by adjusting the core and trimmer VC1. The circuit can then be tuned over a narrow band by the manual control VC2.

The r.f. output from TR1 and TR2 is coupled to the detector D1 by small capacitances C2 and C7. TR3 provides audio amplification, with base bias secured by the rectified signal through D1.

The coils L1 and L2 are each tuned to about 550kHz. When L1 and L2 are operating at the same frequency, no beat note is produced or heard in the phones. The presence of metal near the large search coil L1 detunes its frequency, producing a heterodyne beat heard in the phones. The change of frequency increases as the metal object is approaching the coil, and falls as the distance between coil and object grows larger again.

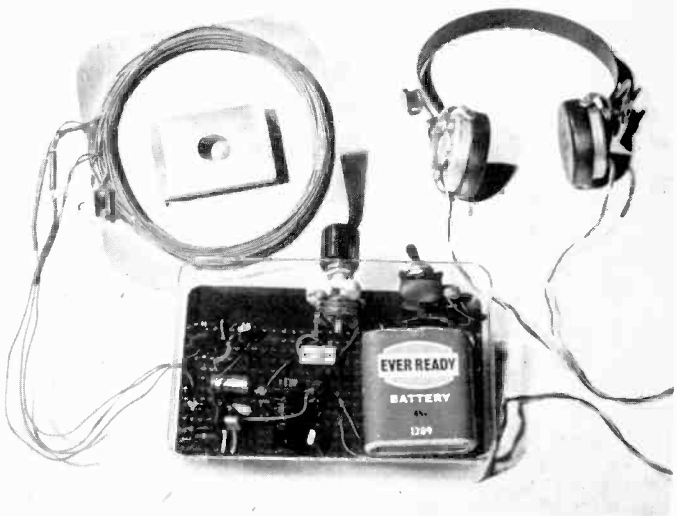
SENSITIVITY

For most sensitive results, VC2 is tuned so that a low audio tone is heard with no metal near L1. The tone then changes when metal is approached. If both tuned circuits are set to exactly the same frequency to begin with, "pulling" of one circuit by the other reduces sensitivity. This effect can be made less serious by reducing the values of C2 and C7, but volume then becomes rather low. It is thus better to work with a constant tone.

The gain of the audio amplifier has no bearing on the range of detection, but boosts detector output to a suitable level. The single audio stage was found sufficient, using 4,000 ohm headphones.

ASSEMBLY

The detector is wired on an s.r.b.p. panel which should fit in a plastics box (Fig. 2), 7in × 4½in × 1½in deep.



Top left—the search coil; top right—the headphones; bottom—the electronic detector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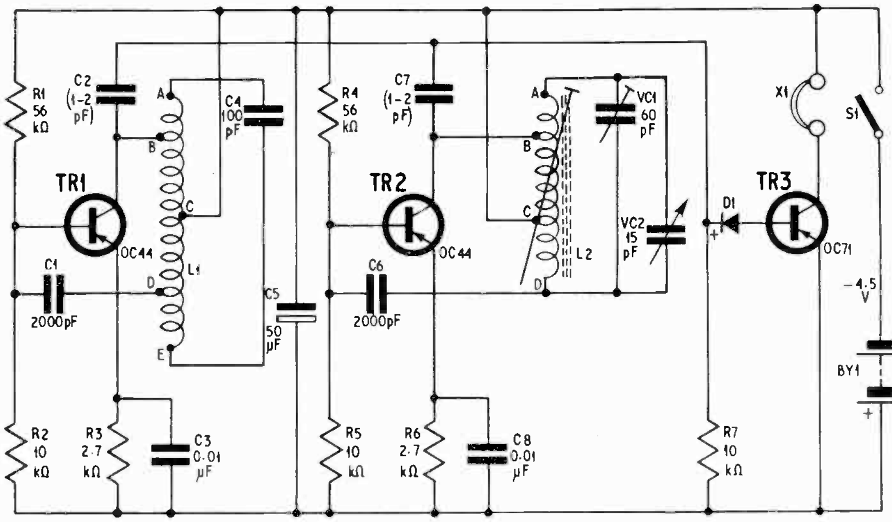


Fig. 1. The complete circuit diagram of the metal detector

COMPONENTS...

Resistors
- R1 56kΩ
- R2 10kΩ
- R3 2·7kΩ
- R4 56kΩ
- R5 10kΩ
- R6 2·7kΩ
- R7 10kΩ
- All ±10%, ¼W carbon

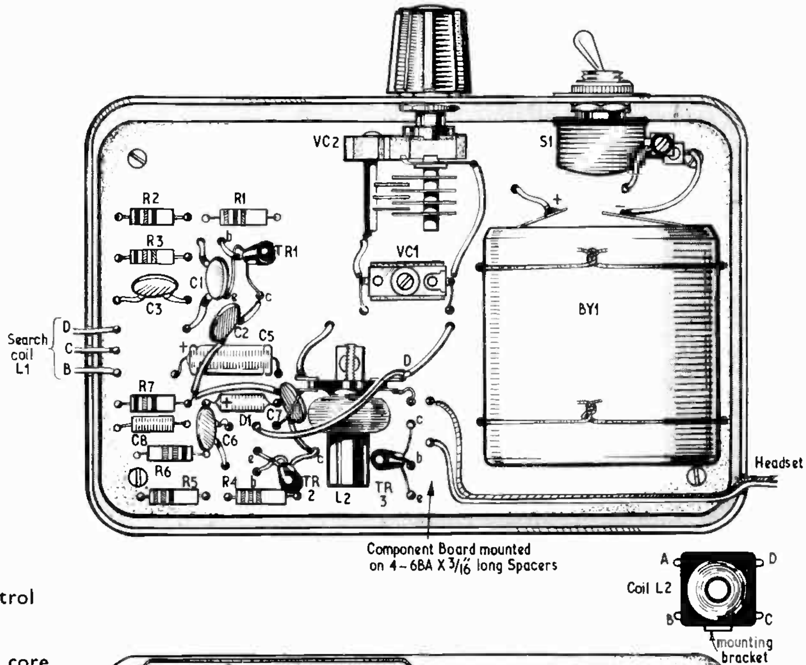
Capacitors
- C1 2,000pF
- C2 2pF ceramic
- C3 0·01µF
- C4 100pF mica
- C5 50µF elect. 12V
- C6 2,000pF
- C7 2pF ceramic
- C8 0·01µF

Variable capacitors
- VC1 60pF compression trimmer
- VC2 15pF air space variable control

Inductors
- L1 uses p.v.c. covered single core bell wire, about 20 yards (see text)
- L2 uses 32 s.w.g. enam. copper wire, about 10 yards and a ½in or 10mm coil former with dust iron core (see text)

Transistors and Diode
- TR1, 2 OC44 or NKT152 (2 off)
- TR3 OC71 or NKT251
- D1 OA79, OA81, or similar

Miscellaneous
- S1 Single-pole, on-off toggle switch
- X1 Headphones, 4,000Ω type
- BY1 Battery 4·5V type 1289
- Plastics box, perforated s.r.b.p. 6½ × 4¼
- Tinned copper wire and p.v.c. covered flexible wire
- Wood for detector sensor and handle (see text)



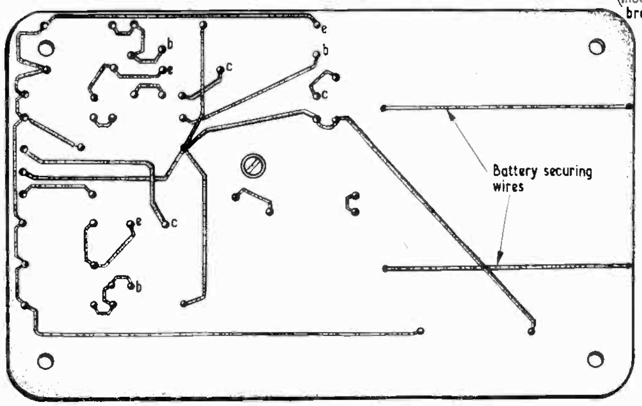


Fig. 2. The electronic unit is mounted in a plastics box. The component side and underside wiring of the board are shown above

The wire ends of the components pass through small holes, and are soldered underneath to 24 s.w.g. wire connections. Insulation is placed on leads where necessary.

The 4·5V battery is secured with cord or wire passed through holes in the component board. Leads are soldered on. Polarity must be correct.

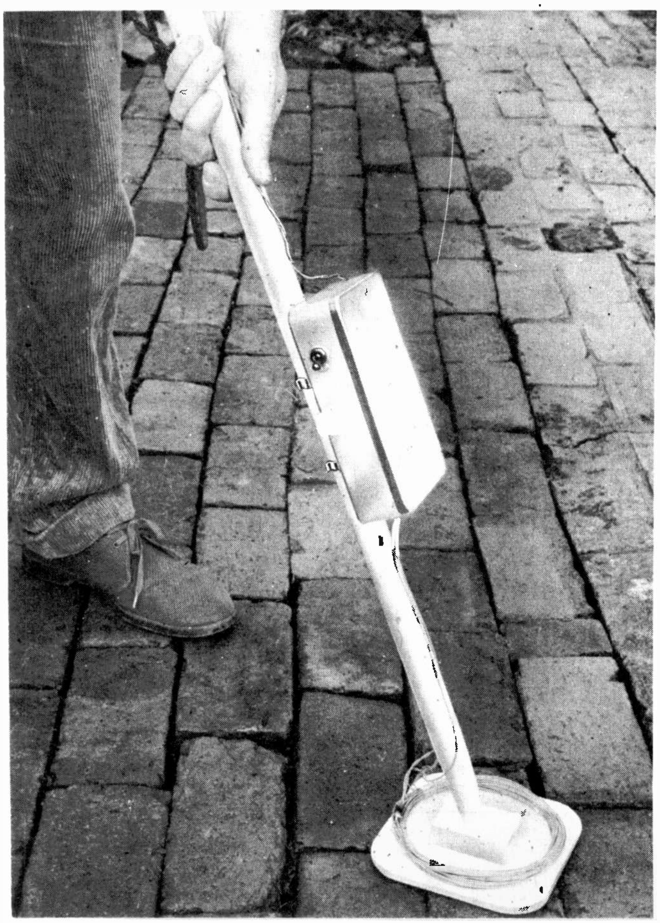
The switch and VC2 are fitted after placing the wired panel in the box. Long leads for the search coil pass through a hole in the box end and are taped to the handle down to the search coil at the bottom.

The capacitors C2 and C7 can be 2pF fixed ceramic types, or be made from thin insulated wire about 1¼in long and twisted together.

COIL WINDING

The oscillator coil L2 is wound from 32 s.w.g. enamelled wire on a ¼in or 10mm diameter former with an adjustable core. The winding begins at A, Fig. 2. This end will go to VC1 and VC2, Fig. 2, after the coil is wound and mounted. For the first section, A to B, wind on 125 turns, in a compact pile. Make a loop of the wire about 3in long at B. Continue winding in a pile in the same direction for a further 45 turns, and make another loop at C (battery negative). A further 15 turns in the same direction finishes the coil; this end (point D) goes to VC1, VC2 and C6.

Do not let the loops cause the coil windings to come loose. Turns are held with a little adhesive or wax. When firmly set the loops at A, B, C, and D are bared for about ¼in and soldered to the appropriate junctions on the component board, or via the tags on the former if fitted.



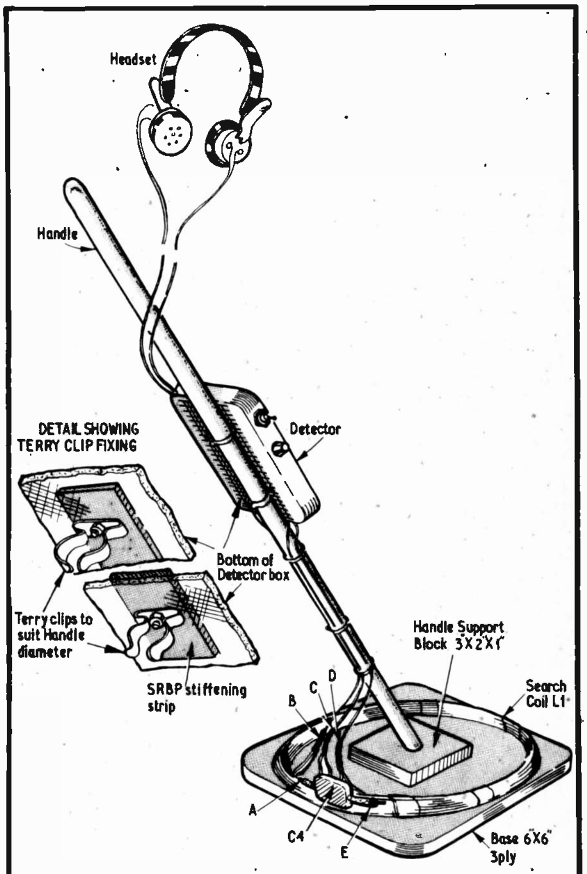


Fig. 3. Construction details of the search coil. Make sure that the Terry clip fixings do not touch the wiring

SEARCH COIL

The search coil L1 is wound with thin single core bell wire and is 5in in diameter. A temporary former of near this diameter is used to wind the coil, winding 10 turns from A to B. A loop is made at B and winding continues for another 12 turns to loop C. Wind four turns more, make loop D, then wind 15 turns more, and end at E. The ends and loops should be identified by coloured sleeving or other means. The insulation is removed for about ¼in for connection to the long leads from the box.

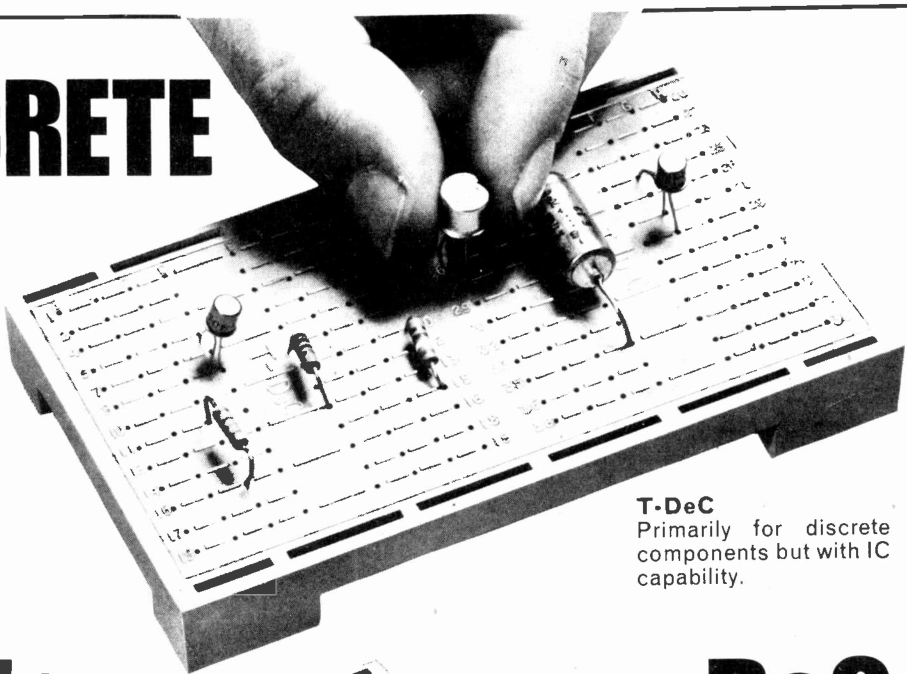
The coil is removed from its temporary former, and bound with adhesive tape. It is attached by adhesive to a piece of 3-ply wood about 6in × 6in, Fig. 3. C4 is soldered to the ends of the coil at points A and E.

ASSEMBLY OF SEARCH COIL

A block of 1in thick wood about 2in × 3in is drilled at an angle to take a thick dowel or broom handle, Fig. 3. This is glued in place, and the block is glued to the centre of the plywood plate.

The detector can be fitted to the handle about 1ft up the handle by means of two Terry clips bolted to the box. The search coil leads B, C and D (Fig. 2) are arranged to run down to the tappings, and are secured with tape or thread to the handle.

DISCRETE



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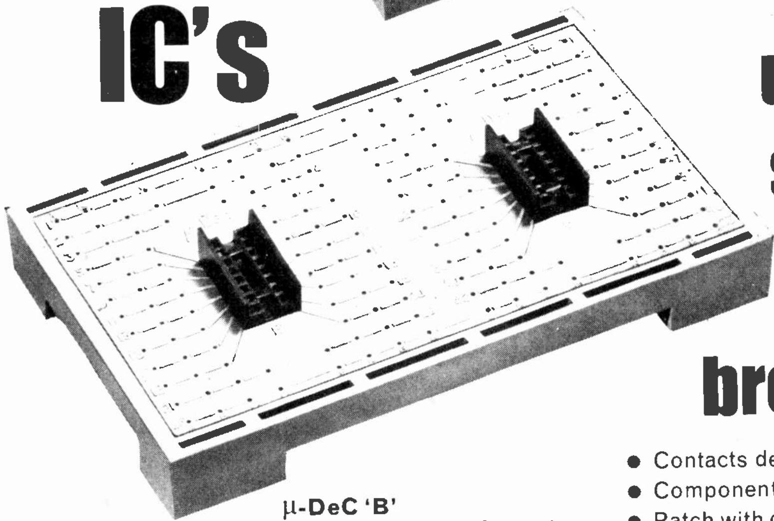

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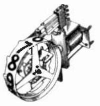

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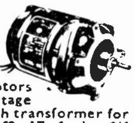

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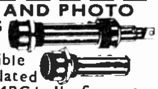

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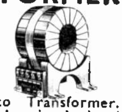

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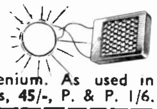

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5	17, 18, 20V at 20A	£6.12.6	6/6
6	6, 12, 20V at 20A	£6.5.0	7/6
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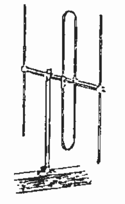

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ADJUSTMENTS FOR CORRECT OPERATION

No results can be obtained until the two tuned circuits are operating on a near frequency. Adjusting VC1, VC2 and the core of L2 throughout their full range should produce a heterodyne whistle in the phones. If so, adjust VC1 so that zero beat arises with VC2 about half closed. Rotating VC2 from this position, in either direction, should cause the tone to rise in pitch.

If no tone can be heard switch off and temporarily disconnect TR3, and use a meter to check battery current. This should change if C4 is shorted, or if VC2 is shorted. If there is no change in current when either of these tests is made, the appropriate oscillator is not working, and connections should be checked. When all is satisfactory reconnect TR3.

If both TR1 and TR2 are oscillating, but no tone is obtained, their frequencies are probably too far apart. One way of checking this is to take a 300pF variable capacitor, and temporarily connect it across L1 (A to E). If closing this capacitor enables a heterodyne to be produced, then the frequency of L1 is too high for L2 to match. This is corrected by increasing C4, or by reducing VC1, or having fewer turns on L2, or withdrawing the core, until VC1 and VC2 can be adjusted as described.

Should a heterodyne only be possible with extra capacitance across L2, then L2 is at too high a frequency. This can be overcome by reducing C4, or increasing the value of VC1, or screwing the core of L2 further in.

VC2 is best adjusted to give a low frequency tone in the headphones, and so that the frequency rises when L1 approaches the metal sought. If the tone falls, passes through zero, then begins to rise, VC2 can be retuned to the other side of zero beat when no metal is near L1.

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THYRISTORS AND THE EXPERIMENTER

continued from page 23

to reduce radiation have been noted earlier and should be followed for minimum interference on radio and television.

The burst-fire control method, however, switches power to the load at a much lower rate, say every second for ½ second at a time, and hence the thyristor is required to switch on-load current that much less often. If additional circuitry is employed—rather too complex to include in the present article—then it is possible to arrange for the load to be both switched on and off at zero mains voltage, i.e. at almost zero load current, and in that case no interference can be generated.

OBJECTIONAL FLICKER

Although the potential interference level is much less using burst-fire, there is (of course!) a disadvantage. If used for lamp control there is a very pronounced, objectional flicker, although when used for the control of heaters this factor does not apply. Since heaters are generally of higher wattage, and so take more current than lamps, higher levels of interference would be generated using phase-shift control with them—hence the recommendation to use burst-fire when possible.

There is another objection to the use of the phase-shift method for high power control.

The phase-shift method introduces some distortion into the waveform of the electricity supply. If a number of high power devices were operating simultaneously in the same electricity supply area, this distortion could assume serious proportions, and affect other equipment connected to this area. For this reason, the Electricity Council recommends the use of the burst-fire method, except for low power devices such as light dimmers.

THE TRIAC

Before concluding, mention must be made of the Triac, which is equivalent to two thyristors in back-to-back parallel. Control of a.c. is possible using a single Triac and no rectifiers, but such devices are dearer than the equivalent thyristors at present. However, they will obviously make their bow in the home construction field before long, and will lead to simplification of circuitry.

SCOPE FOR EXPERIMENT

Since such a variety of circuits have been quoted in this review (most of which have either been tested, or actually evolved, by the author) it has not been possible to give here constructional details for the building of units making use of them. Rather it is hoped that experimenters will be encouraged to try some of the circuits in the applications mentioned, and to think of many more uses besides—the "Ingenuity Unlimited" pages are open to all! Thyristors are very easy to use once their principles are understood.

It would be as well to conclude by re-stating three important points:

1. Do not exceed the rating of the device in use—remember switch on surges, etc.

2. Provide adequate r.f. interference suppression such as an earthed metal case and/or a LC filter.

3. Remember that in applications involving mains, *switch off* before touching any of the exposed circuitry.

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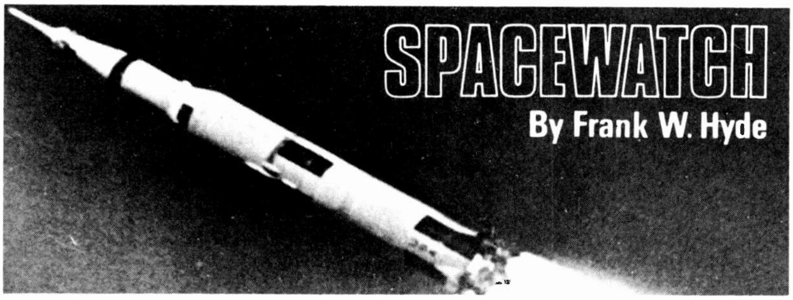

ESRO PROGRAMME

The satellite programme now finalised by the European Space Research Organisation consists of seven vehicles for the period 1969 to 1975. These are all scientific satellites. In addition to these there are several feasibility studies which will be undertaken by both the European Space Research and Technology Centre and industry through ESRO contracts.

These include a combined pure research and operational meteorological satellite for data collection and distribution. The pure research would be devoted to investigation of the lower atmosphere properties of winds and temperatures; the meteorological data would be collected and distributed in the usual way. The satellite would have a three-axis stabilisation, one pointing to the centre of the earth and another along the flight path in addition to normal. Two versions may be made, one of 225kg using *Europa I* for launch and a smaller version for *Scout* launch weighing 115kg.

The research for these projects is being undertaken by Elliot Bros. with Fokker and Dornier. The equipment will include a basic radiometer, a scanning radiometer/photometer, an ultra-violet solar monitor, and a balloon interrogation system. The solar paddles for power supply will be moveable.

ULTRA-VIOLET

The Mercury fly-past probe has already been described. An ultra-violet astronomy satellite *UVAS* may be part of the next major project. This vehicle is intended to be complementary to the NASA Orbiting Astronomical Observatories. One version is by the Culham Laboratory at Abingdon covering U-V spectroscopy and another by Fiat using U-V mapping in place of spectroscopy.

TD-I which is scheduled to be launched by a *Delta N* in 1972 weighs about 450kg. It is an astrophysics laboratory which will measure and analyse electromagnetic radion from the sun and other celestial objects. There are to be seven experiments. Four of these will scan the sky at a number of wavelengths to detect the emission of galactic and extra-galactic sources, two others will be sun pointing, and there will be a cosmic ray telescope to observe primary particles.

VACUUM TELESCOPE

At Sunspot in New Mexico a solar telescope of revolutionary design came into operation in October 1969. The telescope of the tower type was designed and built by the United States Air Force Cambridge Research Observatory at Sacremento Peak. Built at a cost of \$3·2 million it is hoped that it will enable more precise measurements of solar activity and accurate forecasts of possible harmful radiations to be made. Thus astronauts' wellbeing will be safeguarded. It will also enable an assessment to be made regarding communications and allowances made for the effect on the signals to and from spacecraft at great distances.

The tower is 39 meters in height and surrounds the tube of the telescope itself. The tube of the telescope is 98 metres in length, and the upper portion rotates to follow the sun's path. The optics are simplified by this method and are also out of reach of most of the turbulence arising from the ground.

MERCURY BEARING

The tube which weighs about 250 tons is three metres across at its widest point and floats on a mercury bearing near the top of the tower. The sun's rays enter through a quartz window 76cm across and are reflected down the tower to the mirror (which is 45 metres below ground), then up to ground level to three spectroscopes. One of these is a new universal spectroscope specially to serve this telescope.

The unique feature of this telescope is the fact that the whole system is in a vacuum. The tube is kept free of air turbulence and dust by this method. In addition the tower itself is refrigerated to minimise the possible dancing of the image of the sun.

The observatory has a special interest in the study of the chromosphere of the sun. This is the highly turbulent envelope thousands of kilometres deep from which there are eruptions of plasma and the ejections of matter and radiations which affect communications.

THE DENSITY OF PLUTO

It is only now that a more accurate estimate of the density of the most distant planet known in the solar system has been made, that the orbit of Neptune can be more accurately computed. Neptune was discovered in 1846 and has only completed about three-quarters of its orbit up till now.

The theories have all been based on an assumed value for density of Pluto. These have been based on the amount of the orbit of Neptune that has been observed. The two variables which are dependent on each other for their assessment are now again the subject of study.

Hitherto the mass of Pluto has been taken to be about 0·9 that of the earth. American astronomers at the United States Naval Observatory in Washington have suggested that it would be less complicated to assess the correct values if the mass of Pluto was adjusted to what is known now of Neptune's orbit. Accordingly they suggest that mass should be taken as 0·2 as this is the value that best fits the known facts.

The interesting thing about this suggestion is that whereas the earlier figure for the mass implies an extremely high density, the new suggestion requires a density of only 1·5 times that of the earth. This is much more plausible. Of course the whole problem will be solved in the year 2,000 when Neptune will have completed its orbit round the sun. This however may well be after probes have been in that vicinity and sent back direct information.

MORE PULSARS

Professor J. G. Davies has announced that two more pulsars have been found. As the Mark I telescope at Jodrell Bank is undergoing some modifications, it required to be pointed to the zenith without azimuth movement for about two months. The whole of this period was taken up with the study of pulsars.

In October the two mentioned were discovered by a technique developed by Professor Davies. This technique is to look for individual dispersed pulses rather than for pulses over a period. The two frequencies used are a few MHz separation at a frequency nominally 480MHz. One advantage of the method is that it is sensitive to the many pulsars that do not show continuous trains of pulses. The two new ones found were more sporadic in their pulsations than the earlier pulsars found. At the date of the October discovery the total number of pulsars catalogued was 43.

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hifi stereo amplifier

By M. J. Gay Chief Circuit Engineer (Linear), Plessey Microelectronics

LAST month we completed the description of the two main amplifiers and their construction. Now we will describe the pre-amplifier circuit used to feed the amplifiers.

PRE-AMPLIFIERS

The pre-amplifier design uses two Plessey SL702C integrated circuit operational amplifiers per channel. The first amplifier provides amplification and equalisation for the various signal sources. The second amplifier provides further amplification and tone controls. Programme sources covered are crystal or ceramic pick-up, magnetic pick-up, tape replay and radio. The circuit diagram is shown in Fig. 11.

OPERATIONAL AMPLIFIER BIASING

Operational amplifiers, having differential input stages, normally need two supply lines. In the arrangement used here the SL702C generates its own "earth" reference at half supply voltage by means of decoupled d.c. feedback from the normal earth point. Fig. 10 shows the circuit diagram of the SL702C plus biasing arrangements. The amplifiers are operated on a 12V supply.

EQUALISATION SECTION

For radio, tape and magnetic pick-up inputs the amplifier is used with series feedback but for crystal or ceramic pick-up inputs it is used with capacitive shunt feedback. The feedback network is selected by switch S1c and the appropriate input to the integrated circuit by switches S1a and S1b. The "tape" feedback network consists of R11 and C11. Resistor R11 must be chosen to suit the playback speeds as in Table 2. Magnetic pick-up compensation is obtained from the network R10, C9 and C10; C11 provides shunt feedback for use with ceramic pick-ups. For radio inputs the amplifier gain is reduced to just over unity.

Table 2. TAPE EQUALISATION

Speed (inches per second)	**R11**
3·75	22kΩ
7·5	10kΩ
15	6·8kΩ

The use of capacitive shunt feedback when the amplifier is fed from a ceramic pick-up obviates the requirement for a very high input impedance. The pick-up capacitance and the feedback capacitor act as a see-saw about the amplifier's virtual earth input giving a constant gain down to very low frequencies. Furthermore the amplifier can readily handle the possibly very high outputs from ceramic or crystal pick-ups, when connected in this manner. With a 6·8nF feedback capacitor (C11) the amplifier output will be typically seven times lower than the pick-up output. This brings the output near that obtained with other programme sources and ensures that good overload capability is maintained.

RUMBLE FILTER

A simple rumble filter is incorporated in the equalisation circuit by the inclusion of the network R7, R8, R9 and C7 across the feedback components. At low frequencies as C7 impedance rises, the transfer impedance of this network falls causing the amplifier gain to fall (R8 damps the bridged T network resonance between R7, R9, C7 and C11 or C9 plus C10). With radio inputs, when the amplifier gain is set to a much lower level, the rumble filter is inoperative.

With radio, tape and magnetic pick-up inputs the input impedance of the amplifier is set at 47 kilohms by R3. A small (47pF) capacitor (C3) is added to reduce the possibility of h.f. oscillation due to stray capacitance feedback into this impedance when the input is open circuit.

The operational amplifier is stabilised by capacitors C4 and C5 connected to its two compensation points.

TONE CONTROL SECTION

The main amplifier requires a low impedance drive to avoid upsetting the active filter characteristics. Therefore it is not possible to place an attenuator type tone control after the pre-amplifier. Noise considerations make it equally undesirable to place one after the equalisation stage. The tone controls are therefore incorporated into a feedback network around the second operational amplifier. The "Baxandall" arrangement is used since this has the considerable advantage of using linear potentiometers (other

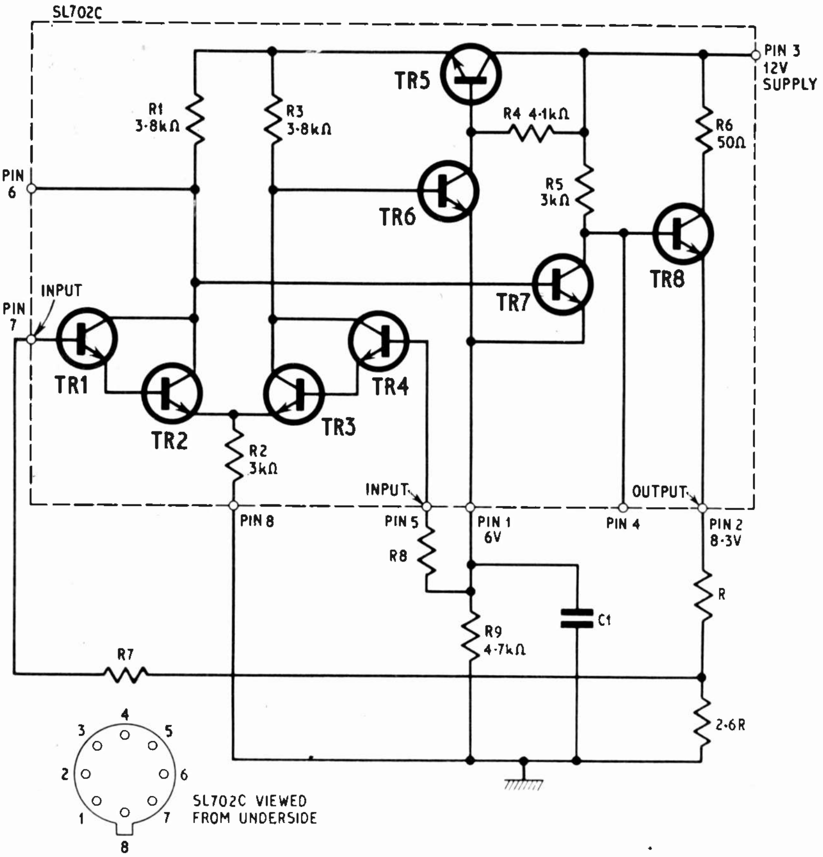


Fig. 10. Biasing arrangements for the SL702C integrated circuit—voltages are nominal values

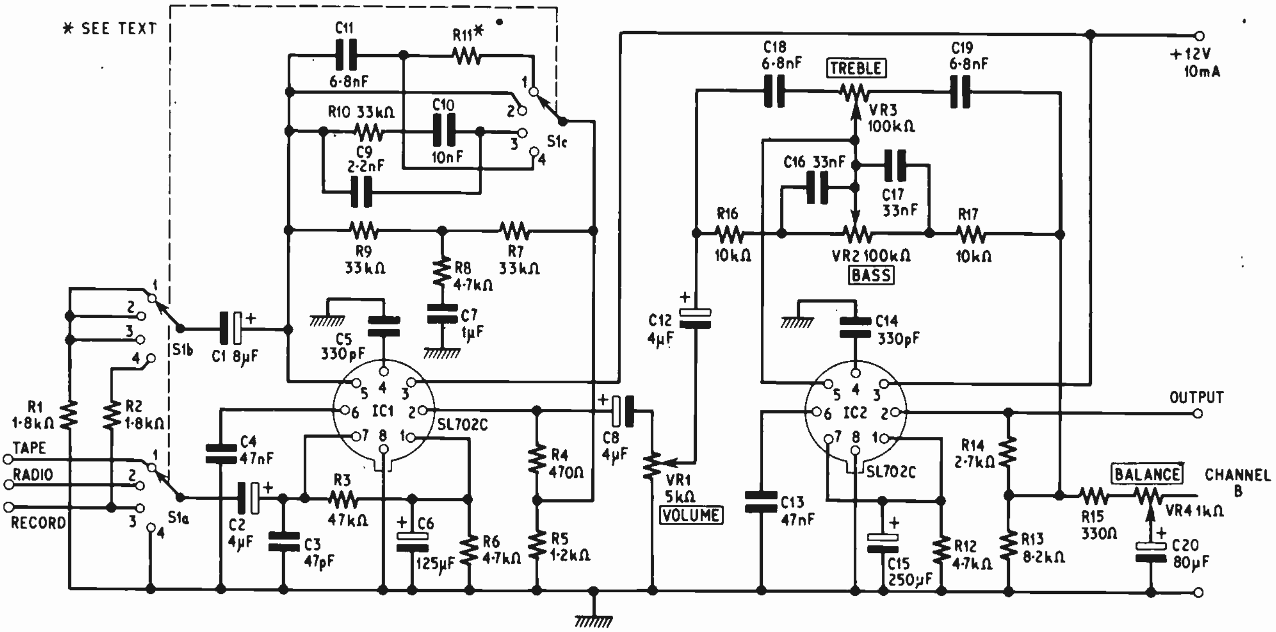


Fig. 11. Circuit diagram and one channel of the pre-amplifier section of the hi fi stereo amplifier. S1 positions are: 1 Tape, 2 Radio, 3 Magnetic pick-up, 4 Ceramic pick-up

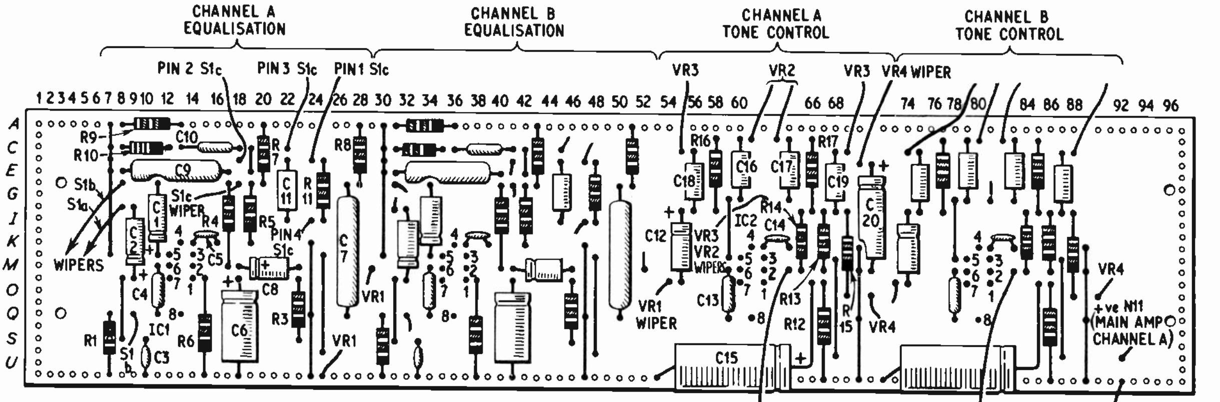
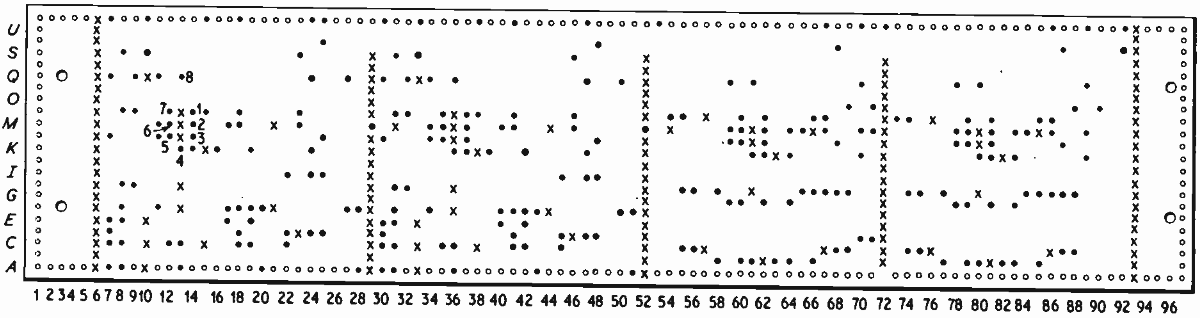


Fig. 12. Veroboard layout and wiring of both pre-amplifiers. Component numbers and wiring connections have been shown for channel "A" only; channel "B" is wired up in the same way. IC1 and 2 connections are indicated by numbers 1 to 8 on the board



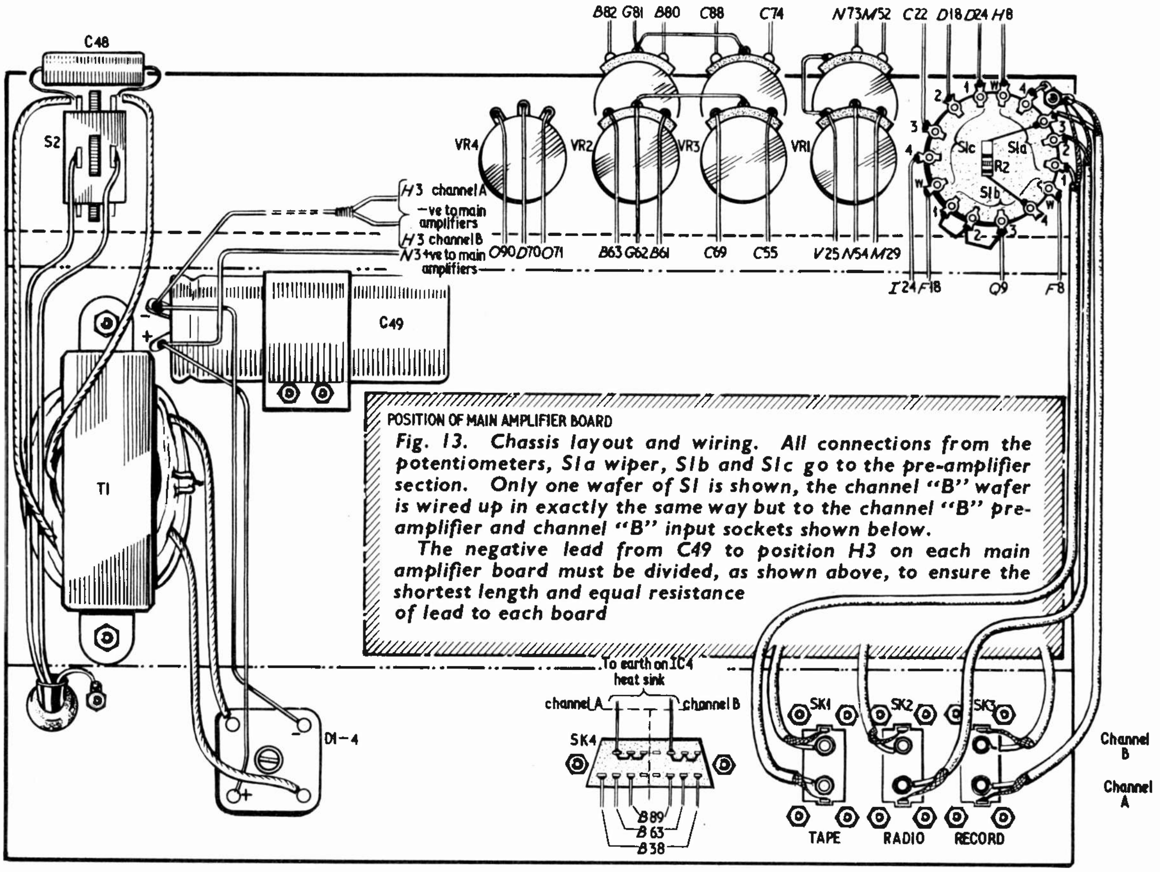


Fig. 13. Chassis layout and wiring. All connections from the potentiometers, S1a wiper, S1b and S1c go to the pre-amplifier section. Only one wafer of S1 is shown, the channel "B" wafer is wired up in exactly the same way but to the channel "B" pre-amplifier and channel "B" input sockets shown below.

The negative lead from C49 to position H3 on each main amplifier board must be divided, as shown above, to ensure the shortest length and equal resistance of lead to each board arrangements require antilogarithmic potentiometers). The standard Baxandall see-saw gives a mid-band gain of unity which is too low for our requirements. An attenuator is therefore placed between the amplifier output and the feedback network to increase the overall mid-band gain to approximately five times.

The attenuation is varied by means of the potentiometer VR4 (Fig. 11) which provides the balance adjustment, and is connected between the two channels. This control gives a gain adjustment range of -3dB to $+6$dB for each channel and thus compensates for balance errors up to 9dB. The operational amplifier is stabilised by capacitors C13 and C14.

PRE-AMPLIFIER CONSTRUCTION

The two pre-amplifiers were built on a 0·1in. matrix Veroboard shown in Fig. 12. Because the potentiometers used had bushes too short to enable the controls to be affixed to the Veroboard and a chassis, they were attached by floating leads. The constructional points made previously in this article should also be considered when building the pre-amplifier section.

The crosses shown on the underside of the Veroboard represent breaks in the copper strip and should be made before affixing the components; this also applies to Fig. 5 last month.

MECHANICAL CONSTRUCTION

The main amplifier boards and pre-amplifier board have been bracketed together as shown in Fig. 14. The assembly is mounted in a simple chassis which carries the controls and power supply components (Fig. 13). To allow adjustment of the speaker sensitivity balancing potentiometers, access holes are drilled in the chassis, Fig. 15.

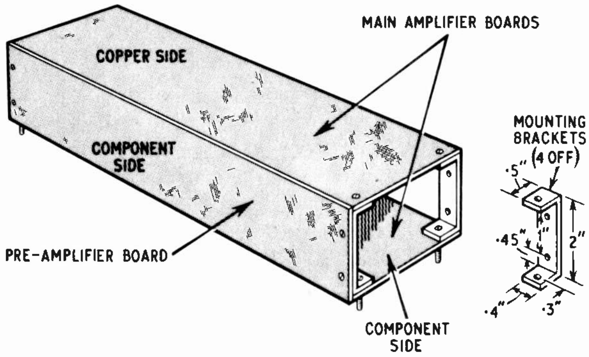


Fig. 14. Circuit board assembly details

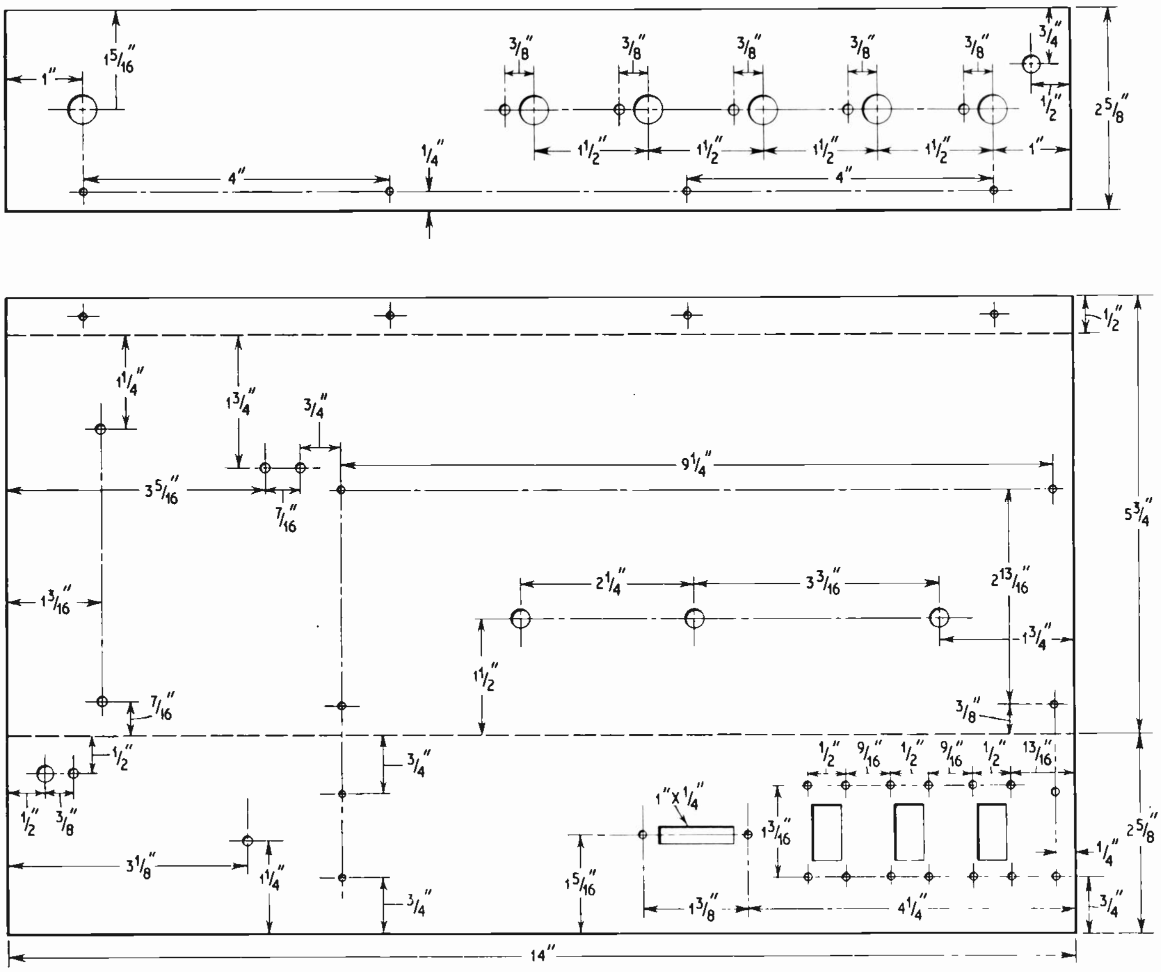
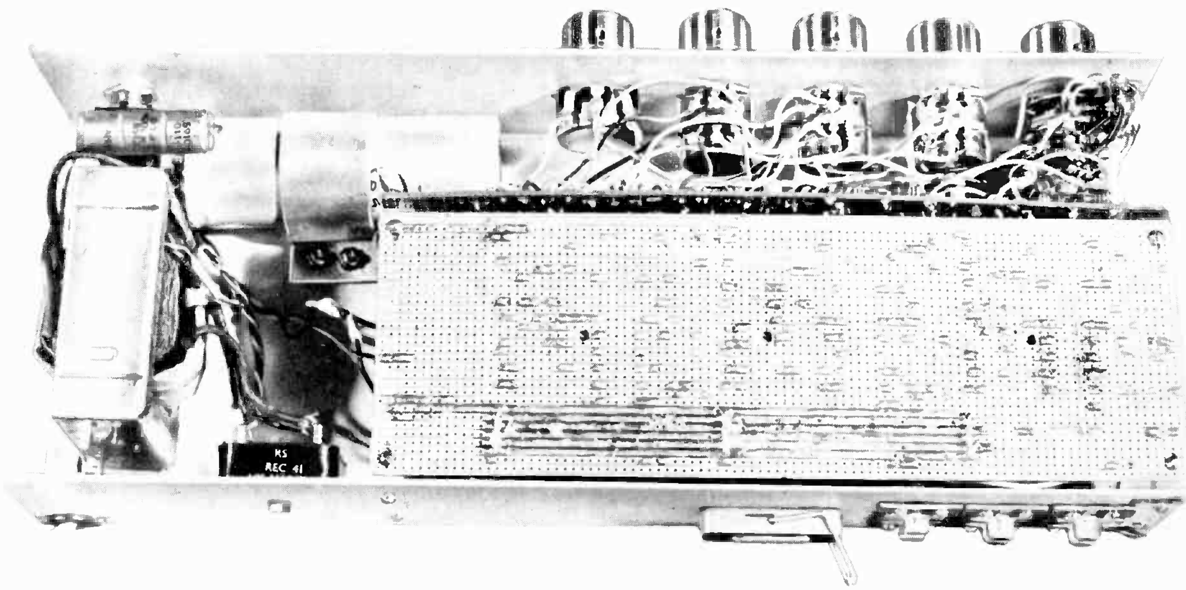


Fig. 15. Chassis details for the hi fi stereo amplifier. The front panel has been made removeable to enable wiring to the controls



Underside view of the completed amplifier ready for use

PRE-AMPLIFIER PERFORMANCE

The response curves for the equalisation section are shown in Fig. 16. Fig. 17 shows the tone control characteristics. The sensitivities at the different settings are given in Table 3 (these are inputs required for 300mV r.m.s. output with volume control at maximum.)

Table 3. INPUT SENSITIVITIES

Input	Radio	Ceramic p.u.	Magnetic p.u.	Tape (3·75in per sec)
Sensitivity	35mV r.m.s.	400mV r.m.s.	2·5mV r.m.s. at 1kHz	2·5mV r.m.s. at 1kHz

The amplifier input impedance allows operation from tape heads of up to one Henry inductance. Typically half track heads of 100mH generate around 2·5mV at 1kHz. If lower output heads are used then higher gain will be required. Referring to Fig. 11 this may be obtained by reducing R15 and VR4 (halving their value doubles the gain). To maintain the l.f. response C15 and C20 must be proportionately increased. The other sensitivities are more than adequate; that quoted for ceramic p.u. is for units of 800pF capacitance. The overload margin of the equalisation section is 30dB at all settings.

DISTORTION

Distortion was measured for the equalisation section at 60mV r.m.s. output (corresponding to full drive into the main amplifier) and at 600mV r.m.s. output, and for the tone control section at 300mV r.m.s. output (full drive into the main amplifier). Since the SL702C is an essentially linear amplifier and we have up to 40dB negative feedback around it, we expect very low distortion; this is the case. The equalisation section generates less than 0·01 per cent distortion (even at

COMPONENTS. . .

PRE-AMPLIFIER and CHASSIS

All components except the potentiometers, C20, S1 and Veroboard must be duplicated for channel B

Resistors

R1	1·8kΩ carbon
R2	1·8kΩ carbon
R3	47kΩ film
R4	470Ω film
R5	1·2kΩ film
R6	4·7kΩ carbon
R7	33kΩ film
R8	4·7kΩ carbon
R9	33kΩ film
R10	33kΩ carbon
R11	see text, film
R12	4·7kΩ carbon
R13	8·2kΩ film
R14	2·7kΩ film
R15	330Ω carbon
R16	10kΩ film
R17	10kΩ film

All ±10%, $\frac{1}{8}$ or $\frac{1}{4}$ watt.

Capacitors

C1	8μF elect. 16V
C2	4μF elect. 16V
C3	47pF silver mica
C4	47nF polyester
C5	330pF ceramic
C6	125μF elect. 16V
C7	1μF polyester
C8	4μF elect. 16V
C9	2·2nF polystyrene
C10	10nF polyester
C11	6·8nF polyester
C12	4μF elect. 16V
C13	47nF polyester
C14	330pF ceramic
C15	250μF elect. 16V
C16	33nF polyester
C17	33nF polyester
C18	6·8nF polyester
C19	6·8nF polyester
C20	80μF elect. 16V

Potentiometers

VR1	5kΩ tandem log
VR2	100kΩ tandem lin
VR3	100kΩ tandem lin
VR4	1kΩ lin

Integrated circuits

IC1 and IC2 SL702C Plessey (2 off) (available from S.D.S. Ltd., Hillsea Industrial Estate, Portsmouth)

Miscellaneous

S1 6-pole 4-way wafer switch
Veroboard 0·1 inch matrix 9·8in × 2·3in
SK1, 2 and 3 double phono sockets (3 off)
16 s.w.g. aluminium $14\frac{1}{2}$in × 12in

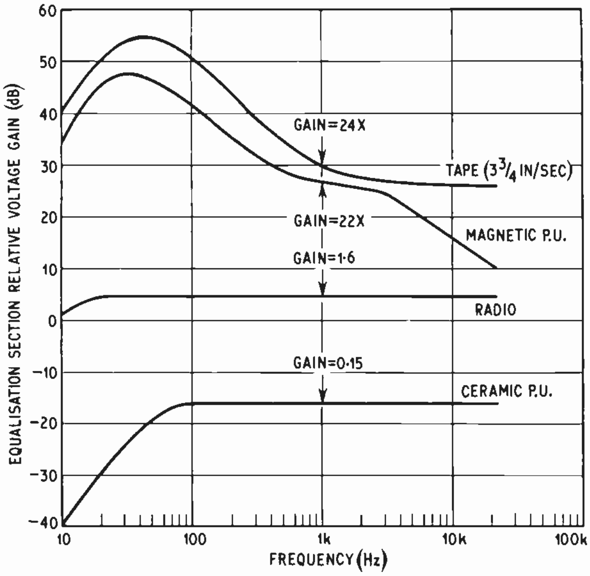
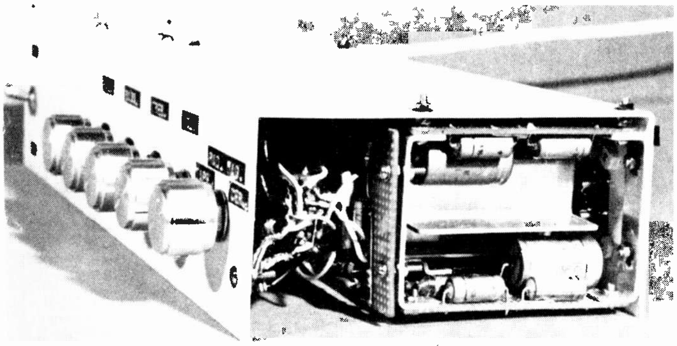


Fig. 16. Input equalisation characteristics of the pre-amplifier. These correspond to RIAA (BS 1928) characteristics



This shows the method of assembling the three component boards inside the chassis. The upper main amplifier board is separated from the chassis by four small spacers

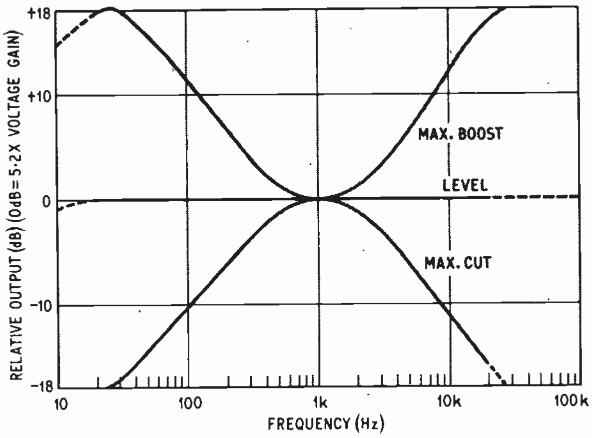


Fig. 17. Tone control characteristics

600mV r.m.s. output) except at very low frequencies in the "magnetic pick-up" and "tape" positions where the feedback is much reduced. At 40Hz for these settings, distortion reaches 0·1 per cent at 600mV r.m.s. output. With tone controls level the tone control section generates less than 0·02 per cent distortion at 300mV r.m.s. output.

NOISE

Noise measurement presents some problems as the noise spectrum is of course shaped according to the equalisation characteristics. For this reason a perceived signal to noise ratio was determined in this case. This is obtained by measuring the noise over the audio frequency band, then weighting the results according to the ear's sensitivity, before integrating to obtain the total effective noise power. Noise was measured with a 10 kilohm source for "radio", an 800pF source for "ceramic p.u." and a 110mH source for "magnetic p.u." and "tape"; these corresponding to real conditions. The results are shown in Table 4.

Table 4. NOISE LEVELS

Input	Radio	Ceramic p.u.	Magnetic p.u.	Tape
Perceived Noise	—83dB	—85dB	—64dB	—62dB
Reference Input	35mV	400mV	2·5mV	2·5mV

The noise levels shown in Table 4 are relative to the reference levels given which are the minimum required for 300mV r.m.s. output (full drive to main amplifier). In most cases, the source output will be substantially larger than these levels, particularly in the case of magnetic pick-ups which typically give 20mV r.m.s. peak music output (the high sensitivity is a by-product of the compensation required). In practice perceived noise levels will be around −90dB for radio and ceramic p.u. inputs, around −80dB for magnetic p.u. input and around −60dB for tape input.

SETTING UP

Caution: the wipers of the speaker sensitivity balancing potentiometers connect to the SL403 main amplifier input and must not be shorted to earth; use only a non-metallic tool for adjustment.

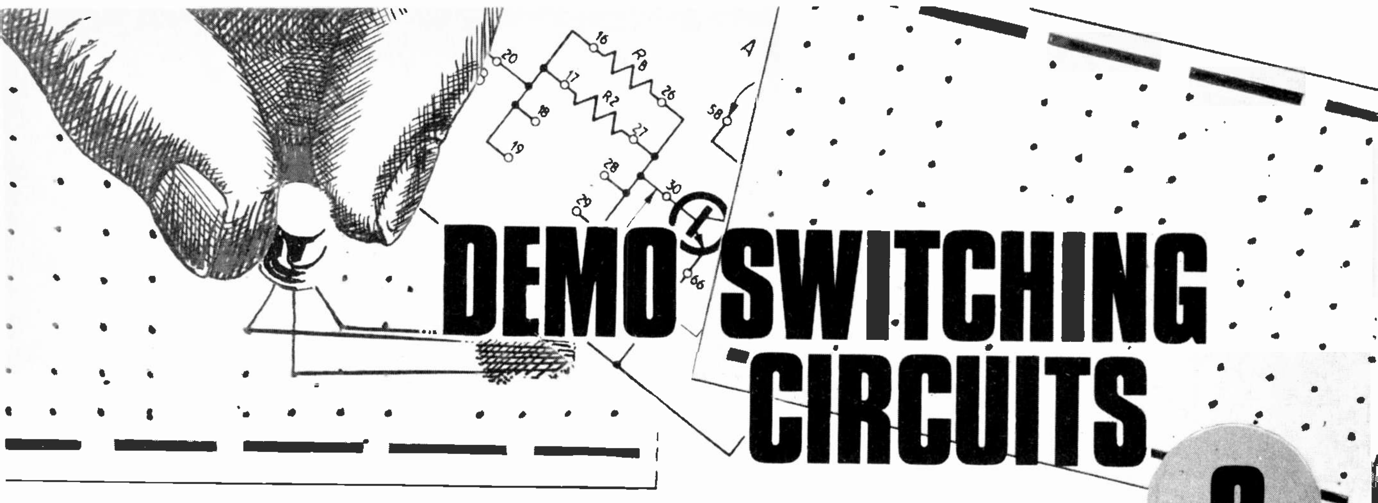
To gain access for adjustment of the bias correction potentiometers, the lower main amplifier board is freed from the assembly; this is a once only adjustment. Again take care not to short the potentiometer wipers to earth.

Listening tests are very satisfactory; the performance of the equipment was found to be significantly better than the author's valve based high fidelity amplifier (a 0·1 per cent distortion 10W system) which it now replaces. ★

Note: In the first part of this article the value of R21 was incorrectly given as 22kΩ, this should have been 12kΩ. Socket SK4 is not duplicated and R1, in Table 1, for the middle channel (250Hz crossover) should be 39kΩ.

Also the equation referring to Fig. 1b should have read:

$$\frac{V_o}{V_i} = \frac{-C_1}{C_3}\left[\frac{1}{1 + \frac{1}{j\omega}\left(\frac{C_1 + C_2 + C_3}{C_1 C_3 R_2}\right) - \frac{1}{\omega^2}\left(\frac{1}{C_2 C_3 R_1 R_2}\right)}\right]$$



DEMO SWITCHING CIRCUITS 2

SCHMITT TRIGGER By B. Pounder

THE Schmitt trigger is an important circuit that appears frequently in electronic switching systems. The basic circuit (Fig. 2.1) consists of a two-stage directly coupled "amplifier" with positive feedback across the common emitter resistor R3.

To see how it works, consider first that the base of TR1 is connected to the common negative line so that TR1 is non-conducting. TR2 conducts, its base current being supplied by means of the potential divider network R1, R2, and R4. The voltage dropped across R3 by the emitter current of TR2 causes the emitter of TR1 to be positive with respect to the common line. The base-emitter junction of TR1 is therefore reverse biased, so TR1 is held off.

Now if the base voltage of TR1 is gradually raised from its initial value of zero, a stage will be reached at which its value is just greater than the emitter voltage. TR1 will then begin to conduct, and as it does so, the increasing voltage drop across R1 will cause the collector voltage of TR1 to fall. The collector of TR1 is connected to the base of TR2 via a voltage divider network, therefore the base voltage on TR2 will drop and TR2 will conduct less heavily.

When the collector current of TR2 begins to fall, the voltage on the emitter falls (emitter follower action) increasing the potential difference between the base and emitter of TR1. Therefore, TR1 conducts while TR2 current is reduced to cut-off.

REGENERATIVE ACTION

The circuit can be made regenerative; that is, it will react to an initial change (the increase in V_{b1} beyond the threshold value in this case) in such a way as to increase continuously the effects of that change. The process stops when no further change is possible; in this circuit, when TR1 is hard on and TR2 is off.

The reverse situation is also true. If V_{b1} is lowered from a value in excess of the threshold, a second threshold will be reached at which the circuit will revert to its initial condition. These two switching processes are exceedingly fast.

The property of the Schmitt trigger to react very rapidly to values of V_{b1} equal to two threshold values suggests two obvious applications:

(a) as a threshold sensitive switch or "level detector";

(b) as a shaping circuit to "square-off" an input voltage waveform of arbitrary shape.

These two applications are evident from an examination of typical input and output waveforms (Fig. 2.2.)

DESIGN CALCULATIONS

The Schmitt circuit design procedure is by no means as simple as it may appear at first sight and a full algebraic derivation of formulae from which design can be carried out is quite complex. However, it is possible to make some simplifying approximations from which useful results can be obtained.

Let us use the formulae to design a circuit which will provide a 6V swing across R5 on switching and a current of 10mA in TR2 when it is conducting. Let V_1 = 4 volts and V_2 = 3 volts (Fig. 2.2). (step 1)

$$R_5 = 6 \times \frac{1{,}000}{10} = 600 \text{ ohms} \qquad \text{(step 2)}$$

(A preferred value resistor of 560 ohms can be used.)

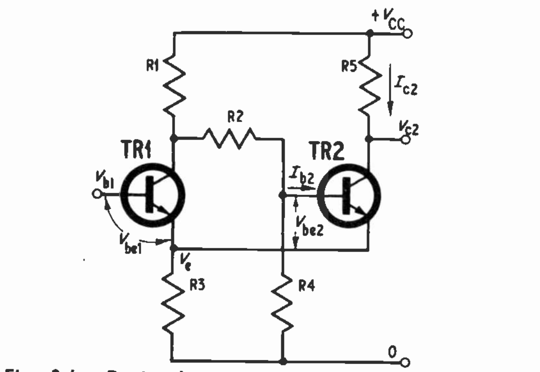


Fig. 2.1. Basic theoretical circuit of the Schmitt trigger

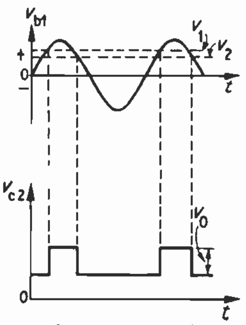


Fig. 2.2 Input and output waveforms for the Schmitt trigger showing the trigger voltages V_1 and V_2

DESIGN STEPS

1. Decide upon values of the upper and lower thresholds V_1 and V_2 respectively, the output voltage swing V_O and the collector current I_{c2} of TR2.
2. Calculate $R_5 = V_O/I_{c2}$
3. Choose a value for V_{CC}. (This must be greater than V_O.)
4. Calculate $R_1 + R_2 + R_4 = h_{FE}V_{CC}/10 \times I_{c2}$.
5. Calculate $R_4 = h_{FE}V_1/10 \times I_{c2}$. ($V_1$ is higher threshold.)
6. Calculate $R_3 = (V_1 - V_{be2})/I_{c2}$.
7. Calculate $I_{c1} = (V_2 - V_{be1})/R_3$. ($V_2$ is lower threshold.)
8. Calculate $R_1 = V_{CC}\left(1 - \frac{V_2}{V_1}\right)\Big/ I_{c1}$.
9. Calculate $R_2 = (R_1 + R_2 + R_4) - (R_1 + R_4)$.
10. Check that $h_{FE}R_3 > R_4(R_1 + R_2)/(R_1 + R_2 + R_4)$.

Let $V_{CC} = 9V$ (step 3); this will be sufficient to supply an output voltage (V_O) of 6 volts and allow for a voltage drop across R3 which will be calculated later.

$$R_1 + R_2 + R_4 = h_{FE}V_{CC}/10 \times I_{c2}$$
$$= 20 \times 9/10 \times \frac{10}{1{,}000}$$
$$= 1{,}800 \text{ ohms} \qquad \text{(step 4)}$$

assuming a worst case value for h_{FE} of 20.

$$R_4 = h_{FE}V_1/10 \times I_{c2}$$
$$= 20 \times 4/10 \times \frac{10}{1{,}000}$$
$$= 800 \text{ ohms} \qquad \text{(step 5)}$$

(A preferred value resistor of 820 ohms can be used.)

$$R_3 = (V_1 - V_{be2})/I_{c2}$$
$$= (4 - 0{\cdot}6)\Big/\frac{10}{1{,}000}$$
$$= 340 \text{ ohms} \qquad \text{(step 6)}$$

(A preferred value resistor of 330 ohms can be used.)

The value of $V_{be2} = 0{\cdot}6$ is based on the use of a silicon transistor for TR2.

$$I_{c1} = (V_2 - V_{be1})/R_3$$
$$= (3 - 0{\cdot}8)/330$$
$$= 6{\cdot}67\text{mA} \qquad \text{(step 7)}$$

$$R_1 = V_{CC}\left(1 - \frac{V_2}{V_1}\right)\Big/ I_{c1}$$
$$= 9(1 - \tfrac{3}{4})\Big/\frac{6{\cdot}67}{1{,}000}$$
$$= 337{\cdot}5 \text{ ohms} \qquad \text{(step 8)}$$

(A preferred value resistor of 330 ohms can be used.)

$$R_2 = (R_1 + R_2 + R_4) - (R_1 + R_4)$$
$$= 1{,}800 - (340 + 800)$$
$$= 660 \text{ ohms} \qquad \text{(step 9)}$$

(A preferred value resistor of 680 ohms can be used.)

The condition of step 10 (i.e. $h_{FE}R_3$) is fulfilled.

ASSEMBLY AND OBSERVATIONS

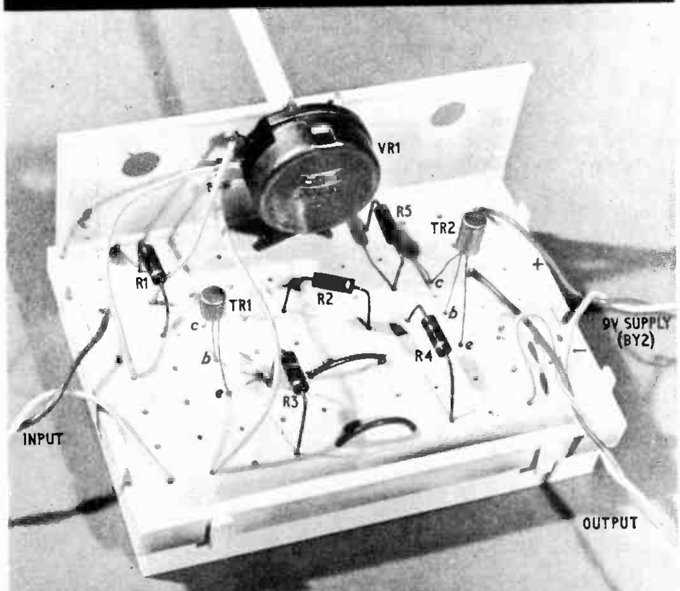
The circuit can be assembled on S-Dec using the connections shown in Fig. 2.3; the switching operation can be observed with the aid of voltmeters. Note that unless the voltmeters have high resistances, their presence will affect the d.c. conditions of the circuit.

Several transistor types can be used; those suggested are the silicon *npn* 2N706 or ZTX300. The numbering in Fig. 2.3 applies for *npn* transistors with a lead sequence e-b-c. Devices such as the TIS50 or 2N2926 which have a b-c-e sequence may need a slightly different layout if the wires are not to be bent across each other.

Dynamic operation of the circuit can be observed if a signal generator is used to provide the input signal, while the output voltage waveform is observed on an oscilloscope. A 6V mains transformer could be used to provide the input if required.

When applying a sinusoidal input, it is easy to cause reverse bias breakdown of the base-emitter junction of a silicon transistor. Just a few volts will often suffice.

Schmitt Trigger



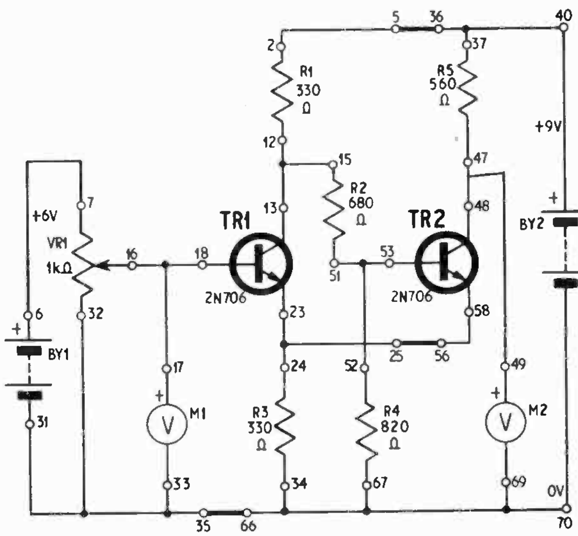


Fig. 2.3. Schmitt trigger circuit with S-Dec hole numbers for npn transistors and other components

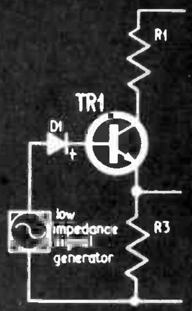


Fig. 2.4. Diode protection against base-emitter breakdown

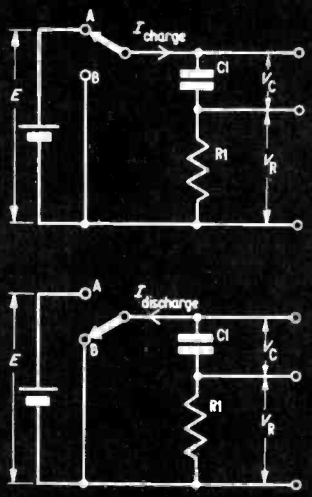


Fig. 2.5. Simple CR circuit with d.c. drive and switching for square wave. The waveforms are shown in Fig. 2.6

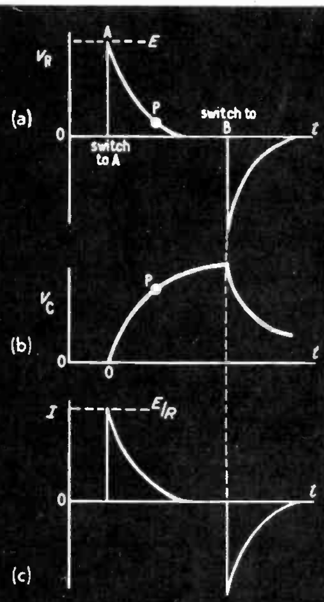


Fig. 2.6. Charging voltage across the resistor and capacitor is divided as shown above in (a) and (b). The current waveform is proportional to the voltage waveform in the resistor and is shown in (c)

To safeguard against this breakdown, a safety diode should be connected in the input lead as shown in Fig. 2.4. Any small diode will be suitable.

The effect of the difference between the thresholds V_1 and V_2 is easy to observe if the output is connected to an oscilloscope.

CR CIRCUIT TRANSIENTS

Series CR circuits are frequently used to perform timing functions in switching circuits and are also to be found in the couplings between individual switching circuits. It is important to understand how they react to rectangular voltage waveforms.

A simple circuit for obtaining a close approximation to a rectangular voltage waveform is shown in Fig. 2.5. If the switch can be made to operate alternately between positions A and B, the voltage applied to the series combination of C1 and R1 has alternate values of E and zero volts.

When the switch is at A, C1 and R1 share the total voltage E supplied from the battery. Thus $E = V_C + V_R$. The battery charges capacitor C1 through resistor R1. As the capacitor becomes fully charged, the charging voltage reduces to near zero.

The initial value of the charging current is approximately E/R_1 from Ohm's Law, but reduces as the voltage charge on the capacitor opposes the applied voltage.

Now the voltage across R1 (V_R) is always equal to $I \times R_1$ from Ohm's Law. Hence V_R has an initial value equal to E and a final value of zero some time after switching to A. It is easily shown that the relation between V_R and time t is

$$V_R = E.e^{-t/CR}$$

This is illustrated by the section of the curve marked AP in Fig. 2.6.

Now because V_R and V_C must always add up to E, the capacitor voltage V_C must be as shown. Its equation is

$$V_C = E - V_R = E(1 - e^{-t/CR})$$

If the switch connection is made to B when C1 has become fully charged, C1 will discharge through R1, the current now flowing in the reverse direction.

As more and more energy is dissipated in R1, the current (and therefore V_R) falls. V_R and V_C are now as shown on the sections of the curves beyond the point P, and are given mathematically by

$$V_R = -Ee^{-t/CR}$$
$$V_C = +Ee^{-t/CR}$$

The quantity CR, which appears in these formulae, is called the time constant of the circuit. Its significance is found by considering what happens after a time equal to CR has elapsed after switching to either A or B. Substitution of $t = CR$ in the above formulae shows that 66 per cent of the total possible voltage changes occur during this time. Thus on first switching to A, the capacitor can be considered to be almost completely charged after a time interval equal to the time constant.

Note that if CR is required in seconds, R must be in ohms and C in farads. Alternatively, R can be in megohms if C is in microfarads; for example,

if $C = 1\mu F$, $R = 1 M\Omega$, $CR = 1$ sec.

if $C = 0{\cdot}001\mu F$, $R = 10 k\Omega$, $CR = 10\mu$sec.

EXPERIMENTS

1. To demonstrate the above results using simple equipment it is easier to use a circuit with a long time constant. The resistance R will therefore be large, so it will be difficult to observe V_R using a moving coil voltmeter, the relatively low resistance of which will shunt R. The value of C will also be large.

If the voltmeter is connected across the capacitor to measure V_C, the meter resistance and R together form a voltage divider across E so the circuit is altered sig-

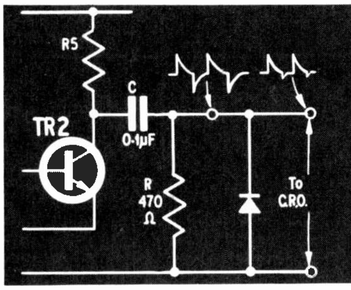


Fig. 2.7. The CR network applied to the output of the Schmitt trigger changes the square wave to a pulse waveform across the resistor. The diode will effectively reduce the negative-going spikes

nificantly. However, if a high resistance (say 20,000Ω per volt) voltmeter is available, it will be possible to demonstrate the voltages V_C and V_R if C is equal to 100µF, and R is equal to about 10 kilohms.

Note that the damping factor of the meter movement will mask a large part of the instantaneous changes indicated on Fig. 2.6. The meter should also be able to measure current to demonstrate the current–time relationship, if it is connected in series with the C and R. The circuit shown in Fig. 2.5 is easily assembled on an S-Dec "breadboard", a jumper lead being used in place of the switch.

2. The Schmitt circuit can be used as a source of a rectangular voltage waveform which can be applied to the CR circuit; the voltages V_C and V_R can be observed on an oscilloscope. A sine wave signal generator is required for the input to the Schmitt.

Apply a 1kHz signal to the Schmitt, of sufficient amplitude to cause the circuit to trigger, and observe the output voltage waveform on an oscilloscope. Now note the effect of connecting the CR circuit across the output as shown in Fig. 2.7. The time constant of this network is short, about 0·05ms, so a series of positive and negative-going spikes will be observed on the 'scope.

If a diode is connected across the resistor, either the positive or the negative-going spikes can be suppressed, the diode acting as an effective low resistance shunt to a spike of the appropriate polarity. The Schmitt is now being used as a source of trigger spikes which occur at well defined intervals synchronised to the frequency of the input waveform.

The triggering point on the input waveform is determined by the value of the trigger level voltage V_1. If the voltage spikes are carefully examined, it will be noticed that the positive and negative-going time constants are not the same. Neither are the amplitudes of the spikes equal.

To be continued

In Part 1 last month the following corrections should be noted:

1. Page 921, third para. to read: "Calculate the voltage drop along R_3 at saturation using Ohm's Law . . ."
2. Page 921, under "Transistor operated as a switch", to read:

Thus

$$V_{CC} = V_L + V_{CE}$$

But

$$V_L = I_C R_L$$

3. Page 922, Fig. 1.9: Diode D1 to be reversed.
4. Page 922, Fig. 1.10a: Diode D1 to be reversed; TR1 is on holes 52, 57, 62; TR2 on holes 24, 29, 34; TR3 on holes 39, 44, 48.
5. Page 922, Fig. 1.10b: $I_{B3} = 0$ should read I_{B3}.
6. Page 923, under "Light operated AND circuit", fourth para. should read: "Typical voltage values are shown in Fig. 1.10b and c".
7. Page 923, eleven lines further down, should read: "Then $R_3 = (6 - 0{\cdot}4)/5 = 1{,}100$ ohms."

P.E. WIDEBAND H.F. COMMUNICATIONS RECEIVER

By R. HIRST S.T.C. LTD. PART FOUR OSCILLATOR MODULES

THIS part of the "Communications Receiver" will describe the construction of two modules; the 2nd Oscillator and the 3rd Oscillator units (see Fig. 1.4). Both these modules were briefly described in part one of this series.

The 2nd oscillator provides the switching signal for the second mixer. The crystal used is of the overtone variety and as indicated earlier in this series is incorporated in an emitter circuit. The small value of output capacity (C42, 4·7pF) avoids damping the tuned circuit or introducing frequency pulling by the following stage (TR11).

CIRCUIT DESCRIPTION

Transistors TR11 and TR12 (Fig. 4.1) form a directly coupled amplifier which is inherently very temperature stable as the circuit tends to compensate for changes. This works in the following manner; assume that the base current of TR11 increases as a result of a temperature rise, therefore the collector current of TR11 will increase, causing the collector voltage to fall. As TR12 is an emitter follower the emitter voltage of TR12 will fall by a similar amount to the decrease in the collector voltage of TR11. This reduction in voltage consequently reduces the base current of TR11, via R48, and the collector voltage of TR11 starts to rise to offset the original fall. This obviously will apply in reverse if the temperature falls.

CRYSTAL TUNING

From the circuit diagram (Fig. 4.1) it is apparent that either a coil or a capacitor may be used in series with X1, both of which would be adjustable. If the correct crystal is purchased, which will be a few cycles low in frequency, a 6 to 24pF variable capacitor can be inserted and the frequency pulled up to precisely the correct value of 36MHz. However, if the crystal is high in frequency it becomes necessary to introduce a coil to pull the frequency down to the required value.

The coil used will depend upon the amount by which the crystal is high in frequency however, if the crystal is nominally 36MHz a coil of approximately 1·5 microhenries can be tried as a starting point. A coil similar to L5 in the r.f. unit can be used if approximately 12 turns are removed. The final assembly will be adjustable but it may be necessary to add or remove turns to suit the crystal. It must be pointed out that if the correct crystal is obtained it will not be necessary to do anything other than to insert a 6 to 24pF capacitor and adjust until the frequency is exactly 36MHz plus or minus 1Hz.

The setting up instructions indicate that the crystal should be removed and a 39 ohm resistor with a 470pF capacitor in series, should be inserted into the circuit at this point before adjusting L9. The reason for this is that it would be difficult to set the coil accurately with the crystal in circuit as the crystal would tend to indicate a constant frequency. If the coil is adjusted so that the free running frequency of the oscillator is accurate, the final circuit after the crystal has been re-inserted will be far more stable.

2ND OSCILLATOR CONSTRUCTION

The construction of this module should be undertaken in exactly the same way as has been described for previous modules. Points a and b shown on the

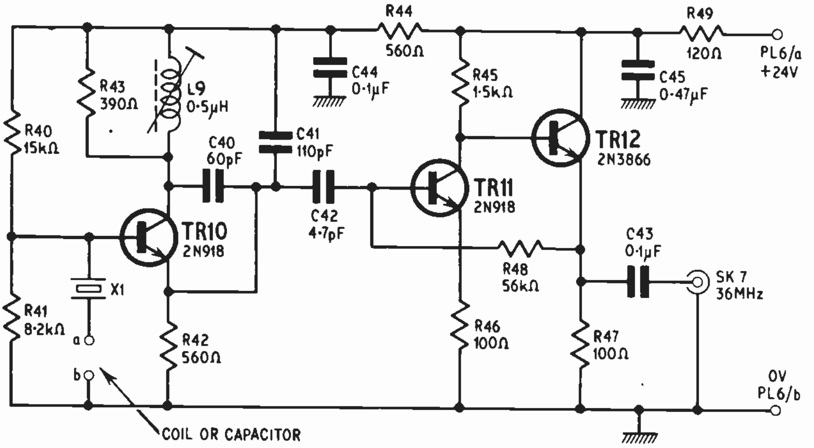
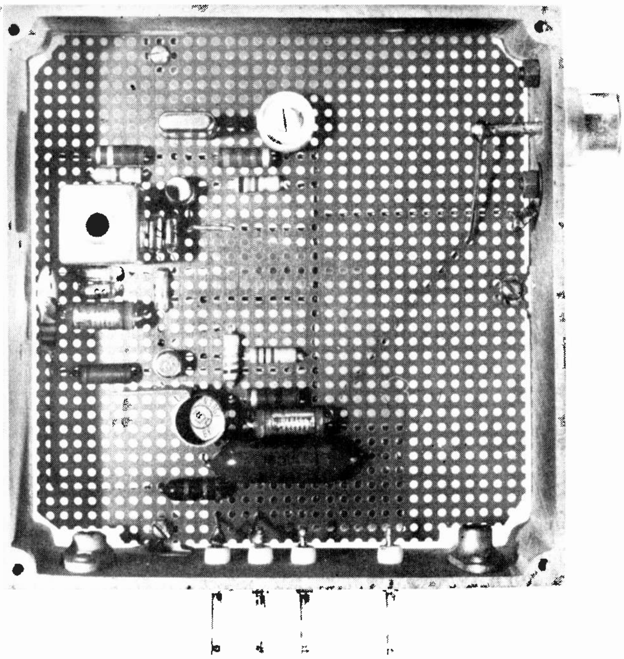


Fig. 4.1. Complete circuit diagram of the 2nd oscillator module

Table 4.1. 2nd OSCILLATOR D.C. VOLTAGES

Stage		Voltage
TR10	Vc	12V
	Vb	4·5V
	Ve	3·9V
TR11	Vc	6·7V
	Vb	1·25V
	Ve	0·55V
TR12	Vc	15V
	Vb	6·7V
	Ve	6V



Second Oscillator Unit (36MHz) module

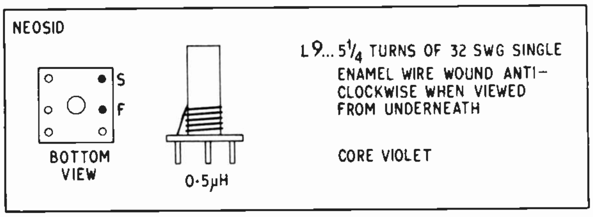


Fig. 4.3. Coil winding details

circuit diagram (Fig. 4.1) and on the construction diagram (Fig. 4.2) should be shorted temporarily during construction to facilitate initial d.c. checks on the circuit. The crystal X1 should be wired up in such a way that it is easily removed for setting up purposes.

Coil winding details for L9 are given in Fig. 4.3.

SETTING UP INSTRUCTIONS

Equipment required:

(a) **Power Supply,** 24V 50mA.

(b) **Valve Voltmeter** capable of measuring 1 volt at 36MHz.

(c) **Counter** capable of measuring 36MHz plus or minus 250Hz.

COMPONENTS . . .

2nd Oscillator

Resistors

R40	15kΩ	R45	1·5kΩ
R41	8·2kΩ	R46	100Ω
R42	560Ω	R47	100Ω
R43	390Ω	R48	56kΩ
R44	560Ω	R49	120Ω

All ¼W to ⅓W high stability, carbon film

Capacitors

C40	60pF	polystyrene ±2·5% (39pF and 22pF in parallel)
C41	110pF	polystyrene ±2·5% (100pF and 10pF in parallel)
C42	4·7pF	polystyrene ±2·5%
C43	0·1μF	polyester or foil
C44	0·1μF	polyester or foil
C45	0·47μF	polyester or foil

Transistors

TR10	2N918
TR11	2N918
TR12	2N3866

Miscellaneous

X1 Overtone crystal (60Hz to 160Hz below 36MHz)
SK7 Coaxial chassis mounted socket
TO5 Heatsink
PL6/a, b, c, d Lead through connectors (4 off)
Veroboard 3½in × 3½in, 0·1in grid

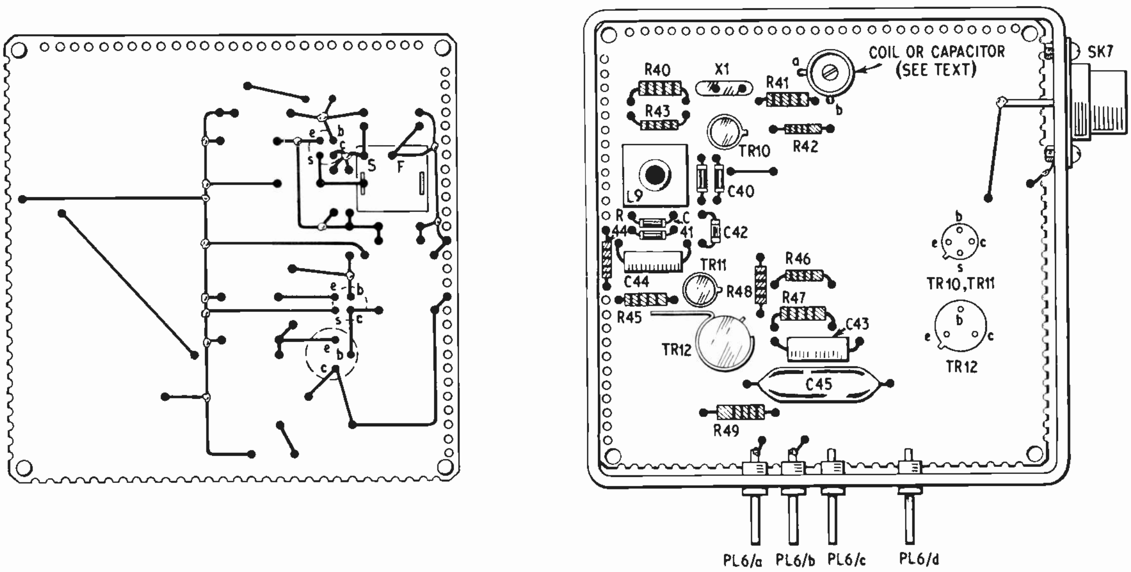


Fig. 4.2. Component layout and wiring of the 2nd oscillator module

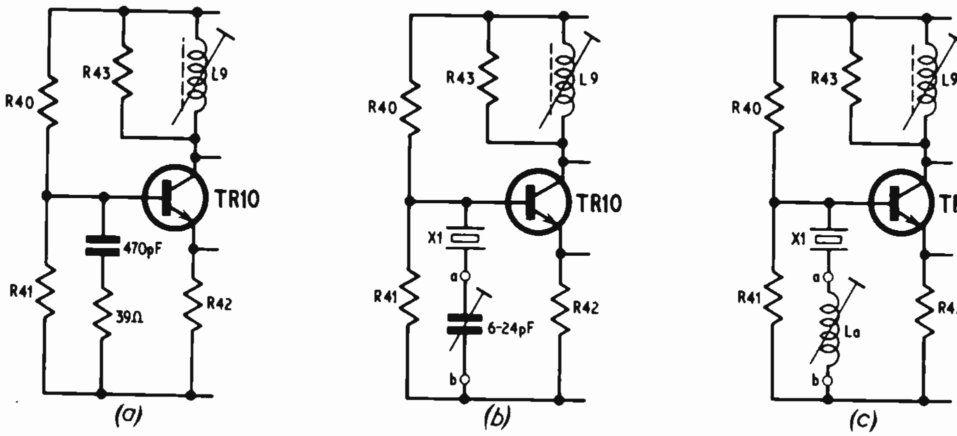


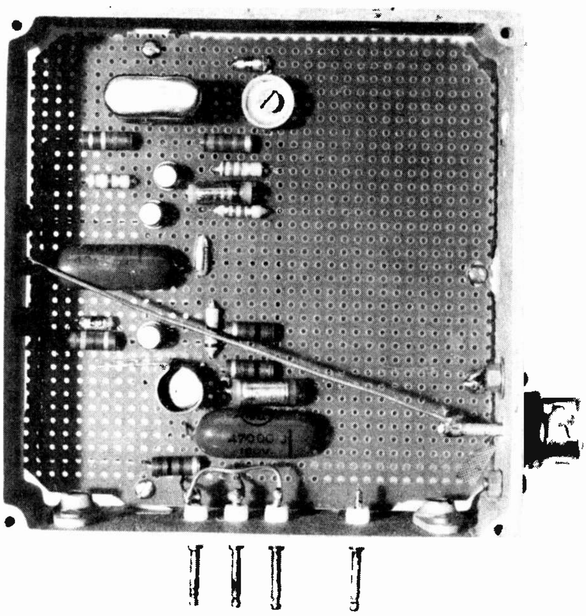
Fig. 4.4. Circuit alterations for setting up: (a) to set up L9, (b) connection for the correct crystal, (c) connection for a crystal which is high in frequency

PROCEDURE

Apply a positive voltage of 24V to the correct terminal (PL6/a) and the negative of the power supply to the earth terminal (PL6/b). Check all the potentials at the base, collector and emitter of all the transistors to ensure that they correspond with the levels given in Table 4.1. If these voltages are correct, replace the crystal with the resistor capacitor network shown in Fig. 4.4a. Connect the counter to output SK7 and adjust the frequency with L9 to read 36MHz as near as possible. Re-connect the crystal (removing the resistor capacitor network) and check the output frequency. If the frequency is lower than 36MHz, connect a capacitor, variable from 6 to 24pF between points a and b as shown in Fig. 4.4b. Adjust this capacitor until the output frequency is as near 36MHz as possible. If the frequency is too high then in place of the variable capacitor insert a coil similar to that described earlier in the text and adjust the coil until the frequency is 36MHz (see Fig. 4.4c). As previously mentioned, if the correct crystal is purchased then it should only be necessary to insert the capacitor and adjust as indicated.

Finally the output voltage at SK7 should be checked with a valve voltmeter to ensure that the output is approximately 0·8 volts when terminated in a 50 ohm load.

THIRD OSCILLATOR



Third Oscillator Unit (2MHz) module

The Third Oscillator Unit (2MHz), which was briefly described in part 1, provides the switching frequency for the last stage of frequency conversion. This oscillator uses two transistors with a 2·0MHz fundamental crystal in series connection.

CIRCUIT DESCRIPTION

Two transistors have been used in this particular circuit (see Fig. 4.5) so that the loading effect of the crystal and its series network is not placed directly across the collector of TR23 (thus reducing the gain to such an extent as to damp the ability of the circuit to oscillate). Transistor TR23A presents a relatively high impedance to the collector of TR23, thus promoting gain in the first stage, and at the same time provides a low output impedance to feed the crystal network.

The crystal is used in its series mode whereby the short circuit characteristic of the crystal in this type of connection provides a short circuit to the positive feedback signal at the required frequency of 2·0MHz. At either side of the operating frequency the crystal rapidly goes into a high impedance state thus effectively blocking the return path for positive feedback.

Transistor TR23 is operating in a grounded base configuration and the bias for both the transistors is developed by the potential divider comprising, R50 and R51. Capacitor C50 decouples the base to a.c. and has been placed on the underside of the board to keep the leads as short as possible. The crystal is pulled onto frequency by C51 which is in parallel with the larger fixed capacitor, C52.

The following pair of transistors, TR24 and TR25 form a directly coupled amplifier giving an output of approximately 1 volt at 2·0MHz into a 50 ohm load. Transistor TR25 is run at rather a high emitter current to keep the distortion to within a reasonable level.

CONSTRUCTIONAL DETAILS

Once again this module is constructed on plain Veroboard (see Fig. 4.6) and, where possible the component leads are used for wiring connections. There are no inductors in this module so construction can commence once all the components have been obtained. Capacitor C50 should be connected in such a way that it can be removed easily, if this proves necessary, during the setting up of this module.

An extra output socket (SK9) has been provided to enable the constructor to more easily set up the final receiver once the whole equipment has been built.

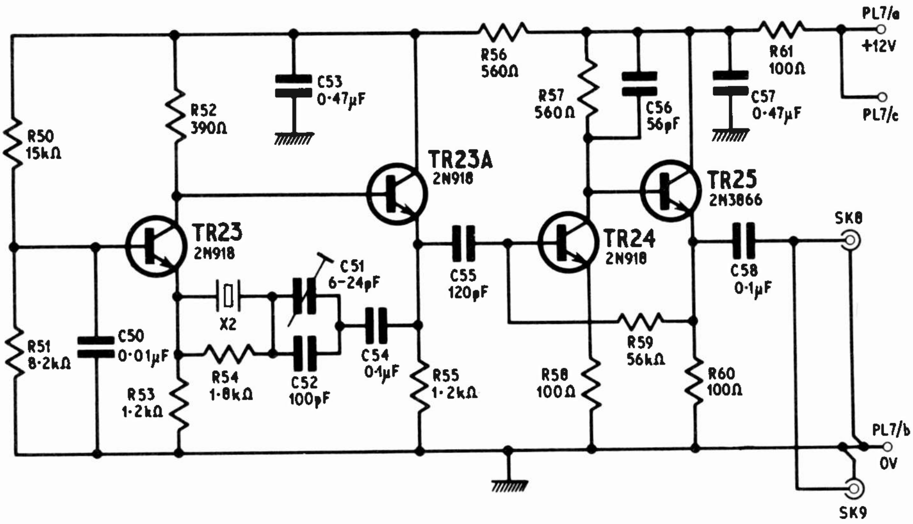


Table 4.2. 3rd OSCILLATOR D.C. VOLTAGES

Stage		Voltage
TR23	Vc	4·5V
	Vb	1·5V
	Ve	1·0V
TR23A	Vc	9·0V
	Vb	4·5V
	Ve	3·7V
TR24	Vc	5·3V
	Vb	1·0V
	Ve	0·3V
TR25	Vc	6·9V
	Vb	5·3V
	Ve	4·4V

Fig. 4.5. Complete circuit diagram of the Third Oscillator Unit (2MHz)

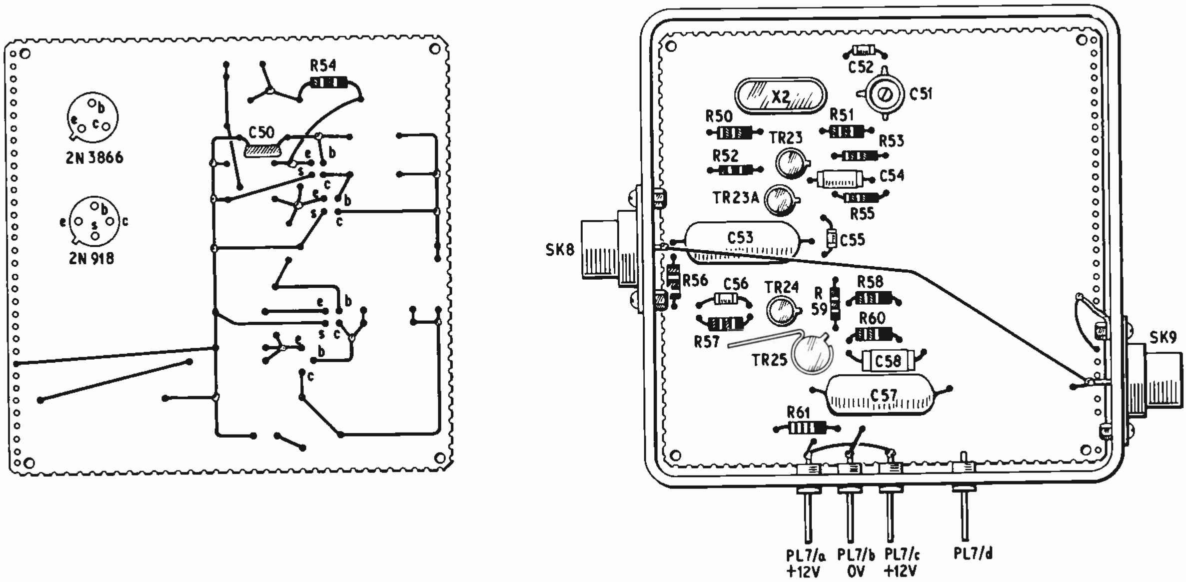


Fig. 4.6. Component layout and wiring of the Third Oscillator module

COMPONENTS . . .

Resistors

R50	15kΩ	R54	1·8kΩ	R58	100Ω
R51	8·2kΩ	R55	1·2kΩ	R59	56kΩ
R52	390Ω	R56	560Ω	R60	100Ω
R53	1·2kΩ	R57	560Ω	R61	100Ω

All $\frac{1}{4}$W to $\frac{1}{3}$W high stability, carbon

Capacitors

C50 0·01μF ceramic
C51 6–24pF ceramic trimmer
C52 100pF polystyrene 2%
C53 0·47μF polystyrene
C54 0·1μF polyester
C55 120pF polystyrene 2%
C56 56pF polystyrene 2%
C57 0·47μF polyester
C58 0·1μF polyester

Transistors

TR23 2N918
TR23A 2N918
TR24 2N918
TR25 2N3866

Miscellaneous

X2 2·0MHz series resonant crystal
SK8, 9 Coaxial output sockets (2 off)
PL7/a, b, c, d Insulated lead through connectors (4 off)
TO5 Heatsink
Veroboard $3\frac{1}{2} \times 3\frac{1}{2}$in, 0·1in grid

SETTING UP INSTRUCTIONS

Equipment required:

(a) **Power Supply,** 12V at 60mA.
(b) **Valve voltmeter** capable of measuring 1 volt at 2MHz.
(c) **Counter** capable of measuring 2·0MHz plus or minus 100Hz.

PROCEDURE

Apply the correct potential across PL7/a and b, switch on and check that the voltages at the base, collector and emitter of all the transistors correspond to the levels indicated in Table 4.2. If these voltages are correct to within 10 per cent a 50 ohm resistor should be connected across SK8 and a valve voltmeter connected at this point to ensure that there is some output.

A counter can now be connected to SK9 and the frequency adjusted to 2·0MHz, plus or minus 1Hz, by C51. It may be necessary to slightly change the value of C50 if the crystal cannot be pulled up to the required frequency. This could happen if the correct crystal has not been used. It is not essential to use the crystal specified but if an unknown device is used it may well present problems and the values of C52 and R54 may have to be experimented with.

Once the circuit is oscillating at the required frequency the output voltage should be checked with the valve voltmeter to see that the level lies between 0·6 volts and 1·0 volt r.m.s.

Note: the panel sizes given under "You Will Need" in Fig. 2.1 should be used, not those given in the diagram.
In Fig. 2.4, R7 should be joined to TR3 emitter.

Next month: Details of the Sideband Filter Unit and the A.F. Unit

NEWS BRIEFS

Computerised Power

When Hunterston "B", the 1,250 megawatt nuclear power station being built for the South of Scotland Electricity Board, becomes operational in 1973, over 6,000 different points in its dual advanced gas cooled reactor (AGR) system will be monitored continuously by two Honeywell 316 computers working hand in hand.

The £300,000 Data Logging and Monitoring System, developed by Honeywell in conjunction with The Nuclear Power Group Ltd., will provide the station's operating staff with regular logs of all plant conditions and will instantly bring to their attention deviations from certain normal plant conditions.

The two computers of the system, using predetermined priority lists, will continually scan the gas outlets and thermocouples connected to each of the two reactors as well as a wide range of other parameters associated with the complete reactor/boiler/turbine system. As the reactor data is collected the computers will compare it with preset alarm limits and then, at the completion of each scan, print details on logging typewriters located in the station's control complex. If the values of particular monitoring points fall outside the corresponding alarm limits, the system will indicate the alarm condition by printing the relevant data in red.

Radar Alarm System

Shorrock Security Systems Ltd., Blackburn, Lancashire, a subsidiary of Hawker Siddeley Dynamics, have introduced a new range of burglar and intruder detection devices using microwave Doppler radar. Until recently the cost of generating microwaves made radar too expensive for most intruder detection systems. But recent research by the Royal Radar Establishment, and in Shorrock's own laboratories, has now developed a technique of using a Gunn Diode to produce microwaves from a six volt torch battery.

Using this system Shorrock's have produced a complete range of portable and fixed radar-operated equipment which can detect intruders at distances of up to 50 yards.

An important feature of these devices is that they can be programmed to differentiate between a human intruder and accidental happenings, such as the falling of packing cases or the blowing about of leaves or paper, and so prevent false alarms. Jamming devices only cause the equipment to give an alarm as does the wearing of anti-radar clothing.

POINTS ARISING

DOUBLE SIX *(December 1969)*

Resistor R15 was incorrectly marked in Fig. 1. Its value should be 56kΩ. Also the polarity of C6 was shown incorrectly in all relevant diagrams—the negative side should be connected to the 0V line.
Plug Connections (all plugs) shown in Fig. 4 should be reversed in order.

BOOK REVIEWS

THE HI-FI AND TAPE RECORDER HANDBOOK

By Gordon J. King
Published by Newnes-Butterworth
304 pages, 9in × 6in. Price 40s.

SINCE the author's earlier book *The Practical Hi Fi Handbook* went out of print, several of the chapters therein were extensively revised and up-dated for inclusion in this new volume. Much additional material is added to make this a valuable addition to the bookshelf.

The increased popularity of tape recording, from bird song to video recording, justifies fully the treatment given to the subject in this work; it must therefore include information on audio theory and circuitry generally used in hi fi equipment.

Some of the common problems in setting up, operating and fault finding in audio equipment are given extensive treatment to enable the tape recorder user to get the best from his equipment. Technical terms are explained and associated equipment, such as turntables and pick-ups, microphones, f.m. radio, and video are also covered, since the good tape recordist frequently has to rely on the efficiency of these ancillary items for first-class results.

Two useful appendices are given to explain amplifier performance specifications and list a wide range of test tapes and discs.

Readers with some knowledge of audio techniques and circuitry will find this book easy to follow; it is not intended as a tutorial text book but rather to help those already familiar with basic fundamentals who wish to graduate to quality recording.

M.A.C.

SERVICING WITH THE OSCILLOSCOPE

By Gordon J. King
Published by Butterworth & Co. (Publishers) Ltd.
176 pages, $8\frac{3}{4}$in. × $5\frac{1}{2}$in. Price 38s. 0d.

PROBABLY one of the most neglected instruments in the workshop, the oscilloscope, has now assumed a potent role as a servicing tool since the advent of colour television. With this renaissance has come the need for 'scopes with a laboratory specification specially tailored to encompass the broad video bandwidth and short pulse rise times found in modern television servicing.

In introducing the oscilloscope Mr King succinctly describes its function as "it takes a whole series of 'instantaneous' changes—a slice of time—and lays it before us as a diagram".

The concern with diagrams, or oscillograms to give them their correct term, is made apparent in the succeeding pages. From introductory chapters familiarising the reader with the fundamental features and applications of the 'scope we are led into fault diagnoses by oscillogram analysis of video, synchronising and timebase waveforms. Typical circuit stages showing Y amplifier test points facilitate the rapid practical reproduction of those traces where servicing is intended.

It is in company with the sine/square wave signal generator and wobbulator that the oscilloscope assumes its most comprehensive service capability. With these, hum, distortion and response tests for both video and audio equipment can be carried out in addition to visual sweep alignment of i.f. stages.

Chapters embracing the use of these auxiliary instruments and the interpretation of the display patterns formed are adequately covered.

Whilst many of the waveforms found in monochrome television are present in colour sets, the latter do include circuits designed to process colour signals and control the unique three-gun tube. For a fuller understanding of the waveforms involved there is a chapter on the basic colour principles.

The final two chapters are concerned with stereo radio waveforms and the testing of audio equipment. In the latter we are shown how to use the "magic eye" to make meaningful—or should it be meaningless—the hi fi specification.

For anyone owning, or intending to purchase a 'scope, this book should prove a useful investment.

G.G.

TRANSISTOR AUDIO AND RADIO CIRCUITS

Edited by A. Peters
Published by Mullard Limited
203 pages, $8\frac{1}{2}$in × 6in. Price 30s.

AUTHORITATIVE books of this kind giving basic design features and proven circuits are a valuable asset to any experimenter. One often finds Mullard circuits reproduced in technical books that are treated with respect and adopted in many practical projects.

In this book we have it all "from the horse's mouth", together with background details of the designs and the results of laboratory tests. It follows a similar style to Mullard's red paperback produced several years ago.

The important difference here is that fundamental transistor characteristics are excluded, since these are available from a multitude of other publications. The space is better used on the design criteria.

Since the publishers have got down to the business of printing complete circuit designs, one really wonders if the manufacturing techniques of transistors given in Chapter 1 is really appropriate.

The remainder is intended to help circuit designers and constructors who have some background knowledge of the subject and are able to adopt their own layout methods and know how to use test equipment.

A complete list of the designs shown would fill this page, so it will suffice to mention them in broad terms under audio amplifiers, i.f. and r.f. stages, a.m. and f.m., tape recorder circuits, mono and stereo control circuits, test equipment, charts, graphs, and nomograms. Components lists are provided with current manufacturers' names. Mullard have gone to some lengths to provide such a comprehensive book, the like of which will be hard to find elsewhere. To those interested in domestic equipment construction this will be money well spent.

M.A.C.

PE ORGAN PART 9

By Alan Douglas, Sen. Mem. I.E.E.E.

THIS MONTH we are concerned with the wiring of the pedalboard and the carpentry of the organ stool.

PEDALBOARD TYPE

The pedalboard used with the organ is the 30 note type D from Kimber-Allen Ltd. This model has full width concave and radiating short length pedals, curved toe and heel board and heel springing. It has the advantage of being a condensed form of full-sized pedalboard; here the reduction being in area, not in note compass.

PEDAL KEYING

As we key the pedal signals from the dividers directly with the foot, the 16ft and 8ft circuits are made up of simple single pole switches. The two are combined in one Kimber-Allen contact block type GB, there being one block to each key.

Fig. 9.1 shows how the depression of a pedal actuates the switches. The gold contacts are made with wipers which can also be bought from Kimber-Allen. These are type C.W.K.S. to suit the ½in contact assemblies.

Since a metallic contact must not be made, the turned over edge of the wiper has a ½in of plastic sleeving slotted and slipped over the end. This is then secured by a drop of Bostik or similar cement. Note in Fig. 9.1 the use of a No. 3 woodscrew to adjust the stroke of the wiper.

Fig. 9.2 shows the wiring of the contact blocks. Here the signal inputs originate from the 100 kilohm pedal resistors. These are then routed from the 16ft and 8ft sockets as described in Part Four, thence to the contact blocks via additional plugs and sockets.

The plain wires of the blocks are connected to the 16ft and 8ft busbars. The bent wires connect to the signal sources. When the contacts are individually keyed the signals are routed back by way of pins 31 and 32 of a pedal socket to the related tone forming circuits. These pins are shown in Fig. 4.1.

ADDITIONAL PLUGS AND SOCKETS

Before getting involved in the pedalboard wiring it is a good idea to first make up the cableforms for mating the pedalboard to the organ console. For this two 32-way plugs and two 32-way sockets are required, these being identical to those called up in Fig. 4.1. Each plug and socket is wired with 3ft lengths of p.v.c. stranded wire, the order of connection given as in Fig. 4.1. When this is completed you should have two terminated looms for 16ft and 8ft pitches, one being shown in the photograph.

MOUNTING THE BLOCKS AND WIPERS

As our pedalboard is a proper radiating and concave one, the contacts when fixed must describe an arc of a circle. This means that some rigid form of backing must be provided beneath the keys. To achieve this three 1in by 1in hardwood battens are fixed to the frame as shown in Fig. 9.3. Single screw fixing is possible at the toe end, but brackets are necessary at the heel.

To carry the contact blocks a strip of ¼in ply is screwed to the battens, this being supported at the frame side by small screwed wooden blocks. In the figure two strips are shown. Here, the lower one will provide a platform for sustain contacts if these are used. However, more about this aspect later.

The main blocks are cemented on with Bostik. When those are fixed we can attach the contact wipers, these being held to the keys by ⅜in No. 3 woodscrews. Of course, the adjustment screw shown in Fig. 9.1 should also be included.

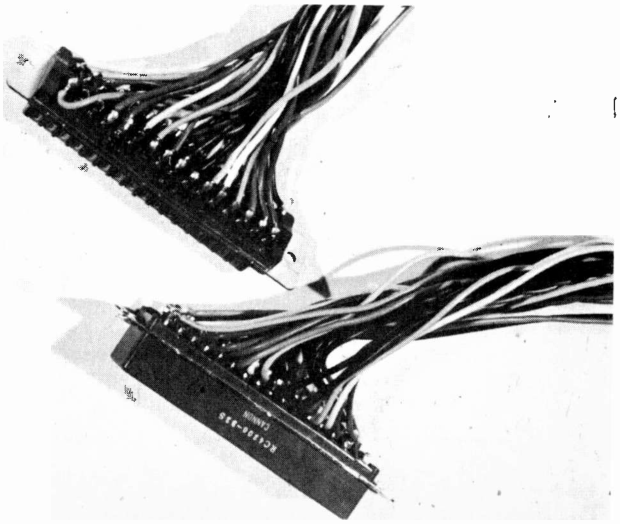
Prior to any wiring the tails of the blocks should be splayed out as this will facilitate later soldering.

WIRING THE BLOCKS

We are now in a position to connect wires to the contact tails. In the accompanying photograph of the pedalboard underside, the extreme left-hand pedal will produce the highest note; the extreme right that of the lowest note. Using the colour code of Fig. 4.1 and the specimen wiring diagram of Fig. 9.2 we can wire from the block tails for the 16ft pitch moving from left to right at the pedal contacts. As the loom forms it should be supported at the ply strip with thin nylon cord.

With the 30 connections made and the loom gathered, holes can be drilled midway along the frame side for taking the wires through. Now the free ends are bared and connected to one of the 32-way plugs called up in the components list of Fig. 4.1. This figure also gives the wiring order for the plug pin connections.

Cannon plug and socket wired to pedalboard loom



PEDALBOARD & STOOL

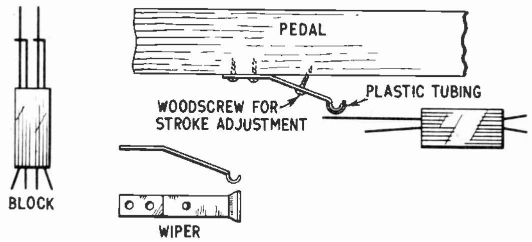


Fig. 9.1. Contact block and wiper used in pedal note switching. Note the inclusion of the stroke adjusting woodscrew which makes for switching precision

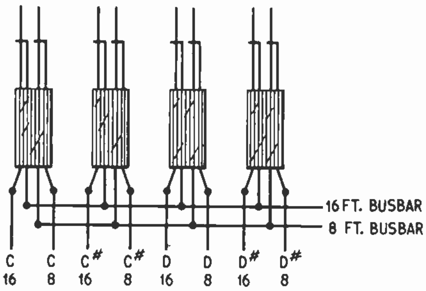


Fig. 9.2. Four representative contact blocks with their tails wired. All 30 blocks should be wired in this fashion

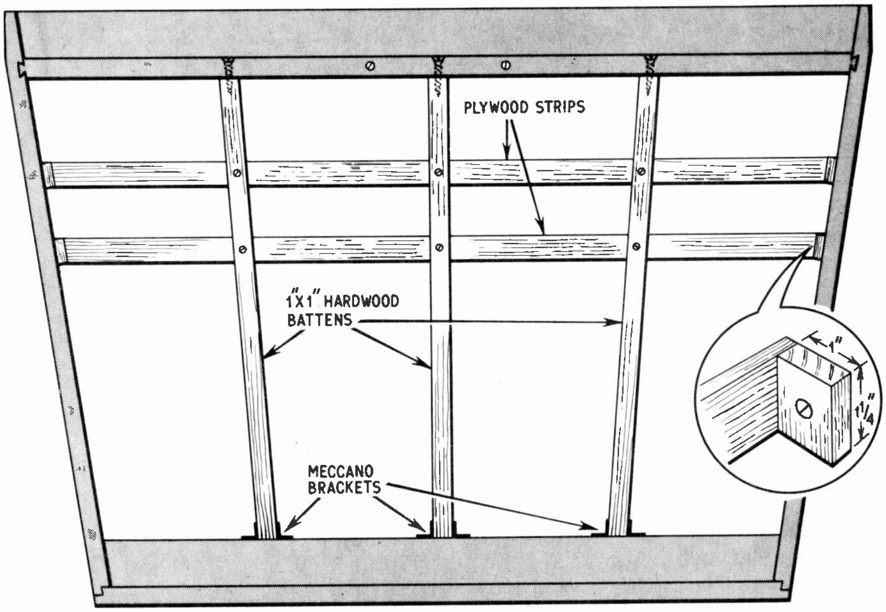
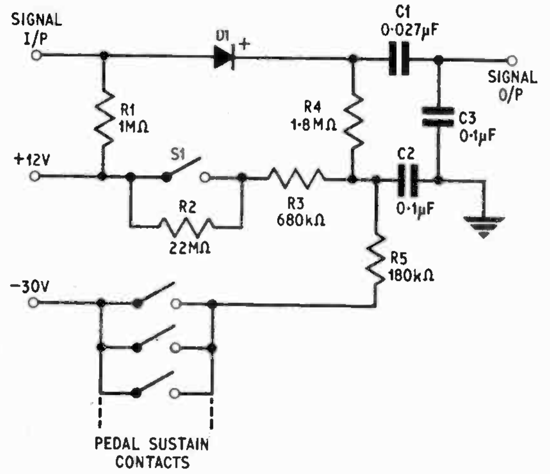


Fig. 9.3. Underside of pedalboard, with keys removed, showing batten and strip frame in position. The upper transverse strip will carry the GB contact blocks, the lower strip the GJ blocks if sustain is required

PEDAL SUSTAIN CIRCUIT



COMPONENTS . . .

PEDAL SUSTAIN GATE
(2 required)

Resistors
R1 1MΩ
R2 22MΩ
R3 680kΩ
R4 1·8MΩ
R5 180kΩ
All 10%, ½ watt carbon

Capacitors
C1 0·022µF polyester
C2 0·1µF polyester
C3 0·1µF polyester

Diode
D1 OA210 (Mullard)

Fig. 9.4. Circuit for pedal sustain. All the pedalboard contacts of the GJ blocks are connected in parallel

8FT CONTACT WIRING

For the 8ft contact wiring the procedure is the same and when completed this loom can be also attached to the strip. Again these 30 wires terminate at a separate 32-way plug.

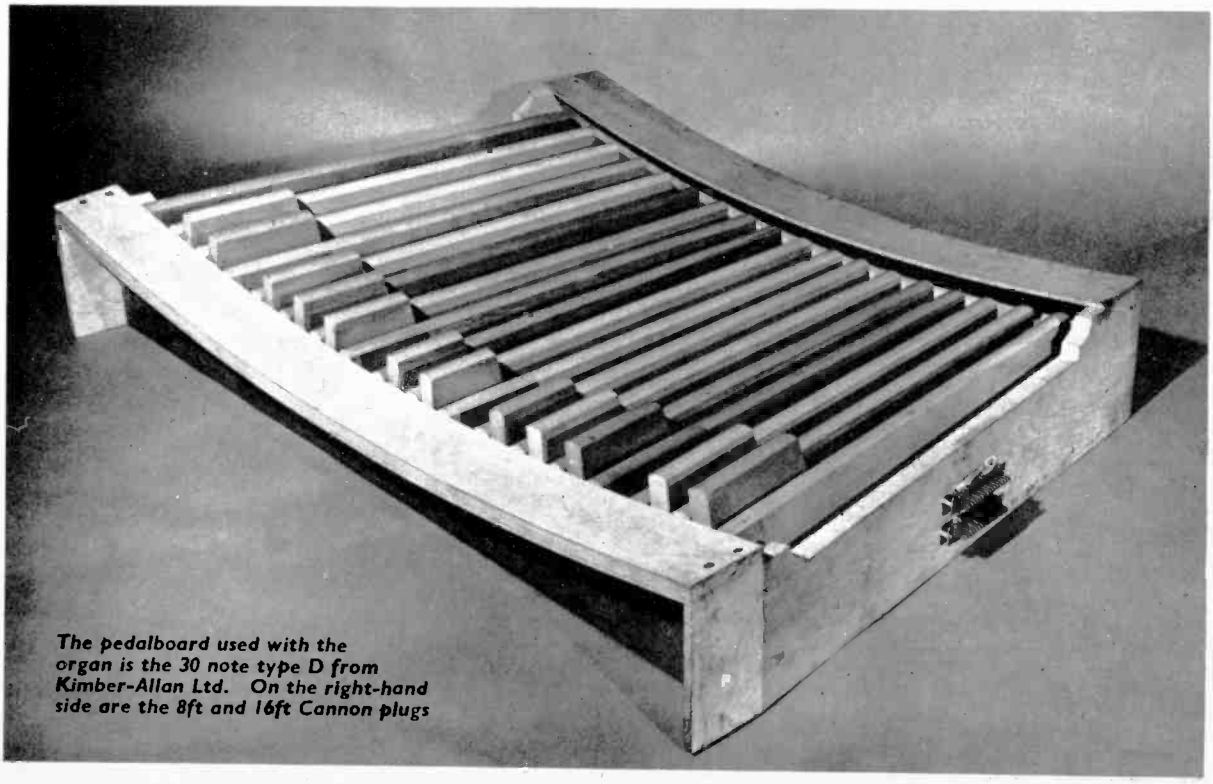
The two plugs can now be fixed to the frame sides with wood screws and stand-off bushes, making sure that the contacts are clear from the wood.

PEDAL SUSTAIN

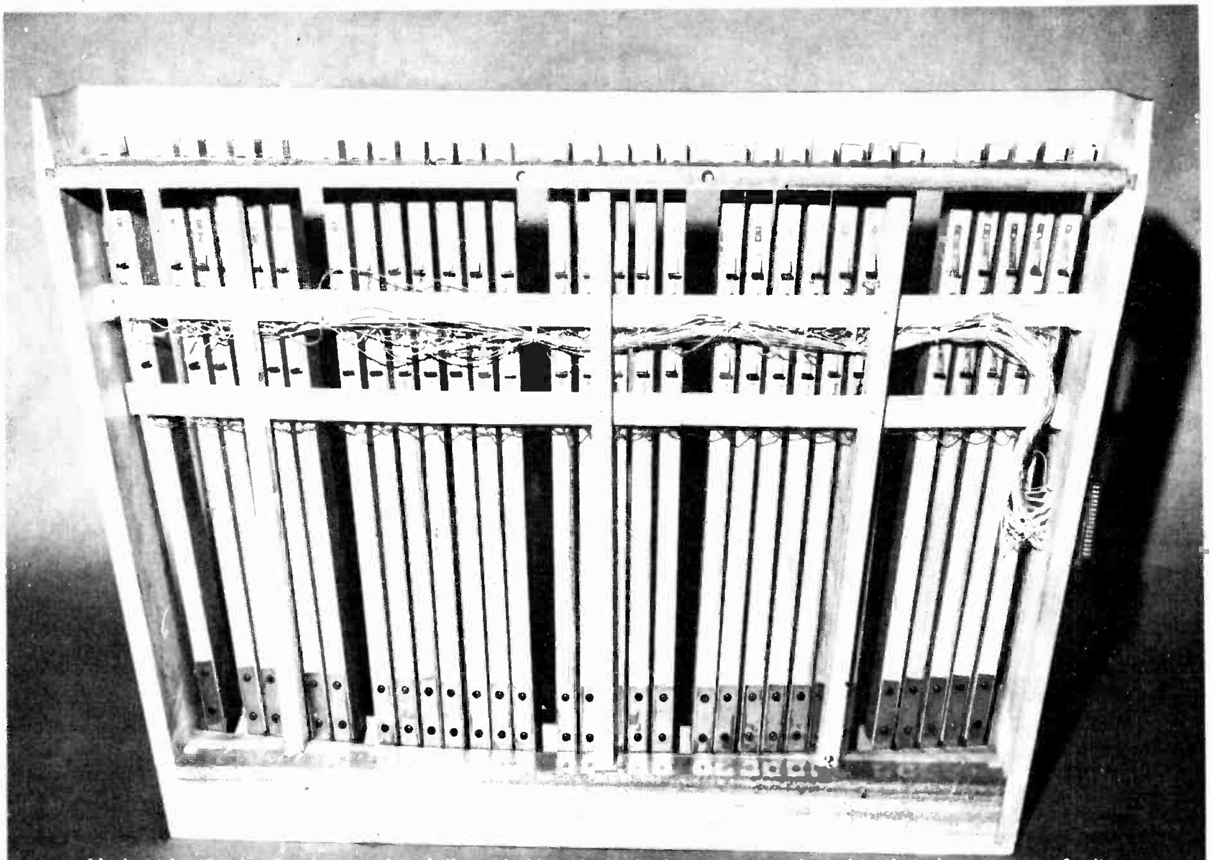
It is quite easy to apply sustain because we are assuming that only one note at a time will be played; hence only one sustain circuit for each pitch is required. The fact that only one note at a time is played means that we can have an electrical sustain with the advantage that the sustain time can be altered at will or removed altogether.

In using auxiliary circuits of this kind, it is usual to close one contact before the other. The normal 16ft and 8ft pair of contacts are closed, which applies the bias to the sustain device.

There is no convenient single pole organ contact on the market, but one side of the Kimber-Allen change-over contact type GJ is suitable. All we need is a



The pedalboard used with the organ is the 30 note type D from Kimber-Allan Ltd. On the right-hand side are the 8ft and 16ft Cannon plugs



Underside of completely wired pedalboard. Note how the looms are gathered and tied to prevent fouling of the contacts

simple single pole switch, but it is an advantage to use the K-A parts because the point at which closure is made is so easily and accurately adjusted by the stroke setting screw of the wiper.

If we intend incorporating sustain then the GJ contacts and wipers should be attached, the former being cemented to the lower transverse ply strip. The sustain switches are wired in parallel. This is made clear in Fig. 9.4. When all solder connections are made, the two free ends are terminated at pins 31 and 32 of the plug that has these pins vacant.

SUSTAIN CIRCUIT

In Fig. 9.4 is shown the sustain circuit. Two of these are required, one for the 16ft pitch and one for the 8ft. Since this is basically a gate it can be inserted before the pedal pre-amplifiers.

POWER SUPPLY FOR PEDAL SUSTAIN GATE

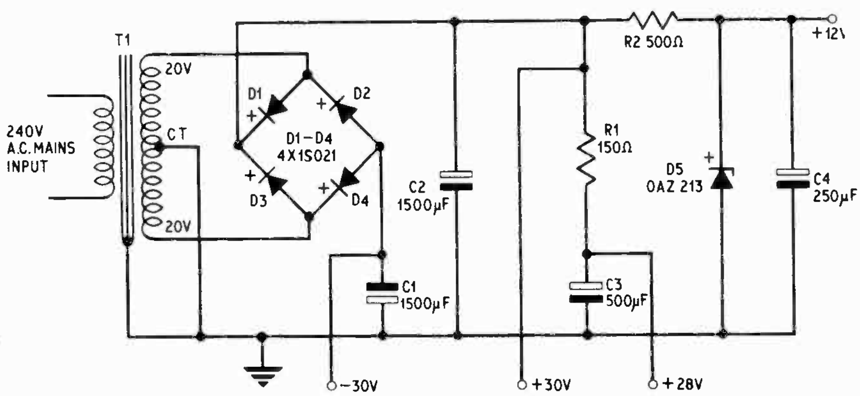


Fig. 9.5. Circuit of power supply required for pedal sustain gate. The additional voltage taps are for manual sustain. A gate for this will appear in a later article

COMPONENTS . . .

GATE POWER SUPPLY

Resistors

R1 150Ω ½ watt
R2 500Ω 1 watt

Capacitors

C1 1,500μF 100V elect.
C2 1,500μF 100V elect.
C3 500μF 50V elect.
C4 250μF 25V elect.

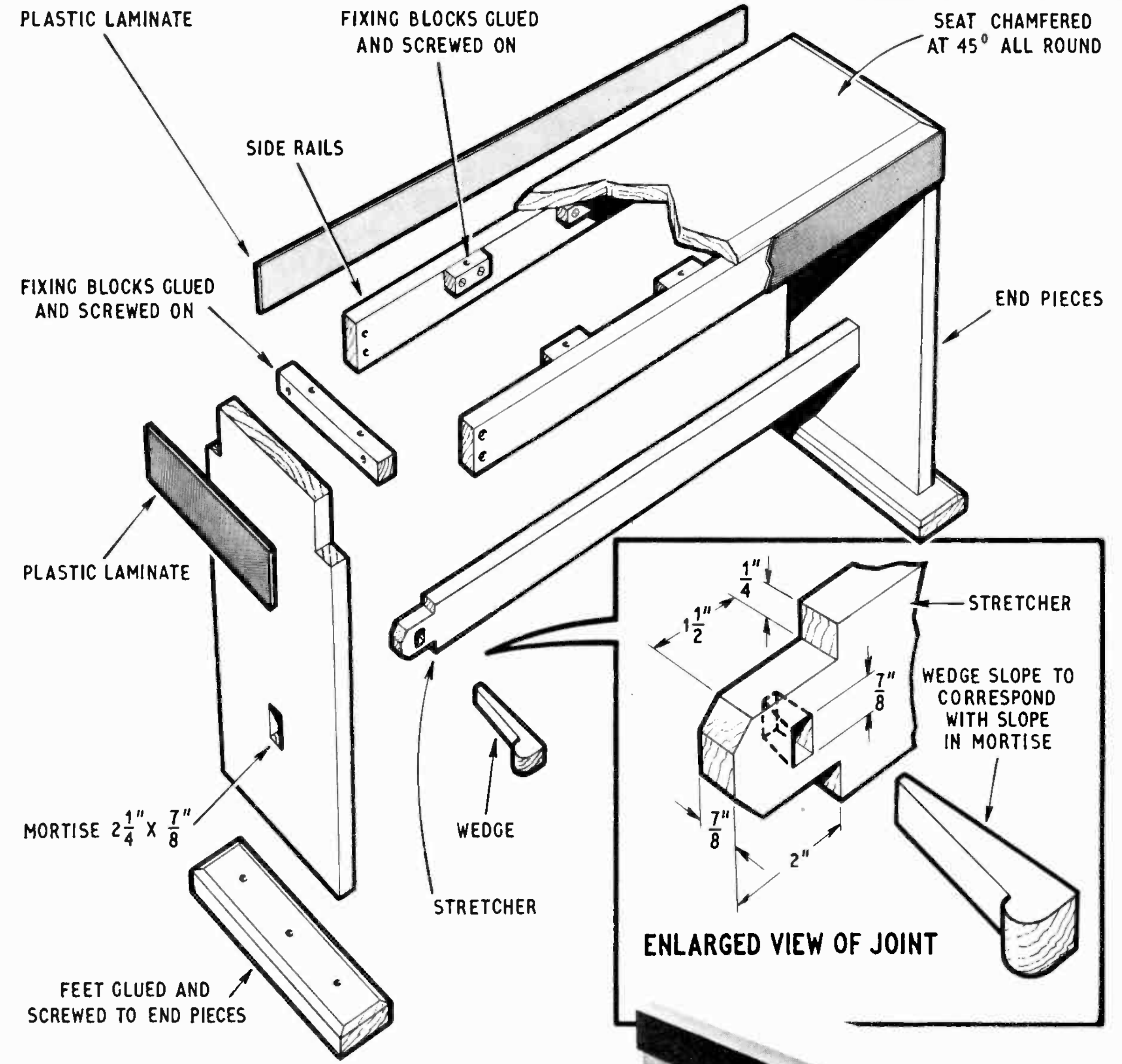
Diodes

D1–D4 1S021 (4 off)
D5 OAZ213 Zener

Transformer

T1 20V-0-20V Rec. Transformer (Radiospares)

Fig. 9.6—ORGAN STOOL



Cutting List

End Pieces	(2 off)	25in × 10in × $\frac{7}{8}$in
Side Rails	(2 off)	44in × $2\frac{3}{4}$in × $\frac{7}{8}$in
Stretcher		48in × $2\frac{3}{4}$in × $\frac{7}{8}$in
Wedges	(2 off)	5in × $1\frac{1}{4}$in × $\frac{7}{8}$in
Feet	(2 off)	12in × $2\frac{3}{4}$in × $\frac{7}{8}$in
Fixing Blocks	(6 off)	$2\frac{3}{4}$in × $1\frac{1}{4}$in × $\frac{7}{8}$in
Fixing Blocks	(2 off)	$8\frac{1}{4}$in × $1\frac{1}{4}$in × $\frac{7}{8}$in
Seat		44in × 10in × $\frac{7}{8}$in

Also required: Plastics Laminate; $1\frac{1}{2}$in × No. 8 countersunk woodscrews and glue.

SUPER BARGAIN STOCKTAKING SALE!!!

.Use the form below for your order. **CONDENSERS MUST BE ORDERED BY STOCK NUMBER ONLY.** If any sale item is "sold-out" when order received we shall substitute items of equal value.

ELECTROLYTIC CAPACITORS

Stock No.	Capacity	Voltage	Price	No. Req'd	£ s. d.
1	1μF	6	4d		
2	4μF	25	4d		
3	4μF	4	4d		
4	6μF	6	4d		
5	3μF	25	4d		
6	64μF	9	4d		
7	20μF	6	4d		
8	20μF	50	6d		
9	30μF	15	6d		
10	8μF	12	4d		
11	8μF	6	4d		
12	1μF	350	6d		
13	8/8/8	350	1/-		
14	50μF	6	4d		
15	100/200	275	6/-		
16	32	150	9d		
17	64	2·5	3d		
18	100/200/200/50	275	7/6		
19	50/80	300	3/-		
20	150/200	275	6/-		
21	24	275	1/-		
22	10	25	3d		
23	125	2·5	3d		
24	2	150	3d		
25	16/32	350	2/6		
26	32	275	1/6		
27	350	12	6d		
28	75/75/75/75	150	2/6		
29	1	20	3d		
30	12·5	40	9d		
31	640	2·5	3d		
32	3,000	35	7/6		
33	3,000	15	3/-		
34	3,000	30	7/-		
35	250	70	2/-		
36	2,500	9	2/-		
37	32	50	9d		
38	750	12	1/9		

Stock No.	Capacity	Voltage	Price	No. Req'd	£ s. d.
39	100μF	275	2/6		
40	30μF	10	3d		
41	2,000/2,000	25	7/6		
42	16μF	50REV	2/-		
43	16/16	275	2/-		
44	16	275	1/-		
45	350	12	9d		
46	20/4	275	1/-		
47	250	50	2/-		
48	500	25	1/6		
49	400	15	1/-		
50	400	2·5	3d		
51	64	275	1/9		
52	32/32	350	2/6		
53	8/8/8	275	1/9		
54	500	6	6d		
55	64	275	1/3		
56	25	6	3d		
57	100	9	6d		
58	400	50	2/-		
59	400	30	1/6		
60	500	4	3d		
61	150	30	1/6		
62	64/32/8	275	2/6		
63	200	275	2/6		
64	40	6·4	3d		
65	50	25	6d		
66	250	50	1/9		
67	30	6	3d		
68	100/100/50	275	5/-		
69	50/50/50	350	4/-		
70	40/40/20	275	2/-		
71	400	6·4	3d		
72	320	10	3d		
73	32/32 25	275 25	2/6		

Total:—

RESISTORS. 5% EXCELLENT QUALITY. 7/6 per 100 or 2/- per doz.
Tick the values required.

13 ohms	220 ohms	1·5k Ω	3·6k Ω	7·5k Ω	22k Ω	39k Ω	62k Ω	130k Ω	560k Ω	1·8M Ω	7·5M Ω
22 ohms	470 ohms	1·8k Ω	4·3k Ω	10k Ω	24k Ω	43k Ω	75k Ω	360k Ω	620k Ω	3·6M Ω	8·2M Ω
36 ohms	560 ohms	2·2k Ω	4·7k Ω	16k Ω	27k Ω	47k Ω	82k Ω	430k Ω	1·2M Ω	5·1M Ω	9·1M Ω
47 ohms	750 ohms	2·4k Ω	5·6k Ω	18k Ω	30k Ω	51k Ω	91k Ω	470k Ω	1·5M Ω	6·2M Ω	10M Ω
91 ohms	1k Ω	3·3k Ω	6·8k Ω								

or our selection (mixed) 6/6 per 100

Total:

SILVER MICA/CERAMIC/POLYSTYRENE CONDENSERS 10/- per 100, 3/- per doz.
Available in following values. Tick those required.

2pF	5pF	12pF	25pF	50pF	80pF	135pF	180pF	250pF	680pF	1,000pF	2,500pF
3·9pF	6pF	15pF	27pF	58pF	82pF	140pF	190pF	330pF	800pF	1,100pF	2,700pF
4pF	8pF	18pF	30pF	62pF	100pF	158pF	200pF	420pF	820pF	1,500pF	3,000pF
4·7pF	10pF	22pF	39pF	72pF	125pF	170pF	240pF	600pF	900pF	2,200pF	6,200pF

Total:

COMPARE THESE PRICES

MULLARD POLYESTER CONDENSERS

	No.	Price
1,000 pF **3d** ea. 400V		
1,500 pF **3d** ea.		
1,800 pF **3d** ea.		
2,200 pF **3d** ea.		
0·15 μF **6d** ea. 160V		
0·22 μF **6d** ea. 160V		
0·27 μF **6d** ea. 160V		
1 μF **1/-** ea. 125V		

Total:

25% discount lots of 100 per type.
50% discount lots of 1,000 per type.

GANGED STEREO POTS. 250K Ω. **2/6** ea.

SKELETON PRESETS. Mixed. **6/-** doz.

VOLUME CONTROLS. ½ MΩ, 1 MΩ, with D.P. switch, **2/-** ea.

TELEVISION REMOTE CONTROLS. Philips, contain 11 7-way cable, 1 double pot., 5 resistors, two condensers, **10/-** ea. (cost £3/3/-).

THIN CONNECTING WIRE
10yd **1/-** 100yd **7/6**. 1,000yd **50/-**

CO-AXIAL CABLE. Black. **6d** yd, **£1** 50 yd.

CRYSTAL MIKES. **10/-** ea.

TRANSISTOR BARGAIN! THEY CAN'T GET ANY CHEAPER!!!
P.N.P. Audio, Untested, unmarked. MAINLY O.K., **10/-** per 100.
N.P.N. Silicon, R.F. types, unmarked. ALL USABLE, **10/-** per 50.
POWER OUTPUT (Similar OC35) ALL TESTED, **4/-** ea; **£2** doz.

SILICON PLANAR TRANSISTORS. ALL TESTED. NO LEAKS OR SHORTS
Gain of 20/50, **6d** ea.; 50/100, **9d** ea.; 100/200, **1/-** ea.
Transistors similar to OCP71 (Light sensitive) **2/-** ea.

THYRISTORS 400V BTY79, **7/6** ea. SCR51 (10A), **£1** ea.

RECTIFIERS Latest type. All marked. 800V peak, 1A mean current type IN4006
2/6 ea., **24/-** doz, **£7/10/-** 100.
S.T.C. 3/4 (400V), **2/6** ea., **24/-** doz, **£7/10/-** 100.
BYZ 13 or 19 (6A), **2/6** ea., **24/-** doz, **£7/10/-** 100.

RECORDING TAPE GIVE-AWAY!!!
ALL BRITISH MADE, BEST QUALITY. 5in, 600ft, **7/3**; 5¾in, 900ft, **9/-**; 7in, 1,200ft, **12/-**.
3in "odd-ends"—may be standard, long or double play—but minimum 150ft, **2/3**.

MAINS DROPPER TYPE RESISTORS. Hundreds of types from 0·7 ohm upwards. 1W to 50W. A large percentage of these are Multi-tapped droppers for radio/television. Owing to the huge variety these can only be offered "assorted", **10/-** per doz.

GIANT SELENIUM SOLAR CELLS. Last few to clear at half price!
Circular, 67mm diameter, **5/-** ea.; 50 × 37mm, 3 for **10/-**.

RECORD PLAYER CARTRIDGES
ACOS GP67/2, **15/-** (Mono)
GP91/3, **20/-** (Compatible)
GP93/1, **25/-** (Stereo)
GP94/1, **30/-** (Stereo, ceramic)
GP93/1 with diamond needle, **32/6**
GP94/1 with diamond needle, **37/6**

TRANSISTORISED FLUORESCENT LIGHTS. 12V.
8W 12in tube, Reflector type, **59/6**
15W 18 in tube, Batten type, **79/6**
Complete with tube. Postage 3/-

TRANSISTORISED SIGNAL INJECTOR KIT 10/-

TRANSISTORISED SIGNAL TRACER KIT 10/-

TRANSISTORISED REV. COUNTER (CAR) 10/-

VERO-BOARD
2½ × 1 × 0·15in, **1/3**
3¾ × 2½ × 15 in, **3/3**
3¾ × 3¾ × 0·15in, **3/11**
5 × 2½ × 0·15in, **3/11**
5 × 3¾ × 0·15in, **5/6**
17 × 2½ × 0·15in, **11/-**
17 × 3¾ × 0·15in, **14/8**
3¾ × 2½ × 0·1in, **4/2**
3¾ × 3¾ × 0·1in, **4/9**
5 × 2½ × 0·1in, **4/7**
5 × 3¾ × 0·1in, **5/6**
Spot Face Cutter **7/-**. Pin Insert Tool, **9/6**.
Terminal Pins, **3/6** for 36.
Spot Face Cutter and 5 2½ × 1in boards, **9/9**.

These prices cannot be repeated. Order now. Don't forget to add your name and address! Please include suitable amount to cover post and packing. Minimum 2/-.

G. F. MILWARD - DRAYTON BASSETT - Nr. TAMWORTH, STAFFS - Phone TAMWORTH 2321

The circuit functions as follows. A blocking voltage of +12V charges the sustain capacitor C2 through R3. With this charged it reverse biases the diode D1 through R2. The pedal signal can now pass.

When a pedal is depressed, −30 volts is applied to C2 through R5, charging it negatively. This voltage then passes through R5 to the diode D1, forward biasing it and allowing the signal to pass. When the key is released, the +12 volt input again charges C2 and blocks the signal off. If the sustain switch S1 is opened, the resistor R2 is introduced between the +12 volt input and C2 resulting in a long charging time, which in turn results in delayed reverse-biasing of the diode.

By selection of R2 we can get a sustain of up to about four seconds, and by shorting it out, we get instantaneous "speech". This is a very useful feature, especially if one's pedalling technique is lacking.

A small additional power supply is required to provide the necessary voltages and this is given in Fig. 9.5. For the sustain switch S1, one of the spare stop units can be used.

ORGAN STOOL

The most important requirement for an organ stool is absolute rigidity. To ensure this wedges were used to fix the stretcher as shown in Fig. 9.6. If the wedges were to work loose they can easily be tapped back tight with a mallet.

First the end pieces are cut to size from mahogany, the dimensions being given in the cutting list. Shoulders are then cut in the top corners of each piece, these being 2¾in by ⅞in. These eventually contain the ends of the side rails.

A 2¼in by ⅞in mortise is then cut at the centre of the width and 6¼in up from the bottom of both end pieces. This last dimension is most important as the stretcher when in position in the mortise must be clear of the pedalboard.

Next the two side rails are cut to length. Then two ¼in diameter countersunk holes are drilled 7/16in from each end through the thickness of the timber. With these rails completed, the third rail or stretcher is tackled. This is longer than the other rail as its tenons will have to protrude through the end pieces. Dimensions for making the tenons are shown in Fig. 9.6.

The feet and the seat can now be cut to size. In completing these a ¼in chamfer at 45 degrees was made at the edges.

To hold the seat in position, screw blocks are cut, glued and then screwed in position. With the seat glued and the feet attached the stool can be finally rubbed down with glass paper.

FINISHING

As a decorative surround, black plastic laminate can be glued at the stool side.

The feet are painted black and the remaining wood surface is given two coats of matt polyurethane varnish.

CORRECTIONS PART—7 (November 1969)

Note: In Fig. 7.2, page 832, the resistor at 27*B*/27*D* should read R3; the resistor at 29*B*/29*C* is R5; the resistor at 29*D*/29*H* should read R4. In Fig. 7.3 there should be a break in the copper strip at hole 16*F*.

Next month we will commence construction of the loudspeaker enclosure and final organ tuning.

NEWS BRIEFS

Faraday Lectures

THE forty-first in the series of Faraday Lectures arranged by the Institution of Electrical Engineers are being given by Mr J. H. H. Merriman on the subject "People, Communications and Engineering". Mr Merriman is the Senior Director (Development) with the Post Office and is also member for technology on the board of the Post Office Corporation. Deputy lecturer is Mr C. A. May, Staff Engineer in Post Office Telecommunications Development Department.

The Lecture is being given in 13 towns in the British Isles; the first was at Rugby, followed by Southampton and Bristol. Other venues will be as listed below.

The Faraday Lecture series spotlights various aspects of modern electrical and electronic science and technology in straightforward language for the general public. Special presentations for students are being arranged at all towns on the tour. Members of the public are admitted by ticket, free of charge, to these lectures.

Venues

Nottingham, Albert Hall; January 13
Stoke-on-Trent, Victoria Hall, Hanley; January 15
Liverpool, Philharmonic Hall; January 29
Sheffield, City Hall; February 10
Cardiff, Sophia Gardens; February 17
London, Central Hall, Westminster, February 19-20
Newcastle, City Hall; March 17
Edinburgh, Usher Hall; March 19
Dublin, Royal Dublin Society Hall; April 15
Belfast, William Whitla Hall; April 17

Tickets are available from various area organisers; the names of these organisers can be obtained from the Institution of Electrical Engineers, Savoy Place, W.C.2.

Flying Laboratories

TWO "flying laboratories" went into service recently with the Board of Trade Civil Aviation Flying Unit. They are HS748 aircraft which have been fitted with the latest flight inspection equipment. This equipment will be used to check to high standards of accuracy the ground navigational aids used by civil aircraft. The use of these aids is a major contribution to safety in the air, particularly in poor weather conditions. The growth of air traffic demands more aids to navigation, to ensure that aircraft maintain regularity and correct separation.

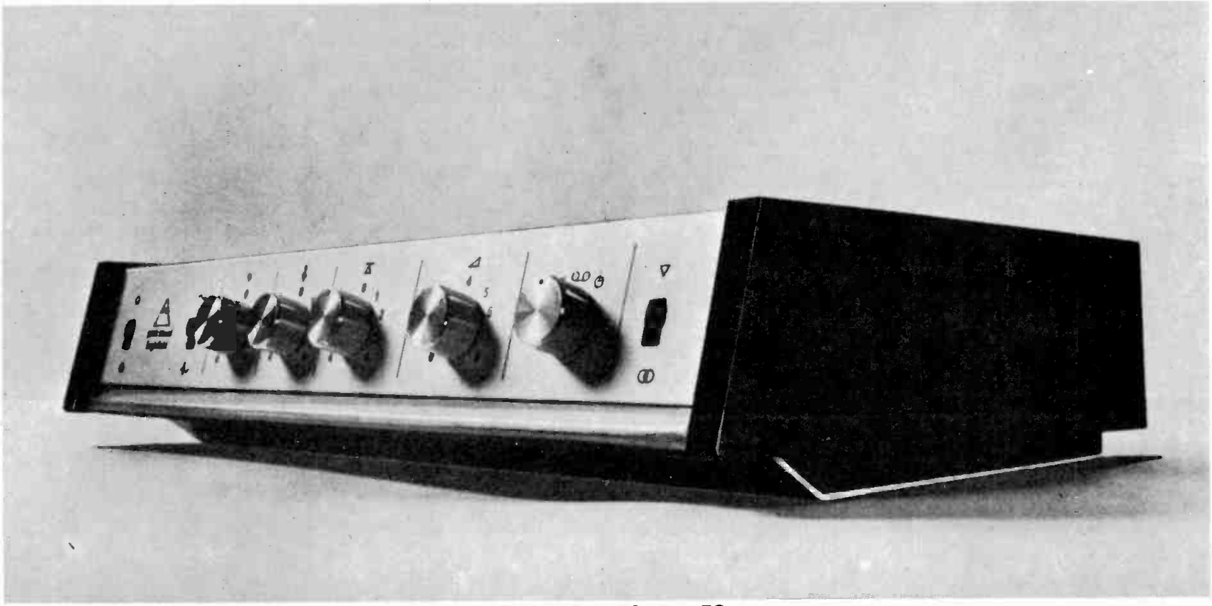
Accepting the aircraft from Hawker Siddeley Aviation at Stansted Airport, Mr Goronwy Roberts, M.P., Minister of State, Board of Trade, said the work of the Unit was vital in the cause of air safety. The new aircraft will be used to commission and periodically check, radar and radio aids to air navigation. He instanced the increasing number of instrument landing systems being installed at United Kingdom airports to meet the latest developments in automatic approach and landing, in which Britain probably led the world.

Microcircuit Film

MULLARD have added a new 24 minute colour film called "Something Big in Microcircuits" to their library (available to interested persons from Mullard Film Library, 269 Kingston Road, Merton Park, London, S.W.19).

The film begins with a look at a typical integrated circuit and goes on to show the basic processes of manufacture of the I.C. A detailed account of actual manufacture is then shown and the film finishes with a reminder that microelectronic design and manufacture is a constantly and rapidly changing process, and although the film shows the basis of microcircuit manufacture, the actual processes used may soon be out-dated.

peak sound englefield



Proved-performance high fidelity with specification guarantee

The Peak Sound Englefield is a new system which assembles from laboratory designed modules to provide a cost-performance ratio which has never been bettered in high fidelity. Here is top-flight circuitry housed in a cabinet of elegantly original design which is both beautiful and completely practical back and front. By assembling these Peak Sound units, you can own one of the best high fidelity instruments you have ever heard or seen and all for a cost of about £38. The assembly is supplied complete down to the necessary connecting wires supplied colour coded, cut to length and stripped at the ends for soldering. You can use the Englefield Cabinet design to house either the 12 + 12 watt system similar to that published in *Practical Wireless*, or the 25 + 25 watt system as approved for the *Hi-Fi News* Twin Twenty by Reg Williamson. Go to your stockist and ask to see and hear Peak Sound equipment now or send for details.

Matching F.M. Tuners will be available very shortly.

and this is the Peak Sound Specification Guarantee

Peak Sound guarantee that their equipment meets all specifications as published by them and that these are written in the same terms as used in equipment reviews appearing in this and other leading British hi-fi journals. Audio output powers are quoted at continuous sine wave power in terms of Root Mean Square values (R.M.S.) into stated loads at stated frequencies.

THE SPECIFICATION

Using two Peak Sound PA. 12-15's, driven simultaneously at 1 KHz from 240 V. mains supply.

Output per channel: 11 watts into 15Ω: 14 watts into 8Ω *(see spec. guarantee).*

Frequency bandwidth: 10Hz to 45 KHz for 1dB at 1 watt.

Total Harmonic Distortion at 1 KHz at 10 watt into 15Ω—0·1%.

Input sensitivities: Mag. PU.3·5 mV. R.I.A.A. equalized into 68KΩ: Tape, 100mV linear into 100KΩ: Radio, 100mV linear into 100KΩ.

Overload factor: 29dB on all input channels.

Signal/noise ratio: −65dB on all inputs. Vol. control at max.

Controls: Volume, Treble, Bass, Low-pass Filter. Mono/Stereo: On/off; Balance.

THE MODULES

Englefield Amplifier Cabinet with front panel, knobs, sockets, cut and stripped wire, fuses, edge connectors, etc.	£6 0 0
Two PA. 12-15 power amp. built modules	£11 19 0
SCU/400 Pre-amp/Control module, built	£15 15 0
PS/45 Power Supply kit	£4 10 0
	£38 4 0

peak sound

To Peak Sound, 32 St. Jude's Rd., Englefield Green, Egham, Surrey

Details of Englefield systems, please and ....

....

Name ....

Address ....

.... PE.1

Write your stockists name and address in margin below and cut out with coupon if necessary

Go to your Stockist. Peak Sound products are already available from dealers in many parts. If your own local stockist is not yet ready with the Peak Sound items you require, please send direct together with your supplier's name and address and your requirements will be dealt with without delay.

TRADE ENQUIRIES INVITED

PEAK SOUND (HARROW) LTD.,
32 St. Jude's Road, Englefield Green,
Egham, Surrey
Telephone: EGHAM 5316

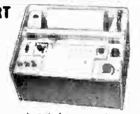
ELECTRONIC BROKERS

NEW—TEST EQUIPMENT

PEN RECORDERS

Ammeter D.C. 0–2mA Single Pen—Elliott	£37.10.0
Portable Single Pen—Record Electrical New	£49.10.0
Quick response recorder QU/RD 15 D2 pen	£10. 0.0
ELLIOTT single pen 5 mA FSD clockwork driven 1" per hour	£20. 0.0

NEW—5 in. CHART PEN RECORDER JY100A-2



High quality single pen recorder with 0–10mV deflection. Chart speed 1 in per min. and 16 in per hour. Adjustable zero location. Power supplies 230V 50Hz. Full specification available on request. £69.10.0. P. & P. 30/-.

PORTABLE WHEATSTONE BRIDGE

with five switched range from 0·05 Ω to 50,000 Ω. 2% accuracy. Price £9.19.6. P. & P. 10/-.

MUTUAL INDUCTANCE BOX

Ranges from 0 to 11·11mHz in 0·002 divisions. Price £26.10.0. P. & P. £1.0.0.

HIGH VALUE DECADE RESISTANCE BOX

Ranges from 0·01M Ω to 111M Ω. Accuracy 0·05%. Maximum Power Rating 0·1W per step. Price £22.10.0. P. & P. £1.0.0.

MUTUAL INDUCTANCE COIL

0·001 Hz. Accuracy 3%. Maximum current 3 amps. Price £2.10.0. P. & P. 7/6.
Full specification available on request.

SET OF MEASURING INSTRUMENTS

Specification Type: Moving Coil D.C. Ranges: 0–75mV, 0–3V, 3–15–150V, 3–150–450V, 0·3–0·75A, 1·5–7·5A, 15–30A. Scale Length: 82mm. Accuracy: 1·0%. Shunts: 1.0·3–0·75 amps. 2. 1·5–7·5 amps. 3. 15–30 amps. Case: Moulded plastic. Carrying Case: Stove enamelled metal. List price £30. Our price £8.19.6. P. & P. 30/-.

DECODER WITH 4 and 5 DIGIT READ-OUT

Can be used to construct frequency counter or Digital Voltmeter: Consists of NOR gates with amplifiers to drive digital display. 4 digit, £19.10.0.; 5 digit, £25.0.0. P. & P. £2.0.0.

MULLARD MATRIX CORE STORE STACKS

A.W. 510 5 planes 8 × 16 cores/per plane	£12. 10.0
A.W. 511 5 planes 18 × 32 cores/per plane	£25. 0.0
A.W. 534 20 planes 64 × 64 cores/per plane	£89. 10.0
A.W. 597 8 planes 32 × 32 cores/per plane	£55. 0.0
Single plane 40 × 25 4	£8. 10.0

MODEL S7 TYPE G SELF STARTING SYNCHRONOUS MOTOR

1 RPM & 1 RPH. Complete with gearing spindle shaft ⅛" dia. ½" long. Torque 2500 grm. centimeter. 40/- plus 3/- P. & P.

LOW COST ELECTRONIC & SCIENTIFIC EQUIPMENT AND COMPONENTS

MOTORS

HYSTERESIS REVERSIBLE MOTOR

Incorporating two coils. Each coil when energised will produce opposite rotation of output shaft. 240V 60Hz. ½ r.p.m., ¼ r.p.m., ⅛ r.p.m., 6 r.p.m. 30/- each. P. & P. 3/-.

LOW TORQUE HYSTERESIS MOTOR MA23

Ideal for instrument chart drives. Extremely quiet, useful in areas where ambient noise levels are low. High starting torque enables relative high inertia loads to be driven up to 60Z/in. Available in the following speeds and ranges: 240V 50Hz, 15 r.p.m., 4 r.p.m., 2 r.p.m., 1½ r.p.m., 1 r.p.m., ½ r.p.m., ¼ r.p.m., 1/3 r.p.m., 1/5 r.p.m., 1/6 r.p.m., 1/10 r.p.m., 1/12 r.p.m., 1/40 r.p.m., 1/60 r.p.m., 1/75 r.p.m., 1/120 r.p.m., 1/180 r.p.m., 1/360 r.p.m., 1/720 r.p.m., 1/14400 r.p.m., 1/2880 r.p.m.; 120V 50Hz. 1/6 r.p.m., 1/5 r.p.m., 1/15 r.p.m., 1/16 r.p.m., 1/20 r.p.m., 1/30 r.p.m., 1/60 r.p.m., 1/120 r.p.m., 1/240 r.p.m., 1/300 r.p.m. 25/- each.

HYSTERESIS CLUTCH MOTOR

With integral clutch allowing the motor to drop out of engagement with the gear train, thereby facilitating easy resetting when used in timers or in conjunction with a light spring. 6 oz torque at 1 r.p.m. 240V, 50c/s. L = left, R = right. 15 r.p.m. L, 8 r.p.m R and L, 6 r.p.m. L. 4 r.p.m., ½, ⅓, ¼ r.p.m. L, 1/5 r.p.m., 1/6 r.p.m., R and L, 1/10 r.p.m., 1/12, 1/15 r.p.m. L. Also 120V 50c/s 2, 1/6, 1/12, 5/12, 4/11, 1/10 r.p.m. 25/-. P. 3/-.

MINIATURE DIGITAL DISPLAY

Operates on a rear projection 6·3 pilot lamp. The lamp projects the corresponding digit on the condensing lens through a projector lens, on to the viewing screen at the front of the unit. 1in width. 3 5/16 in deep. 1 5/16 in high. Weight 3½oz. Character size ⅝in high, 0·9 with 8 right hand decimal point and degree. List price 6 gns. Our price 49/6. P. & P. 5/-.

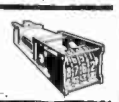
EAC DIGIVISOR Mk. II DIGITAL READ-OUT DISPLAY

Ideally suitable for use in conjunction with transistorised decade counting devices. The DIGIVISOR incorporates a moving coil movement which moves a translucent scale through an optical system and the resultant single plane image is projected on a screen. The translucent scale is made to represent digits 0–9. Specifications: 6·3V 250 microamp. Image height ⅜in. Size 4 9/16 × 2 39/64 × 1⅞in. Our price 3½ gns. List price 8½ gns.

MINIATURE MOVING COIL RELAY S115

By Sangamo Weston, suitable for D.C. circuit. A high sensitivity relay more sensitive than the electromagnetic type. Single Coil Resistance 310 micro amps. 315 Ω. List price £4.10. Our price 20/-.

ELECTRO MAGNETIC COUNTER



Slow impulse counter of 10 impulses per second. 6/6. P. & P. 3/-.

6 DIGIT ELECTRICAL IMPULSE COUNTER

with electrical and mechanical reset counter driven by 110 V DC 4400 ohms coil. Reset 110 V DC 800 ohms coil. Housed in plastic-alloy case. The units can be interlocked with each other to give vertical or horizontal displays. Price 79/6. P. & P. 5/-.

REPEAT CYCLE TIMERS

These timers repeat a set cycle of switching operations via a cam and micro switch, for as long as the motor is energised. Single Cam RB 21in 2 min, 3 min, 4 min, 5 min, 6 min, cycles at 45/-. Twin Cam RD 22 in 1 min, 2 min, 3 min, 4 min, 5 min cycles at 55/-. 4 Cam RD 24 in 4 min, and 5 min cycles at 75/-. 3 Cam RD 26 in 1 min, 2 min, 3 min, 4 min, 5 min cycles at 95/-. 8 Cam RD 28in 1 min, 2 min, 3 min, 4 min, 5 min, cycles at 115/-. All plus P. & P. 5/-.

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Frequency Range 50kc/s–80Mc/s. Output 0·5V. Price £15. Carriage £1.10.

Low ohm safety meter 12mA 5 ohms. Suitable for testing circuits where currents must be limited. W/N and P/E. £12.10.0. P. and P. 17/6.

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	Input Volts	Output Volts	Amps	Price
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N.S.F. wafer switches driven by 24V or 48V d.c. motor. Ideal where switching is to be controlled by a signal pulse. Following sizes available: 2E—3 wafers, 1 pole, 12 position per wafer. 3E—1 wafer, 1 pole, 12 pole per wafer. 35/- each. P. & P. 3/6.

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Ex-equipment but fully tested in our laboratory. Carr. 30/-

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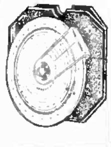

Save time and solve all your multiplication, division, percentage, cube and square root problems. Easy to use pocket calculator with no errors. Invaluable daily aid, should last a lifetime, offered complete in black wallet with full instructions, 3¼in diam. 12/6 each. P. & P. 1/6.

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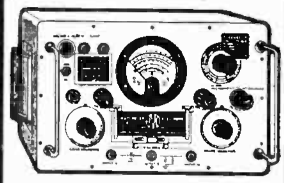

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Automic L.F. Sweep Oscillator Dawe 444C New	£89.10.0
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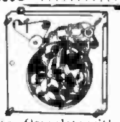
CONTINUOUS TAPE CASSETTE



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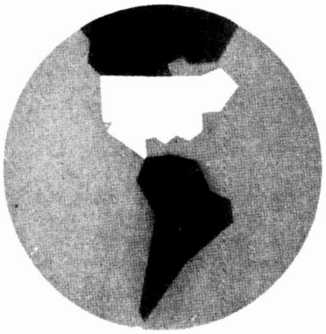


Report from AMERICA

BY L. HUGGARD B.Sc.

... HAMFEST ... AND VARACTORS ...

A "Hamfest" in the United States is a get together of radio amateurs to trade equipment and parts, and of course to consume beer. The Cincinnati "Hamfest" is a traditional happening which has been growing successfully for over 30 years, as the 20 year holder of the presidency happily assured me. By mid afternoon the previous year's gate of just over 2,000 had been comfortably exceeded.

It is organised by the Greater Cincinnati Amateur Radio Association who charge five dollars admission, extracted under a large sign saying "Flea Market!" The admission ticket is a passport to unlimited free beer, two substantial picnic meals and various other snacks, and the ticket number is entered in the hourly prize draws throughout the day.

OPEN MARKET

The wheeling and dealing is conducted by the amateurs round the open boots of their cars packed into a picnic ground taken over for the day, on the outskirts of the city. Here the unwanted junk of the previous year, bearing a hoped for price with occasionally an exhortation to "Fight Poverty, Buy Something" competes with the somewhat more professionally displayed wares of the Government surplus and surplus components dealers, whilst some new equipment manufacturers trade from the grandeur of the bad weather shelter.

The goodies on display defy cataloguing, and ranged in price from thousand dollar brand new transmitter receivers with digit frequency readout to new transistors at two cents each. There were amateur built pieces of equipment. There were old scopes with indignant spiders busily repairing their disturbed webs amongst the tubes. There were early post World War One service radio equipment and even older devices.

There were cameras, lenses, air-compressors, clarinets, trumpets, and all sorts of pickings with knobs and without. Best of all were the boxes of pure junk, fitting accompaniment to another paper carton of free beer.

No matter what one wanted, in the dark corner under the spare wheel of some car, there it would be.

FUN AND GAMES

For the more frivolous there were "hunt the transmitter" games, but to play it was best to have remembered to bring a 440MHz receiver; the lazy alternative was to go and lie in the sun and watch the demonstration radio controlled model planes shave the trees.

The man in the flamingo pink cap just *had* to be an Englishman. He was. Now after nine years in this country a company vice president and operator of station WA8QXU, which he assured me could be heard in Britain.

The prize draw in the late afternoon was the final adrenalin raiser, after which for many inexperienced salesmen came the awful decision, to dump it or try and sneak it back past the wife's eagle eye to the basement for another year.

VARIABLE CAPACITANCE DIODES

For many applications the mechanical variable capacitor is doomed to extinction. Those splendid rows of shining plates on ball bearing spindles, so much a part of radio, will disappear, to be replaced by the Variable Capacitance Diode or "Varactor".

Plastic encapsulated varactors are now being introduced at consumer prices. High capacitance devices which could be substituted for a couple of hundred puffs tuning capacitor are still relatively more costly. Prices are coming down and this state is unlikely to last.

The capacitance effect in the diode is due to the depletion layer formed at the junction of the *p* and *n* type materials forming it. The depletion layer can be looked upon as an electrically neutral area, exhibiting a high resistance because of the lack of conduction carriers.

The diode thus resembles a simple parallel plate capacitor, the *p* type material being one plate and the *n* type the other, separated by the dielectric, the depletion layer. The width of the depletion layer, and thus the distance apart of the "plates" can be varied by varying a reverse bias voltage applied across the junction.

Varactors can be obtained with nominal capacitances of up to 250pF and a tuning range of ten-to-one. These are more expensive than lower values with reduced range.

TUNING RATIO

The tuning ratio is the ratio of the capacitance at the lower reverse bias voltage to that at the upper reverse bias voltage.

$$\text{TR (tuning ratio)} \doteq \frac{C_2}{C_{10}}$$

where C_2 = Capacitance at 2V reverse bias.
and C_{10} = Capacitance at 10V reverse bias.

The reverse voltage cannot be increased indefinitely or the junction will break down at too high a value.

A PRACTICAL EXAMPLE

A typical tuning application is shown in Fig. 1. Note that the inductor L is in parallel with the series combination of C and C_d, where C_d is the varactor capacitance.

C is made very much larger than C_d so that its effect on the resonant frequency of the circuit is negligible and that frequency is given by

$$f = \frac{1}{2\pi\sqrt{LC_d}}$$

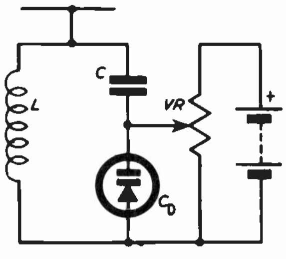


Fig. 1. Note that diode is reverse biased by potentiometer VR

C blocks the bias voltage from the coil, which would otherwise provide a low resistance path for bias currents, reducing the voltage across the varactor. VR can be large, about 470 kilohms, so that the bias circuit loading of the tuned circuit is small.

The reverse resistance of the diode is large and virtually the whole of the voltage picked off the potentiometer VR appears across the tuning diode. The circuit is thus tuned by varying the setting of the potentiometer. There is one snag, the maximum signal appearing across the tuned circuit must be much smaller than the minimum bias voltage applied to the diode or serious intermodulation distortion will result.

An obvious use for such a circuit is to permit tuning by remote control, and the ingenious can carry on from there.

EDUCATED EMMA

ELECTRONIC MIME MOBILE ANIMAL

By G.C.BROWN
M.S.H.A.A. A.M.R.S.H.

This article is an extension of the EMMA project published in the March and April 1969 PRACTICAL ELECTRONICS. It is expected that readers wishing to add EMMA's new capability will be familiar with the previous articles; the component numbering is carried on from the earlier circuits and reference is made to diagrams in the March and April 1969 issues. We regret that we are no longer able to supply copies of these issues.

SINCE the formative weeks following EMMA's rather difficult birth back in March she has, as we would have expected, already come of age. Indeed, she now exhibits a kind of self-preservation awareness which encourages her to perform simple work tasks for a living. More accurately, given the right situation EMMA really "wants" to work because to do so is now part of her make-up and she can learn that quite often this will pay-off.

In order to embody this new faculty EMMA's shape has filled out just a little with an additional circuit board. However, the modifications to her existing systems are not unduly complicated and the keen Bionics constructor will probably be overjoyed to know that at last he can have a semi-intelligent "animal".

ANATOMICAL CHANGES

To encourage EMMA to work in return for reward requires a few extra circuit blocks and if the reader refers to Fig. 1, a clear impression of the technique will be gained.

The philosophy behind the original scheme for EMMA has not been changed drastically, but there are now included such items as a Schmitt trigger which monitors the supply voltage level and of course the inevitable learning circuit with which by now we must all be familiar. This embodies a pair of monostables, one (the extension monostable) having a duration of 20 seconds and the other (the differential monostable) a period of 1 second.

As usual there are also included an AND gate and a summer with its attendant learnt threshold Schmitt which triggers upon the summer level reaching some pre-determined value.

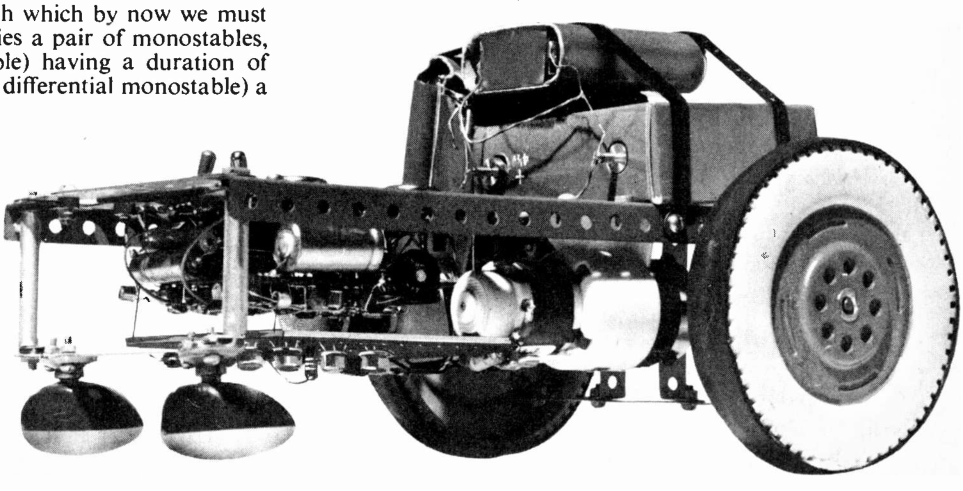
DESIGN PHILOSOPHY

Now it is intended that EMMA should learn to work, so this implies that she must additionally have a need to work in the first place. If a situation is made sufficiently attractive she will be prepared to do some simple chore provided she has a previous memory of being rewarded.

These requirements are largely accommodated by deliberately reducing EMMA's muscle control supply for short periods. This makes her hypersensitive to loads during which she is encouraged to carry a heavy book or similar object.

Periodically we may give her some "reward" by returning the supply to normal so that she realises that we intend to pay her when the work has been done.

We achieve all this in a somewhat synthetic way by switching out one of the cells forming part of the forward drive supply battery. Thus during conditioning her supply for the forward mode is a little less than 3 volts unless we provide a reward, in which case it rises to about 4·5V.



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250-0-250 80 mA. 6.3 v. 3.5 a. 6.3 v. 1 a, or 5 v. 2 a.	30/-
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300-0-300 v. 120 mA., 6.3 v. 4 a. C.T.; 6.3 v. 2 a.	45/-
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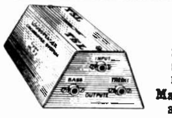

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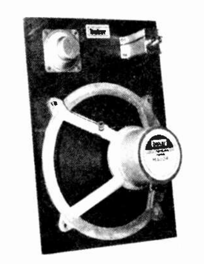

30-14,500 c.p.s., Hi-Fi double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 45 c.p.s. Rated 20 watts. Voice coils available 3 or 8 or 15 ohms. Price £8, or Module kit, 30-17,000 c.p.s. with tweeter, crossover, baffle and instructions. £10.19.6.

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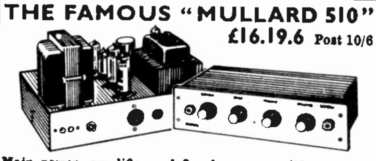

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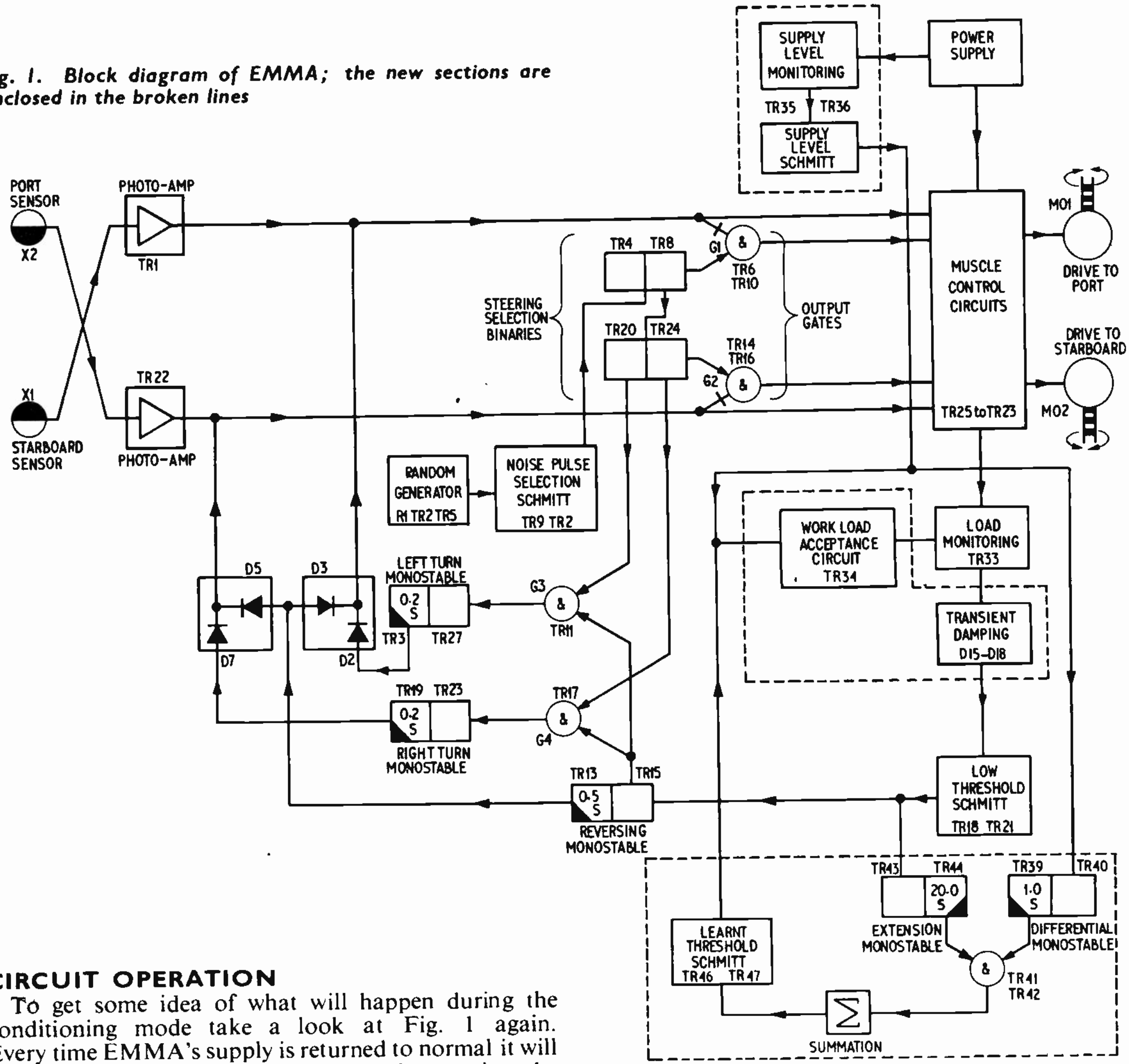
Fig. 1. Block diagram of EMMA; the new sections are enclosed in the broken lines



CIRCUIT OPERATION

To get some idea of what will happen during the conditioning mode take a look at Fig. 1 again. Every time EMMA's supply is returned to normal it will trigger the supply level Schmitt thereby causing the differential monostable to fire.

Assuming just prior to this that a physical load has been applied then the load monitoring section will have previously fired the extension monostable. As a result, and provided the differential monostable fires during the time the extension monostable is in the quasi-stable condition, the AND gate will be enabled and consequently the summer output level will begin to rise.

If we repeat the process a number of times the existence of the reward can obviously become significant because the increasing level from the summer will ultimately reach a point where the learnt threshold Schmitt fires.

Immediately this occurs the work-load acceptance circuit will raise the threshold of the load monitoring system allowing EMMA to tolerate greater loads, indeed, the very same kind of loads she would accept were her supply to be at a normal level. However, she has at this stage learnt to understand that her supply will return to normal and so she "soldiers on" in the knowledge that all will be well.

Nevertheless, if we decide to stop rewarding EMMA her memory for the "good life" will gradually diminish as the summer level falls, until a point is reached where the load will no longer be tolerated. At such times she will "twist and turn", being thoroughly intractable as her normal reflexes take over and the avoidance system goes into operation.

Like any real creature EMMA, given the opportunity, can improve her chances for continued existence by taking advantage of certain situations. Thus she can adapt herself to doing a small task if it promises some form of payment and just as easily give the job up if not adequately reimbursed.

CIRCUIT IMPROVEMENTS AND MODIFICATIONS

In her existing form EMMA will normally function quite satisfactorily and so if it is not intended to add the new circuitry her "neurology" can be left as it is. Nevertheless, there are certain improvements that can be made and certain modifications that must be attended to before adding the learning system.

The changes are all extremely simple and so will be indicated in relation to the existing circuit diagrams for the reflex and muscle control sections discussed in the March and April issues of P.E. The relevant areas of discussion are in Figs. 2 and 5, in the March and April 1969 issues respectively.

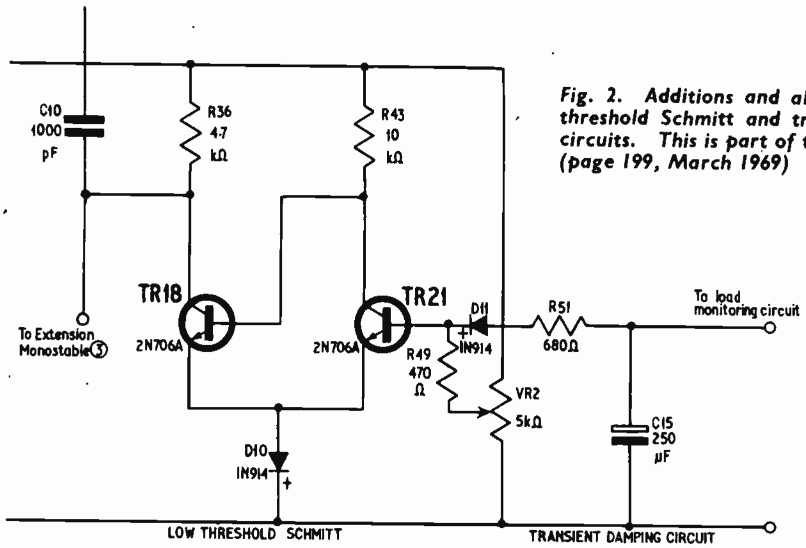


Fig. 2. Additions and alterations to low threshold Schmitt and transient damping circuits. This is part of the reflex circuits (page 199, March 1969)

TRANSIENT DAMPING CIRCUIT

In this circuit (Fig. 2, March 1969) a diode must be added (cathode end to base of TR21) in series with R51 to ensure that the voltage across C15 is entirely attributable to the output from the load monitoring system. Otherwise C15 can charge via VR2 and R49. Resistor R49 must be reduced to 470 ohms. Fig. 2 (above) shows the relevant section of the circuit.

LOW THRESHOLD SCHMITT

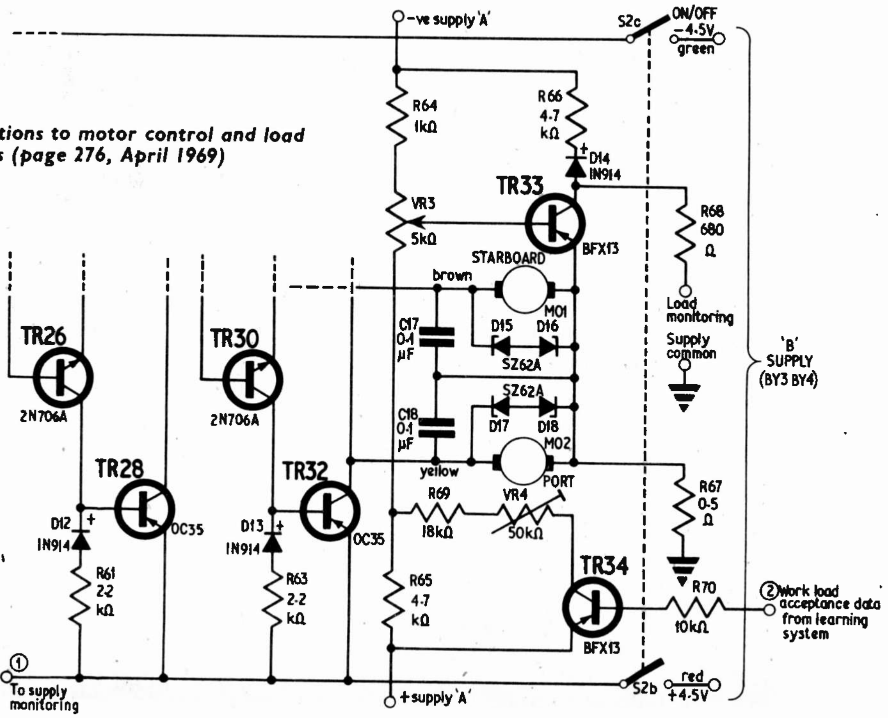
The resistor R40 must be removed and replaced with a diode (Fig. 2), its cathode being taken to the −4·5V rail of the "A" power supply. This modification results in there being an almost constant potential between TR18 and TR21 emitters and the negative rail. As a consequence the backlash of the Schmitt is effectively reduced to zero with the result that it comes on and goes off almost at the same point.

A connection from the low threshold circuit must also be taken from the collector of TR18; this can take the form of a short piece of insulated wire and may be coiled back out of the way until it is called upon to connect the reflex circuitry with the extension monostable discussed later.

MUSCLE CONTROL SYSTEM

In earlier articles we discussed the problem of motor noise; the "hash" was reduced using a pair of capacitors C17 and C18, across the motors (Fig. 5, April 1969). An improvement has now been embodied which really minimises the problem. This involves using a pair of 6V Zener diodes connected back-to-back (as shown in

Fig. 3. Alterations to motor control and load sensing circuits (page 276, April 1969)



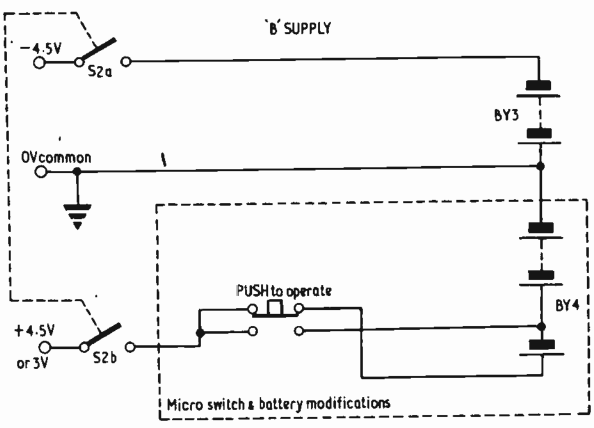


Fig. 4. Circuit diagram of the new "B" power supply and switch wiring

Fig. 3) across each motor. Noise spikes of either polarity and in excess of the Zener voltage of one diode and the forward voltage drop of the other are thus suppressed.

Additional diodes (D12 and D13) are connected in series with R61 and R63 (cathodes to the bases of TR28 and TR32 respectively) and also D14 in series with R66 (anode to collector of TR33). These are included to prevent any paths between the supply being monitored (the "forward" half of this supply) and the supply which feeds the monitoring circuit ("A" supply).

For similar reasons the load monitoring circuit is now not run from the "A" supply and suitable arrangements must be made to reconnect R64 and R66 to the negative rail of the "A" supply. The resistor R65 must go to the positive rail of the "A" supply and is shunted with the series combination R69, VR4, and TR34 (Fig. 3) which constitutes the work load acceptance circuit.

"B" POWER SUPPLY

The forward-mode battery (type 126) of the "B" supply requires a small modification so that either 3V or 4·5V may be obtained. This entails carefully opening the paper flap at the top of the battery with a razor blade and taking a connection from the 3V tapping (i.e. one cell down from the positive side of the battery). The 4·5V and 3V outputs thus obtained are then taken to a double pole changeover microswitch (Fig. 4) so that in use EMMA's forward operation can be obtained from either normal or reduced supplies.

This completes the various modifications to the existing hardware and we are now in a position to concentrate on the learning system, also to the way in which it interconnects with the rest of EMMA's person (see Fig. 5).

SUPPLY LEVEL MONITORING

This circuit comprises a Schmitt trigger which is similar in form to the type mentioned earlier (i.e. it has extremely little backlash) and has its input connected via R71 to VR5 which goes to the positive rail of the "B" supply. Adjustment of VR5 sets the threshold at which the Schmitt fires; generally this need only be just at the "B" supply level and no lower.

The capacitor between TR35 base and the negative rail of the "A" supply prevents transients switching the Schmitt.

Once set-up the Schmitt trigger will switch whenever the voltage at the positive rail of the "B" supply falls below normal (influenced by operation of the microswitch). Hence TR35 will turn off and TR36 will come on with the result that TR37 will cease to conduct. With TR37 collector positive TR34 will turn off and consequently EMMA will be extra sensitive to loads.

When the supply is returned to normal TR35 will again turn on and TR36 will turn off. At this time the positive voltage at TR36 collector will be passed to the differential monostable causing it to fire. Simultaneously, TR37 will turn on again thereby raising the load threshold.

DIFFERENTIAL AND EXTENSION MONOSTABLES

Both monostables are a little unconventional in that they each use extra transistors forming the Darlington pairs TR38, TR39 and TR44, TR45. These provide higher gain and hence permit larger timing resistors to be used.

Diodes D22 and D23 provide a fair degree of noise immunity and so prevent the monostables from triggering prematurely if any short-term voltage drop occurs on the "A" supply. Under such conditions D22 and D23 are reverse biased and the associated capacitor (C21 or C22) effectively bridges the interval during a voltage drop "holding-up" the collector of the transistor that is turned off.

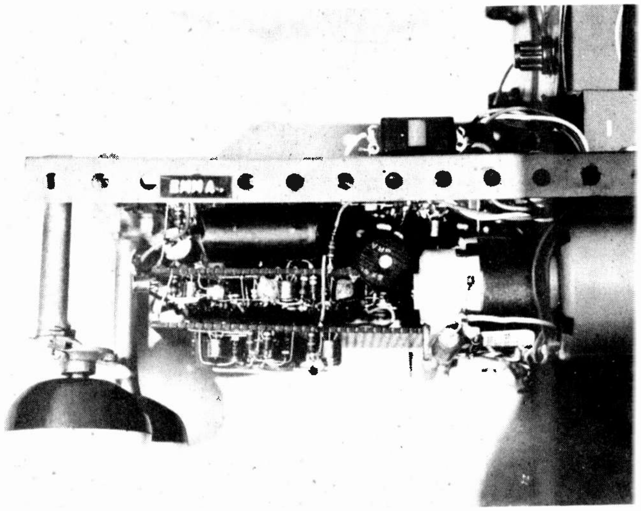
The extension monostable is triggered from the load threshold Schmitt and fires whenever the load exceeds a certain level. As mentioned earlier the differential monostable triggers whenever the positive end of the "B" supply is returned to normal.

COINCIDENCE GATE

The coincidence (AND) gate comprises TR41 and TR42. Assuming a sufficiently heavy load has been applied to EMMA then the extension monostable will have fired hence turning off TR42.

If during the 20 second period of the extension monostable the positive rail of the "B" supply has been returned from low to normal then the differential monostable will be triggered.

View of "Educated EMMA" showing the position of the new circuit board



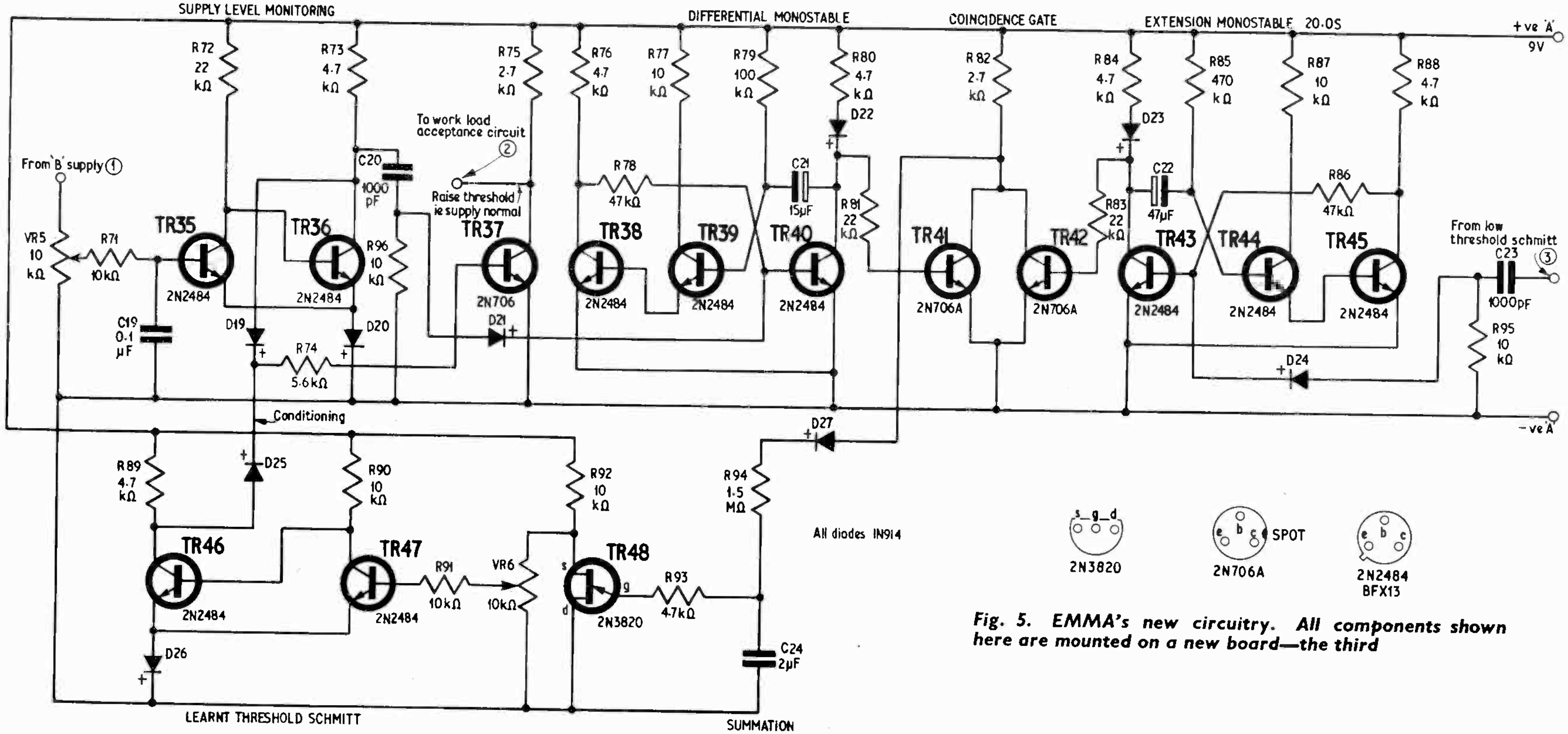


Fig. 5. EMMA's new circuitry. All components shown here are mounted on a new board—the third

COMPONENTS . . .

Resistors

R49	470Ω	R78	47kΩ	R88	4·7kΩ
R69	18kΩ	R79	100kΩ	R89	4·7kΩ
R70	10kΩ	R80	4·7kΩ	R90	10kΩ
R71	10kΩ	R81	22kΩ	R91	10kΩ
R72	22kΩ	R82	2·7kΩ	R92	10kΩ
R73	4·7kΩ	R83	22kΩ	R93	4·7kΩ
R74	5·6kΩ	R84	4·7kΩ	R94	1·5MΩ
R75	2·7kΩ	R85	470kΩ	R95	10kΩ
R76	4·7kΩ	R86	47kΩ	R96	10kΩ
R77	10kΩ	R87	10kΩ		

Potentiometers

VR4 50kΩ
VR5 10kΩ } skeleton preset
VR6 10kΩ

Capacitors

C19 0·1μF
C20 1,000pF
C21 15μF elect. 12V
C22 47μF elect. 12V
C23 1,000pF
C24 2μF non polarised 63V

Diodes

D10 to 14 IN914 (5 off)
D15 to 18 SZ62A or equivalent 6V Zener (4 off)
D19 to 27 IN914 (9 off)

Transistors

TR34 BFX13
TR35, 36 2N2484 (2 off)
TR37 2N706A
TR38–40 2N2484 (3 off)
TR41, 42 2N706A (2 off)
TR43–47 2N2484 (5 off)
TR48 2N3820

Miscellaneous

D.P.S.T. microswitch
Veroboard 5in × 2½in, 0·1in matrix

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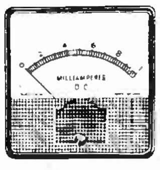
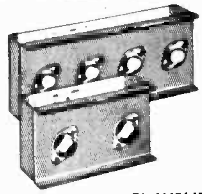


✱ QUALITY PANEL METERS

38 Series. Face size 42 x 42mm (1⅝in x 1⅝in). 50µA, 37/6; 100µA, 35/-; 200µA, 32/6; 500µA, 27/6; 1mA, 5mA, 10mA, 50mA, 100mA, 500mA, 25/- each; 10V, 20V, 50V, 100V, 300V and 500V, 25/- each; 1A and 5A, 25/- each. "S" meter, 1mA, 29/6. VU meter, 37/6. 65 Series. Face size 86 x 78mm (3⅜ x 3⅛in). 50µA, 62/6; 100µA, 52/6; 200µA, 47/6; 500µA, 45/-; 1mA, 5mA, 10mA, 500mA, 37/6 each. "S" meter, 1mA, 42/6. Other ranges and sizes available. List on request with full details.



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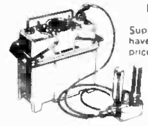

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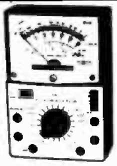

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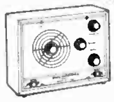

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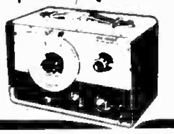
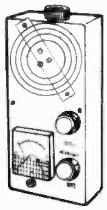
32	C.R. Bridge	10	10	0	26
33	Inductance Bridge	20	0	0	29



✱ SINE/SQUARE WAVE AUDIO GENERATOR

Provides audio output on 4 bands. Sine wave 20c/s to 200kc/s, output up to 7V; square wave 60c/s to 30kc/s, 7V p-p. Distortion under 2%. Output impedance 1kΩ. Variable output amplitude control. Supplied with leads and instructions. A.C. mains operated.

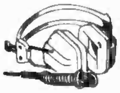
TE22 Price £16.10.0.



✱ GRID DIP METER

All transistor grid dip meter, absorption wavemeter and osc. detector. Frequency range 440kc/s to 280Mc/s in 6 coils. Uses 3 transistors plus diode with 500µA meter. Internal battery.

TE15 Price .. £11.10.0 pp.3/6



STEREO HEADPHONES

Featuring soft Padded Headsets, wide frequency response. Adjustable Headbands. Fitted Jack plugs.

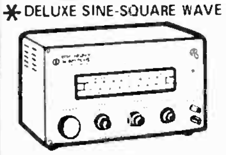
DHO 2/S Recommended 20C/S–15KC/S .. £2.19.6
SE28 Built in Tweeters and Volume Controls £9.19.6
KOSS, KO727 £16.10.0. PRO-4A .. £23. 0.0
SP-3KC .. £11.15.0

CALL FOR DEMONSTRATION

Mono Switched 8/16 ohms and 4K ohms Price £4.4.0

Stereo Headphone Amplifiers
Inputs for PU/Tuner, Battery Model Mains Operated High Quality

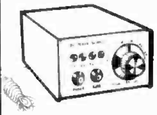
Eagle HA10 .. £8.19.6
Shure SA2/E .. £18.18.0



✱ DELUXE SINE-SQUARE WAVE RC AUDIO GENERATOR

Weinbridge RC Audio oscillator featuring four overlapping scales covering 18c/s to 200 Kc/s. Output waveforms are sine, square and complex. Mirrored scale with smooth geared tuning control. Output 5 volts RMS or 10 volts P-P. Sinewave response ±1dB, Distortion under 1% at 1Kc/s. Stability ±1%. Accuracy ±2%. O/P Impedance under 3Kohms Variable Attenuator. Mains operated. With Handbook.

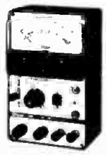
ORC 27A Price £28 10 0 pp.10/-



✱ DC STABILISED POWER SUPPLY

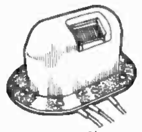
Switched DC Stabilised Outputs UP TO 1AMP. 3-6-9 & 12 VOLTS. Indicator lamp for each voltage. Fully fused mains operated. Negligible ripple. Regulation 1%.

SE101A Price £8 15 0



✱ TRANSISTOR CHECKER

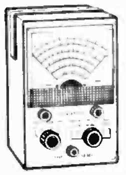
Complete capacity for checking all transistors npn and pnp for alpha, beta and German. Also diodes complete with leads and instructions. **ZQM-2, Price £5.19.6, p.p. 3/6.**



GRAVINER FIRE DETECTOR UNIT

The Detector Unit consists essentially of a highly sensitive 931A photo-electric cell combined with a firing circuit. Incorporates a single cold cathode electronic relay, capacitors and resistors designed to fail to safety if external wiring is open or short circuited. Encapsulated in a resin which fully insulates the unit electrically and provides a high degree of mechanical and thermal shockproofing. Original price £74 OUR PRICE, BRAND NEW £6 each, with data sheet

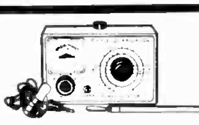
SIZE 4 x 3 x 2½ in. Limited quantity available.



✱ VACUUM TUBE VOLTMETER

Features low price for such an instrument. Large 6in full view scaled meter. 28 ranges. D.C. volts: 0/1½/5/15/50/150/500/1500. A.C. volts: 0/1½/5/15/50/150/500/1500 r.m.s.: 0/1·4/4/14/40/140/400/1400/4000 p-p. Resistance: R x 10–100–1k–10k–100k–1m–10m. Range 0·2 ohm to 1000MΩ. dB scales: −10 to +65dB. Complete with instructions and leads.

MODEL TE65
£17.10.0 p.p. 7/6
HV Probe 50/-
R.F. Probe 42/6

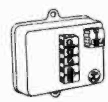


✱ FIELD STRENGTH METER

5 Ranges 1–250 mc/s. Fitted 200µA meter. Earphone output. Calibrated tuning scales.

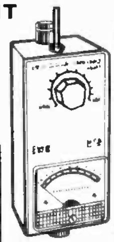
FL30HA Price 72/6 pp.2/-

Also non-calibrated type peaking F/S meter. FSI Price 45/- pp.2/6



EXPERIMENTER'S MODULE

Terrific offer of brand new STC time delay electronic units. Adjustable 3–15 recs. 9–12V operated. Supplied complete with suggested uses circuits. **STC Module Price 35/-.**



✱ SWR ALIGNMENT METER

Ideal for all transmitter alignment. Built-in field strength meter 100µA. Complete. Ready to use. SWR 1:1 to 1:3.

SWR 3 .. Price 69/6 p.p. 2/6

✱ 20,000 OHMS PER VOLT MULTIMETER

Popular model but with extra scale range. 20,000 ohms per volt. 0/5/25/50/250/500/2500V d.c., 0/10/50/100/500/1000V a.c., 0/50µA, 0/2½/250mA. Resistance 0–6kΩ and 6MΩ. Also dB scales or capacitance.

Model 200H 77/6 pp2/-
(Leather case, Price 15/- pp.2/-)

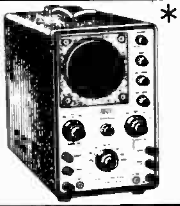
✱ TRANSISTORISED INTERCOMMS

Bellphone £4.10.0
2-station, £3.10.0; 3-station, £5.15.0; 4-station, £6.12.6 (2-station uses no wires) mains operated, £11.19.6. Telephone amplifier, 59/6. P. & P. 3/6

9 VOLT 100 m A STABILISED SUPPLY
Size 3" x 2" x 1¼". Fused ready to use. U.K. made Transistorised.
PRICE 45/-. p.p. 2/6.

WELLER SOLDERING IRONS

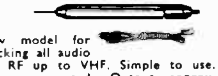
8200 Gun & Iron 59/6
8200D PK Gun Kit .. 79/6
ANTEX CN Iron 29/6
ANTEX Iron Kit 42/6



✱ PORTABLE OSCILLOSCOPE

Features 3in clear view tube, easy to use controls and good stability. Y amp. Sensitivity ·1V p-p/CM. Bandwidth 1·5 cps—1·5 MHz. Input imp. 2 meg Ω. 25 PF. X amp sensitivity ·9V p-p/CM. Bandwidth 1·5 cps—800 KHz. Input imp. 2 meg Ω. 20 PF. Time base, 5 ranges 10 cps—300 KHz. Synchronization. Internal / external. Illuminated scale. 140 x 215 x 330 MM. Weight 15 lbs. 220/240V. A.C. Supplied brand new with handbook.

TO3 Price £35 p.p. 10/-



✱ SIGNAL INJECTOR

New model for checking all audio and RF up to VHF. Simple to use. Battery operated. Output approx. 1kc/s, 1·4V pp. Harmonics up to VHF.

SE250B Price 35/- p.p. 1/6

✱MATCHING SIGNAL TRACER
SE 500 Price 27/6 p.p. 1/6

Transistors

Huge quantities in stock for Industrial users—Write for Industrial Price List. Includes all Types of Semiconductor Device.

***MULTIMETER**

Return of a popular model. 2000 ohms/V. 0/10/50/500/1000V a.c./d.c. 0/50µA. 0/10/250µA d.c. 0/10/100kΩ/1MΩ resistance. dB and capacitance scales. Size 5in. x 3½in x 1½in. Robust and easy to use. Complete with leads, batteries and instructions.

THL 33A 82/6 p.p. 2/6
Leather case Price 22/6

CATALOGUES—TWO NEW EDITIONS NOW AVAILABLE SEE BACK COVER FOR DETAILS

Did you know we stock 1,000 Transistors and Devices? Ask for Latest FREE List (No. 36)

HENRY'S RADIO LTD.
303 & 309 Edgware Rd, London W2

'303' Components/Equipment/Organ Parts also MAIL ORDER DEPT. 01-723-1008/9

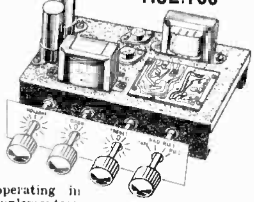
'309' Test Gear/High Fidelity etc. 01-723 6963

ALL MAIL ORDERS TO '303'

SHOP HOURS 9 a.m.—6 p.m. THURSDAY 1 p.m. OPEN ALL DAY SATURDAY.

MONO TRANSISTOR AMPLIFIER

HSL.700



A really high fidelity monaural amplifier with performance characteristics to suit the most discriminating listener. 6 transistor circuit with integrated preamplifier assembled on special printed sub panel. AD161-AD162 operating in symmetrical complementary pair. Output transformer coupled to 3 ohm and 15 ohm speaker sockets. Standard phono input sockets. Full wave bridge rectifier power supply for a.c. mains 200–240v. Controls: bass, treble, volume/on/off. Function selector for PU1, PU2, tape, radio. The HSL.700 is strongly constructed on rigid steel chassis bronze hammer enamel finish, size 9¼ × 5 × 4½in. high.

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

Output power measured at 1Kc—6·2 watts RMS into 3 ohms, 5·8 watts RMS into 15 ohm. Overall frequency response 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.

LOUDSPEAKER BARGAINS

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 21/-, 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.

E.M.I. 3½in HEAVY DUTY TWEETERS. Powerful ceramic magnet. Available in 3 or 8 ohm 15/- each; 15 ohm 18/6 each. P. & P. 2/6.

12in "RA" TWIN CONE LOUDSPEAKER. 10 watts peak handling. 3 or 15 ohm, 37/6, P. & P. 6/-.

35 OHM SPEAKERS

3½in 14/-, P. & P. 2/6; 7 × 4in 21/-, P. & P. 4/-.

80 OHM MOVING COIL SPEAKERS. High Flux Magnet 2½" dia. 12/- each. P. & P. 1/6.

SPECIAL OFFER

Hi-Fi Celestion Speaker Unit. Size 6 x 4in. Powerful 11,000 line magnet with specially treated cone surround. 10–12 ohm impedance. Few only at 20/-. P. & P. 3/6.

QUALITY PORTABLE TAPE RECORDER CASE. Brand new. Beautifully made. Only 49/6, P. & P. 8/6.

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

HIGH IMPEDANCE CRYSTAL STICK MIKES. OUR PRICE 21/-. P. & P. 1/6.

HIGH IMPEDANCE DYNAMIC STICK MIKES. High sensitivity. 39/6. P. & P. 2/6.

PYE MICROSWITCHES S/P. C/O. Lever roller action. Rating 250v. AC at 5 amps. Size approx. 1" × ⅜" × ⅜". 4/- each. P. & P. 1/- (6 or more post free).

HONEYWELL MICROSWITCHES S/P. C/O. Push-button action. Rating 250v. AC at 15 amps. Size approx. 1⅞" × ⅞" × ⅝". 5/- each. P. & P. 1/- (6 or more post free).

TELESCOPIC AERIALS WITH SWIVEL JOINT. Can be angled and rotated in any direction. 12 section Heavy Chrome. Extends from 7" to approx. 56". Maximum diameter ½". 10/- each. P. & P. 1/6. 6 section Lacquered Brass. Extends from 6" to approx. 22½". Maximum diameter ⅜". 5/- each. P. & P. 1/-.

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 3¼nL × 3¼inW × 3inD. Price 32/6. P. & P. 6/-.

MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240V. Sec. 9–0–9 at 500mA. 11/-. P. & P. 2/6. Pri. 200/240V. Sec. 12–0–12 at 1 amp. 14/6. P. & P. 2/6. Pri. 200/240V. Sec. 10–0–10 at 2 amp. 27/6. P. & P. 3/6. Tapped Primary 200–220–240V. Sec. 21·5V at 500mA. 12/6. P. & P. 2/6.

BRAND NEW MAINS TRANSFORMERS for Bridge Rectifier. Pri. 240v. AC Sec. 240v. at 50mA and 6·3v. at 1·5 amp. Stack size 2⅛ × ⅞ × 2¼in. 10/6. P. & P. 3/6. (Special quotations for quantities.)

BRAND NEW! PARMEKO MAINS TRANSFORMERS. Primary 110v-250v. Secondary 330-0-330v. 100mA and 6·3v. at 2 amps, 6·3v. at 2 amps and 6·3v. at 1 amp. Conservatively rated. Fully impregnated Electrostatic screen Suitable for vertical or drop through mounting. Overall size 4⅛ × 3⅜ × 3¼in. Weight 8 lb. Limited number only at 37/6. P. & P. 8/-.

SPECIAL OFFER!!

Your opportunity to acquire a first class HI-FI LOUDSPEAKER SYSTEM at an extremely moderate price! Beautifully made teak finish enclosure with most attractive Tygan front. Size 16½" high × 10½" wide × 6" deep. Fitted with E.M.I. Ceramic Magnet 13" × 8" bass unit, two H.F. tweeter units and crossover. Power handling 10 watts. Available 3 or 15 ohm impedance.

OUR PRICE WHILE LIMITED STOCKS LAST 8 Gns. Carriage 10/-

TRANSISTOR STEREO 8 + 8 MK II

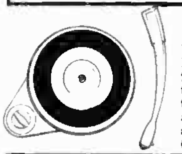
Now using Silicon Transistors in first five stages on each channel resulting in even lower noise level with improved sensitivity. A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors giving 8 watts push pull output per channel (16W mono). Integrated pre-amp. with Bass, Treble and Volume controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 3 to 15 ohms. Compact design, all parts supplied including drilled metal work. Cir-Kit board, attractive front panel, knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Freq. response ± 3dB. 20–20,000c/s. Bass boost approx. to +12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 25V at 0·6 amp.

PRICES: AMPLIFIER KIT £10.10.0; POWER PACK **KIT £3.0.0; CABINET £3.0.0.** All Post Free.

Also available **STEREO 10 + 10.** As above but 10 watts per channel. **PRICES:** AMPLIFIER **KIT £12.** POWER PACK KIT £3.10.0.

Circuit diagram, construction details and parts list (free with kit) 1/6. (S.A.E.).

Official stockists of all PEAK SOUND HI-FI EQUIPMENT including the **P.W. DOUBLE 12 STEREO AMPLIFIER** as featured in Practical Wireless April, May and June issues. Component pack as specified. Total cost £23.5.6 plus P. & P. 11/-. (Excluding metalwork, knobs, plugs and sockets and fuses.)



SPECIAL PURCHASE! E.M.I. 4-SPEED PLAYER

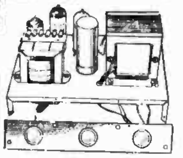
Heavy 8¼in. metal turntable. Low flutter performance 200/250 V shaded motor (90 V tap). Complete with latest type lightweight pick-up arm and mono cartridge with t/o stylii for LP/78. ONLY 63/-. P. & P. 6/6.

QUALITY RECORD PLAYER AMPLIFIER MK II

A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. × 3 d. × 6 h. Ready built and tested. PRICE 75/-. P. & P. 6/-. ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet below. PRICE 97/6. P. & P. 7/6.

DE LUXE QUALITY PORTABLE R/P CABINET MK II

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 7¾in w. × 4in. d. × 4¾in. 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/-.

HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. 79/6. P. & P. 6/-.

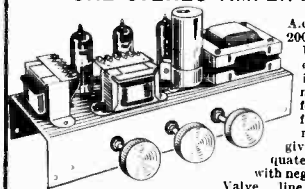
BRAND NEW TRANSISTOR BARGAINS. GET 15 (Matched Pair) 15/-; V15/10p, 10/-; OC71 5/-; OC76 6/-; AF117 3/6; 2G339 (NPN) 3/-.

Set of Mullard 6 transistors OC44, 2—OC45, AC128D, matched pair AC128 25/-; ORP12 Cadmium Sulphide Cell 10/6. All post free.

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. 1½" × 1¼". 7/6 each. P. & P. 1/6. (3 or more Post Free).

DE LUXE STEREO AMPLIFIER



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

4-SPEED RECORD PLAYER BARGAINS

Mains models. All brand new in maker's packing.
B.S.R. UA25 with latest mono compatible cart... £6.19.6
All plus Carriage and Packing 6/6.

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

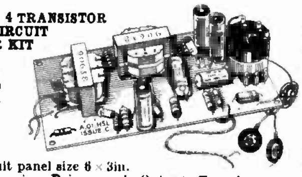
PLINTH UNITS cut out for Garrard Models 1025, 2025, 2000, 3000, AT60, SP25. With transparent plastic cover. OUR PRICE **5 gns.** complete. P. & P. 8/6.

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



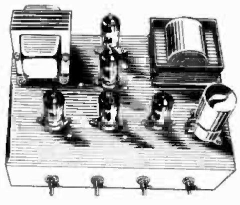
● Peak output in excess of 1½ watts.
● All standard British components.
● Built on printed circuit panel size 6 × 3in.
● Generous size Driver and Output Transformers.
● Output transformer tapped for 3 ohm and 15 ohm speakers. ● Transistors (GET114 or 81 Mullard AC 128D and matched pair of AC128 o/p). ● 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 49/6 P. & P. 6/-

10/14 WATT HI-FI AMPLIFIER KIT



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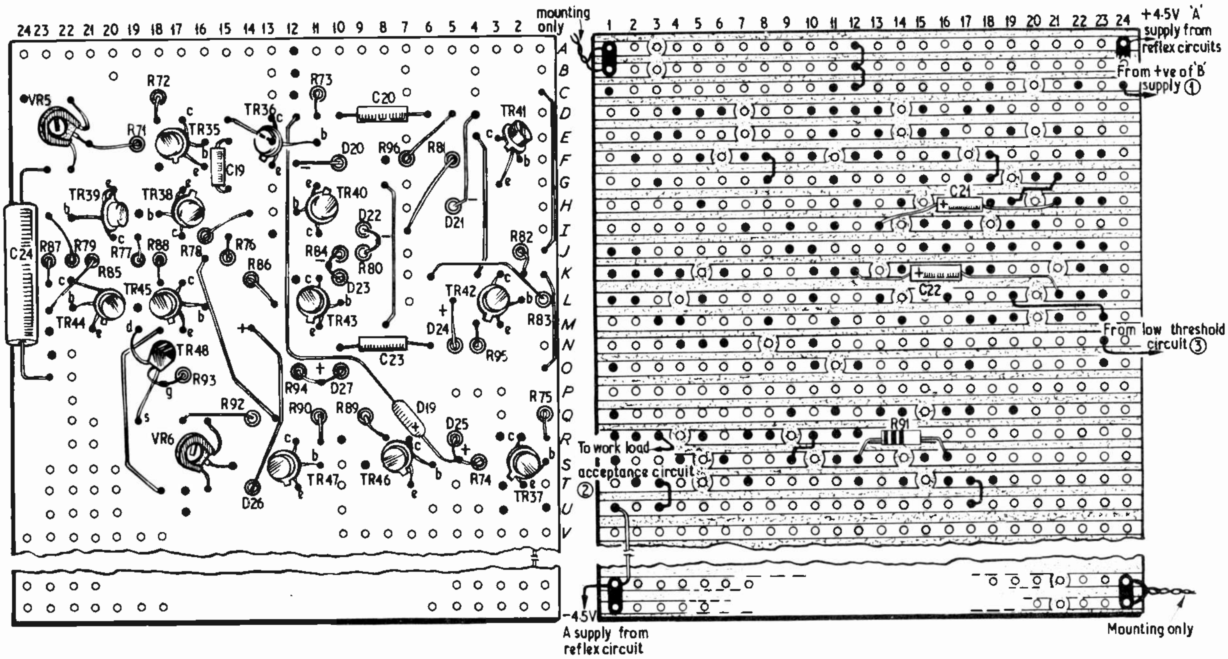


Fig. 6. Component layout and wiring for the new board: (a) component side, (b) copper side showing breaks in the copper strips

Transistor TR41 will also turn off, and the common collector point of TR41, TR42 will go positive for a time, essentially determined by the period of the differential monostable, i.e. one second or less if the extension monostable is close to the end of its quasi stable state. The output from the coincidence gate is taken to the summation circuit.

SUMMATION CIRCUIT AND "LEARNT" THRESHOLD

As implied by its designation, the summation circuit adds or integrates the output pulses from the coincidence gate and comprises TR48 and its associated components. Capacitor C24 and R94 provide a time-constant sufficiently long to ensure that the maximum summation limit extends to accepting greater than 15 input pulses.

Unwanted discharge of the capacitor is minimised by inclusion of D27 and by the very high input impedance presented by TR48 which is an f.e.t. Initially TR48 will be conducting, but as pulses from the coincidence gate gradually charge C24 so the voltage at TR48 source will climb towards the positive rail.

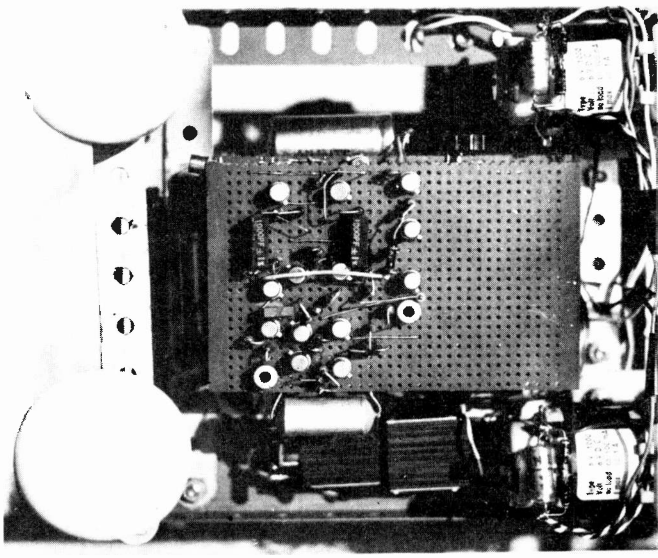
At some level of summation, dependent upon where VR6 has been set, the learnt threshold Schmitt will switch causing TR37 to turn on. This condition will remain until the level on C24 drops below the point necessary to maintain the Schmitt in the triggered state.

However, due to the reasons discussed earlier this will take a fair time and consequently TR37 will remain on to ensure that EMMA accepts higher loads at low supply levels. Of course, if this state of affairs is not reinforced periodically by giving EMMA a short rise in her "B" supply level then the voltage across C24 will gradually decay to a point where the load threshold drops again.

CIRCUIT BOARD CONSTRUCTION

The method for layout and wiring of the learning system circuit board is shown in Figs. 6a and 6b. Depending on the potentiometers used the Veroboard may require some drilling, however, all other components are mounted by way of their individual leads. The board itself is attached to the existing reflex board by 18 s.w.g. wire soldered to its four corners.

Underside view of EMMA showing the new circuit board



It is important to note that all necessary breaks in the copper strip should be made prior to mounting the various components.. Care should be taken to ensure that the complete width of the copper has been removed at each break.

Always mount transistors and diodes last and be sure not to keep them in contact with the soldering iron longer than necessary.

CHECKOUT

When the work on the circuit board has been completed it should be carefully examined to make sure that no dry joints or solder bridge-overs exist and that all components are carefully connected. It can now be inter-connected with the remainder of EMMA's anatomy.

Set EMMA's muscle control and the reflex system switches on. Connect a meter between the zero point of the supply batteries and the positive rail of the "B" supply to ensure that the level is approximately 4·5V. Operate the microswitch and check that this level falls to 3V. Release the microswitch and disconnect the meter. Inhibit EMMA's random generator circuit by turning the associated Schmitt permanently on through the use of VR1. Ensure that both motors are running.

SUPPLY LEVEL SCHMITT

Place EMMA on the ground and adjust VR2 so that she will carry a relatively heavy load, but goes into the avoidance reaction upon bumping into an obstacle.

Return EMMA to the work bench and with the meter connected between the collector of TR36 and the negative rail of the "A" supply, adjust VR5 until the supply level Schmitt *just* triggers, evidenced by the meter reading almost rail potential. Operate the microswitch and ensure that the meter reading drops to near zero level; if not, re-adjust the Schmitt. Disconnect the meter.

Now place EMMA back on the ground and replace the load. Ensure that, as before, the avoidance reaction does not occur unless she meets with an obstruction. Operate the microswitch and check that both EMMA's speed is reduced and that she immediately goes into the avoidance mode. If she is functioning correctly return EMMA once more to the table.

DIFFERENTIAL AND EXTENSION MONOSTABLE

Connect the meter between the common collector point of TR41, TR42 and the negative rail of the "A" supply; there should be an almost zero reading.

Now simulate a load by stalling the road wheels and, shortly following this, operate the microswitch. There should be a reading of almost rail potential. If not, check that the differential and extension monostables are functioning—the meter connected to either TR40 or TR43 collector will establish this following triggering.

Transfer the meter to the source of TR48. Momentarily short out C24 when the meter reading should be approximately 1V. Trigger the extension monostable, as before, and operate the microswitch every couple of seconds or so. Ensure that there is a gradual increase in the meter reading.

Note that it may be necessary to re-trigger the extension monostable because its time period could have elapsed during this check. Momentarily short out C24 again and check that the meter reading falls once more to about 1V.

LEARNT THRESHOLD SCHMITT

Connect the meter now to the collector of TR46 and set VR6 wiper about midway. The reading on the meter should be near zero. Operate the microswitch occasionally and apply a simulated load from time to time. Ultimately the meter will indicate that the learnt threshold Schmitt has triggered.

Naturally, it is a matter of choice as to the point in the summation curve where one wants this Schmitt to trigger, but a sensible arrangement would be to have the summer integrate about ten or eleven pulses before this occurs. It is simple to control this factor by varying the setting of VR6.

FINAL CHECK

If everything checks out remove the meter and short out C24 again to make sure EMMA forgets all about our unbridled inquisition of her internal parts. Set EMMA down on the floor once more and make this final check!

Place a fairly heavy book on EMMA's back and operate the microswitch periodically. After a time (that will probably seem like an eternity) EMMA will carry the load under reduced power supply conditions. The easiest way to maintain the low supply state for a while is to clip a clothes peg across the microswitch and so hold the operating button depressed.

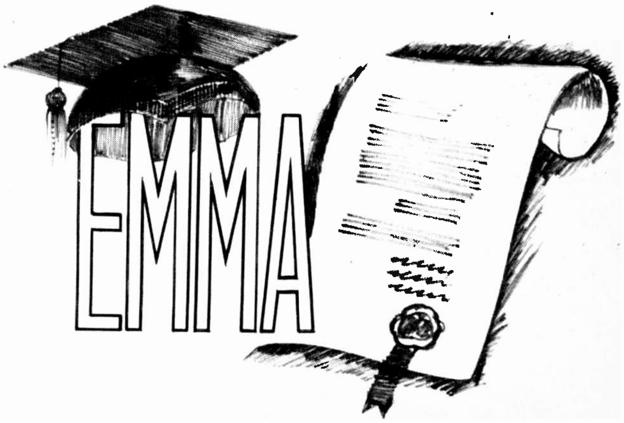
Remember that EMMA's batteries don't last forever, so do start off with fresh ones. A heavily loaded supply on its "last legs" may make it virtually impossible to set up the monitoring circuits for reliable operation.

FINAL EMMA

You may have every reason to say "All this just to have a heap of electronics and metalwork behave in this odd fashion." But that is the very point, it *is* just a heap of electronics and metalwork—not a living creature! Crude though she may be EMMA definitely shows certain preferences and can learn that some actions are worth the trouble while others are not.

To demonstrate that a machine can have a kind of self preservation awareness, we have cheated a little by playing around with the power supplies used. The reason though is valid because had we employed, say, re-chargeable nickel cadmium cells it would have been virtually impossible to see EMMA exhibit this new ability.

However, there is no reason why a keen Bionics man should not attempt an even more ambitious scheme—after all there is a machine in existence which can go and plug itself into the nearest 13 amp socket when it feels peckish! ★



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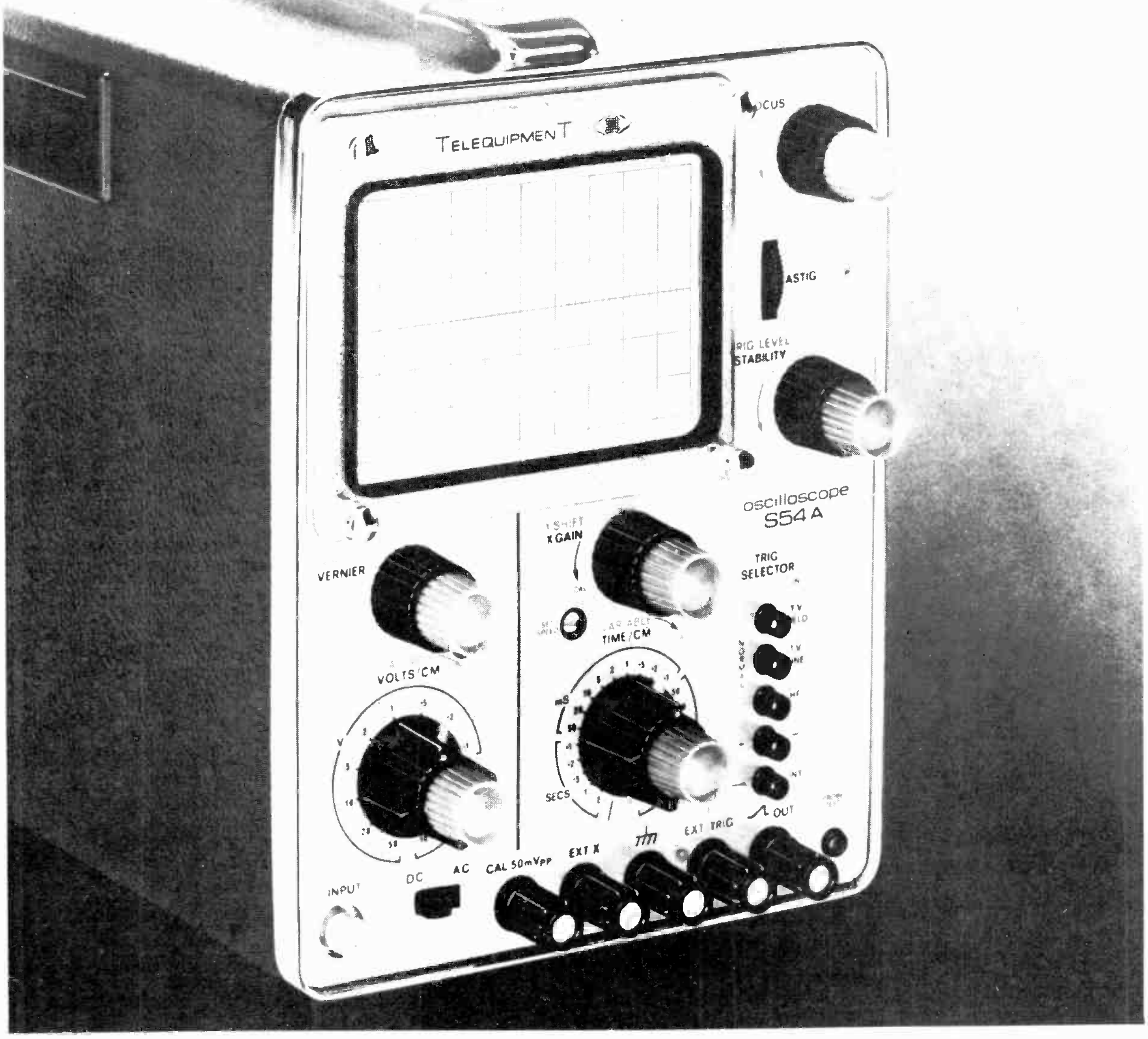

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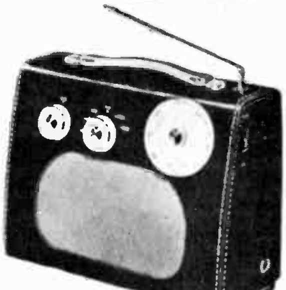

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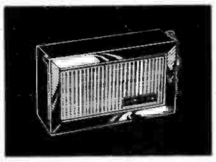

Attractive black and gold case. Size 5½ × 1¼ × 5½in. Tunable over both Medium and Long Waves with extended M.W. band for easier tuning of Luxembourg, etc. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker, also Personal Earpiece with switched socket for private listening. Easy build plans and parts price list 1/6 (FREE with parts).

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

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Attractive case with red speaker grille. Size 6¼ × 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).

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PE 1

MARKET PLACE

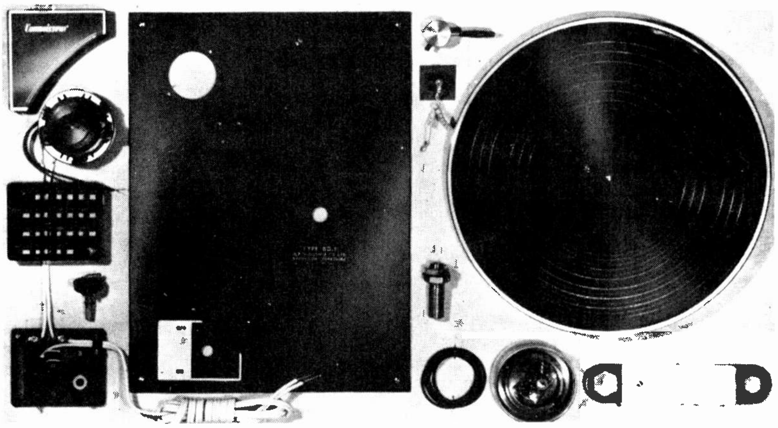
Items mentioned in this feature are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned.

TURNTABLE KIT

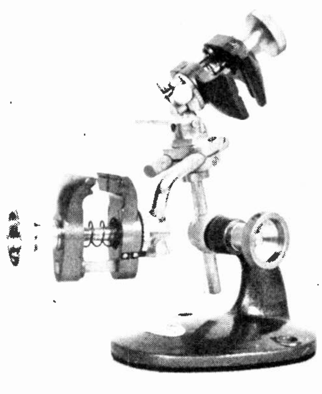
Something new for the audio fan is the Connoisseur BD1 belt drive turntable kit from **A. R. Sugden & Co. (Engineering) Ltd.,** Market Street, Brighouse, Yorkshire.

It is claimed the kit can be assembled by the constructor within the hour and the only tools required are a small screwdriver, a pair of pliers and a spanner. No soldering is necessary.

The turntable operates at 33⅓ and 45 r.p.m. and the use of a belt drive system is claimed to reduce vibration and transmission noise to a minimum. The turntable is of non-ferrous aluminium casting and speed change



Connoisseur BD1 turntable kit marketed by A. R. Sugden & Co.



Multi-Mini Twin from Coventry Movement

is carried out manually by shifting the belt on the pulley, eliminating mechanical linkages.

The turntable works from the mains, 200/240V a.c., and the rumble is claimed at −60dB when referred to a velocity of 70cm/sec at 1kHz. Hum level is −80dB and wow and flutter is less than 0·1 per cent. The motor used is a slow speed synchronous type running at 375 r.p.m. at 50Hz.

The price of the BD1 kit is £9 9s plus tax. A plinth, dust cover lid and a SAU2 pick-up arm is available as extras.

UNIVERSAL VICE

Recently we mentioned a workshop base and workholder; now we have received brief details of a universal two-in-one vice and base.

Called the Multi-Mini Twin, it features two sets of adjustable jaws, which can be set to any angle up to 360 degrees. The advantage of this arrangement is that any two separate components can be held in any desired position. It should be invaluable for the home workshop as a drilling jig, clamp for gluing or soldering, or as a table-top camera tripod.

Full details of the Multi-Mini Twin (price £5 18s) and a standard Multi-Mini can be obtained from **The Coventry Movement Co., Ltd.,** Burnsall Road, Coventry.

CONSTRUCTION KIT

A series of 30 experiments aimed at gradually increasing the beginner's understanding of radio and electronic circuits is contained in the Radionic X30 constructional kit from **Radionic Products.**

The kit consists of a special printed circuit board and a complete instructional manual for all projects; plus a section on fundamentals of electricity and electronics. The resistors, capacitors, transistors, lamp, and light dependent resistor are mounted on a plastics base with threaded brass fixing pillars. Also included is an earphone, ferrite cored coil, nuts, bolts, washers and box spanner.

All experiments when completed are working models and projects include a transistor radio, burglar alarm, morse code practice oscillator, etc.

The Radionic X30 retails for £7 19s 6d, including tax, and is available from electrical shops and some toy departments of large stores.

PRINTED CIRCUITS

Many readers may be interested to learn that **P.H. Electronics** are now producing printed circuit boards of some of the past constructional articles published in PRACTICAL ELECTRONICS.

The board is drilled and roller tinned and an instruction sheet is also included. The instruction sheet contains only minimum information and purchasers of boards are referred to the relevant issue of the magazine.

Further details of the boards available and prices can be obtained from P.H. Electronics, Sandwich Industrial Estate, Sandwich, Kent.

Radionic Products X30 construction kit

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.

Component supermarket

Sir—As many readers will have noticed, the Mecca of London based enthusiasts, Tottenham Court Road, has recently become the home of showrooms for expensive ready-made gear, several cinemas showing "adult" films and an avant-garde theatre. While not wishing to decry these innovations, the inevitable long term result of Tottenham Court Road becoming a part of "swinging" London will be a rise in property values, which will drive away and disperse the component shops.

This is a threat, but also a challenge. After all, is there any real reason why an electronics supermarket, with stands from all the main suppliers, couldn't be established? Maybe under the trilateral leadership of the electronics magazines, the learned societies and commercial interests.

It may sound like an impossible dream now, but if such a venture could be established, not only would it prove highly lucrative but, by encouraging our vital hobby, the electronics industry and also the whole nation would gain through an increased awareness of electronics.

S. H. Hertz,
London, N.3.

We suspect there will be some disagreement concerning the actual location of the component seekers' "mecca". Some enthusiasts might plump for Lisle street!—Ed.

Liquid etchant

Sir—Several younger constructors have asked me from time to time what the liquid is that is used to etch printed circuits; often they have bought a printed circuit kit, and the etchant is used up first.

A recent article described an excellent solution made up of several fluids, one of which was dilute hydrochloric acid. This solution was in fact the classical circuit etchant, but I now find that in some areas chemists will not sell dilute acid to younger persons, or do not stock it in any case.

I feel, therefore, that it may be of value to tell them through your columns that there is a very good etchant available through any chemist, under the pharmacist's name of Liquor Ferri Perchloridi. The British Drug House sells this in convenient 500ml bottles, for a few shillings.

There are two points to watch, however; the first is that it makes an excellent dye for clothing. The second is that, diluted with water, it is sometimes used as an "iron tonic", and the buyer must therefore be careful to obtain the concentrated variety (ask for "fort"), and to keep it well away from any medicine cupboards.

The compound formed with copper is a heavy black precipitate, and it is therefore necessary to agitate the circuit panel in the solution for up to 10 minutes to ensure even etching.

J. Anderson,
Macclesfield,
Cheshire.

There is another point that should be remembered: this solution contains an appreciable amount of acid and so should be handled with care. In particular, it must NOT be poured down the sink, especially if the plumbing is copper.—Ed.

Too ambitious?

Sir—Since the August issue of PRACTICAL ELECTRONICS was published I have felt that your magazine has been catering for the more ambitious of your readers, and is paying little attention to the man with a limited amount of time and money. This has been verified by the list of constructional projects in the November 1969 issue. All these projects (except perhaps the *I.C. Basic Amplifier*) are costly and time consuming.

Bring back ones like the *Homecom*, the *Electronic Stockmarket* or the beginner's projects!

E. W. Lawson,
Glasgow.

We have a very wide readership, and interests vary considerably. Certainly you can expect to see more basic projects in the future, and articles specially designed for the beginner will be featured from time to time.—Ed.

Nematic crystals

Sir—I was pleased to find an article on *Conductive Glass* by F. J. Stone in your November issue. It must be very many years since I came across a really constructive project such as this (do-it-yourself is so cut and dried these days), and it is quite a thrill to get back to something requiring dexterity and luck for a sense of achievement.

The Variable Transparency window is particularly interesting, and I should like to construct one as a project with a group of the Merton Science Society. Unfortunately, Mr Stone does not tell us how to make a *nematic liquid* or how high a potential must be applied across a ¼in thickness of liquid. Perhaps you could get him to pass on this vital information.

By the way, according to the precautions which he quite rightly warns us about, he says that tin is poisonous, but surely tin is harmless otherwise how is it that all our food is kept in tin cans?

George E. Dunning,
Morden,
Surrey.

The only nematic liquid crystal known to me is one referred to in the October 31, 1968 edition of the *New Scientist*, page 260, "Trends and Discoveries", "Lining up Dye Molecules to Switch Light Colours", which effect I referred to in my article. This uses methyl red dye in a 0·1 to 1·0 per cent (by weight) solution in the host liquid crystal, P-N Butoxy Benzoic Acid, with the glass plates about 12 micrometres apart.

The above named liquid is, as I expect most others are, not so readily available. It is one thing to know the name of a substance, but it is another thing altogether to obtain it. There are more liquids in this general group which exhibit this or similar effects. I am sorry I cannot provide any further information regarding the availability of nematic liquid crystals.—F.J.S.

Glass centre

Sir—I was most interested to read F. J. Stone's article on *Conductive Glass* in November 1969 PRACTICAL ELECTRONICS, but do not feel I can cope with the experiment of making my own.

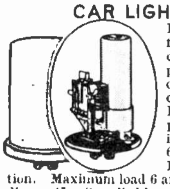
Do you think if I advertised in your miscellaneous column a supplier could be found?

When I enquired at the "glass centre" at the Building Exhibition, no-one appeared to have a clue. According to Stone's article, the Russians appear to have it, so where are we in this research?

Perhaps I have not done enough reading outside electronics and Pilkington and Triplex have the answer.

Leslie D. E. Light, G3KDL,
Wembley,
Middlesex.

CAR LIGHT FLASHERS



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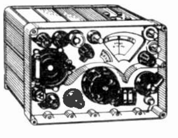

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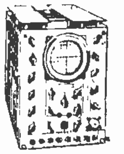

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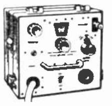

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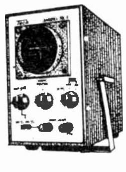

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Double beam. D.C. to 9 Mc/s. Perfect order. **£65.** Carr. 50/-.

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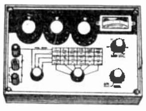


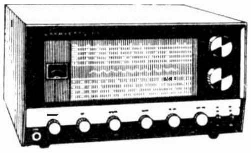
A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω-11·1 megΩ 6 Ranges $\pm$1%. L.1 μH - 111 HENRYS 6 Ranges -2%. C. 10pF - 1110mFd. 6 Ranges $\pm$ 2%. TURNS RATIO 1:1/1000-1:11100. 6 Ranges $\pm$1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7¼ × 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.**

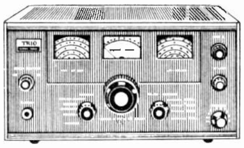
TRIO JR-310 NEW AMATEUR BAND 10-80 METRE RECEIVER. In stock. **£77.10.0.**

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 F E T 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 × 9½in × 8½in. Weight 18lb. EXCEPTIONAL VALUE. £45. Carr. 10/-. S.A.E. for full details.

TRIO COMMUNICATION RECEIVER MODEL 9R-59DE

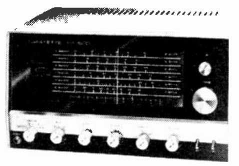


4 band receiver covering 550Kc/s to 30Mc/s. continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW ● ANL ● Variable BFO ● S meter ● Sep. bandspread dial ● IF 445Kc/s ● Audio output 1·5W. ● Variable RF and AF gain controls. 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

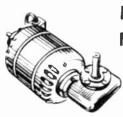
TRIO TS 510 AMATEUR TRANSCEIVER with speaker and mains P.S.U. £212

LAFAYETTE HA.800 SOLID STATE AMATEUR COMMUNICATION RECEIVER



SIX BANDS 3.5-4, 7-7.3, 14-14.35, 21-45, 28-29.7, 50-54 Mc/s.
Dual conversion on all bands. 2 · 445 Kc/s mechanical filters. Product detector. Variable B.F.O. 100 Kc/s crystal calibrator. 'S' meter. Huge slide rule dial. Operation 230v AC or 12v DC. Size 15" . 9¼" . 8½". Complete with instruction manual. **£57.10.0.** Carr. paid.
(100 Kc/s Crystal 39/6 extra)

GEARED MAINS MOTORS

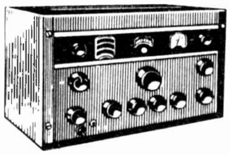


Paralux type SD19 230/250V a.c. Reversible 30 RPM. 40 lb in. Complete with capacitor. Excellent condition. **99/6.** Carr. 10/-.

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.

RCA COMMUNICATION RECEIVER AR88D

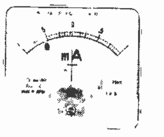


Latest release by ministry BRAND NEW in original cases. 110-250V a.c. operation. Frequency in 6 Bands. 535Kc/s-32Mc/s continuous. Output impedance 2·5-600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price **£87.10.0.** Carr. £2.

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. 75Ω aerial input. Headphone jack. Operation 230V. A.C./12V. D.C. Neg. earth. **£37.10.0.** Carr. 10/-.

CLEAR PLASTIC PANEL METERS



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

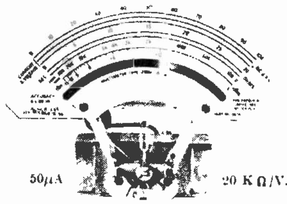
50μA	40/-	500-0-500μA	27/6	50mA	27/6	150V. D.C.	27/6
50-0-50μA	37/6	1mA	27/6	100mA	27/6	300V. D.C.	27/6
100μA	37/6	1·0-1mA	27/6	150mA	27/6	500V. D.C.	27/6
100-0-100μA	35/-	2mA	27/6	200mA	27/6	750V. D.C.	27/6
200μA	35/-	5mA	27/6	300mA	27/6	15V. A.C.	27/6
500μA	40/-	10mA	27/6	500mA	27/6	50V. A.C.	27/6
		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/-

Full range of other sizes in stock. Send s.a.e. for leaflet.

POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range ex-stock Single hole fixing, ¼in. dia. shafts. Bulk quantities available.
25 WATT. 10/25/50/100/250/500/1,000/1,500/2,500 or 5,000 ohms, **14/6.** P. & P. 1/6.
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.

AVOMETER MOVEMENTS



Spare movements for Model 8 or 9. (Fitted with Model 9 scale) or basis for any multi-meter. Brand New and Boxed **69/6** P. & P. 3/6.

AVO 48A. Perfect order with set of shunts and resistances. **£12.10.0.** P. & P. 7/6.

T.E.40 HIGH SENSITIVITY A.C. VOLTMETER

10 meg. input 10 ranges: ·01 / ·003 / ·1 / ·3 / 1 / 3 / 10 / 30 / 100 / 300V. R.M.S. 4c/s.-1·2Mc/s. Decibels −40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V a.c. **£17.10.0.** Carr. 5/-.

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

Frequency 0·20 Kc/s on 2 ranges. Output 500Ω or 5kΩ. Operation 200/250V. A.C. Supplied in perfect order. **£12.10.0.** Carr. 10/-.

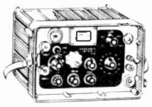
TE-65 VALVE VOLTMETER

High quality instrument with 28 ranges. D.c. volts 1·5-1,500V. A.c. volts 1·5-1,500V. Resistance up to 1,000 megohms. 220/240V a.c. operation. Complete with probe and instructions. **£17.10.0.** P. & P. 6/-. Additional Probes available: R.F. **35/-.** H.V. **42/6.**

COSSOR 1049 DOUBLE BEAM OSCILLOSCOPES

D.c. coupled. Band width 1kc/s. Perfect order. **£25.** Carr. 30/-.

AM/FM SIGNAL GENERATORS



Oscillator Test No. 2. A high quality precision instrument made for the ministry by Airmec. Frequency coverage 20-80Mc/s. AM C.W./FM. Incorporates precision dial, level meter, precision attenuator 1μV-100mV. Operation from 12V d.c. or 0/110/200/250V a.c. Size 12 × 8½ × 9in. Supplied in brand new condition complete with all connectors fully tested. **£45.** Carr. 20/-.

HAMMARLUND SP600J COMMUNICATION RECEIVER. 540 Kc/s-54 Mc/s in 6 bands. FEW ONLY! **£100.**

EDDYSTONE VHF RECEIVERS MODEL 770R. 19-165 Mc/s. Excellent condition. **£150.**

TE-16A Transistorised Signal Generator. 5 ranges 400 kHz-30 mHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide, easy to read scale. 800 kHz modulation. 5¼ × 5¼ × 3½. Complete with instructions and leads. **£7.19.6.** P.&P. 4/-.

FIELD TELEPHONES TYPE L

Generator ringing, metal cases. Operates from two 1·5v. batteries (not supplied). Excellent condition. **£4.10.0** per pair. Carr. 10/-.

AUTO TRANSFORMERS

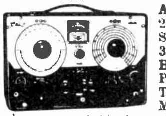
0/115/230v. Step up or step down. Fully shrouded.

150 W.	£2.2.6,	P. & P. 3/6
300 W.	£2.19.6,	P. & P. 4/6
500 W.	£4.10.0,	P. & P. 6/6
1,000 W.	£6.10.0,	P. & P. 7/6
1,500 W.	£7.19.6,	P. & P. 8/6
7,500 W.	£15.10.0,	P. & P. 20/-

G. W. SMITH & CO (RADIO) LTD.

Also see oppos. page

ARF-100 COMBINED AF-RF SIGNAL GENERATOR



A.F. SINE WAVE 20–200,000 c/s. Square wave 20–30,000 c/s. O/P. **HIGH IMP.** 21V. P/P600 Ω 3·8 V. P/P. TF 100 kc/s–300 Mc/s. Variable R.F. attenuation int/ext. modulation. Incorporates dual purpose meter to monitor AF output and % mod. on R.F 220/240 V a.c. **£30.0.0.** Carr. 7/6.

TE-20RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 kc/s–260 Mc/s on 6 bands. Directly calibrated variable R.F. attenuator. Operation 200/240V a.c. Brand new with instruction. **£5.15.0.** P. & P. 7/6. S.A.E. for details.

TE22 SINE SQUARE WAVE AUDIO GENERATORS

Sine: 20c/s to 200 kc/s on 4 bands. Square: 20c/s to 30 kc/s. Output impedance 5,000 ohms. 200/250V. A.C. Supplied brand new and guaranteed with instruction manual and leads. **£16.10.0.** Carr. 7/6.

MARCONI TF142E DISTORTION FACTOR METERS. Excellent condition. Fully tested. **£20.** Carr. 15/-.

LAFAYETTE TE46 RESISTANCE CAPACITY ANALYSER

2pF-2,000 mfd 2 ohms-200 megohms. Also checks impedance, turns ratio, insulation, 200/250V a.c.
Brand New £17.10.0. Carr. 7/6.

ADVANCE TEST EQUIPMENT

Brand new and boxed in original sealed cartons.

VM.76 **VALVE VOLTMETER R.F. measurements in excess of 100Mc/s and d.c. measurements up to 100V with accuracy of ±2% d.c. range 300 MV to 1kV a.c. range 300MV to 300V RMS. Resistance 0·02–500M Ω. Price £72.**

VM.79 **UHF MILLIVOLT METER. Transistorised. A.c. range 10MV–3V. D.c. current range 0·01μA–0·3MA. Resistance 1 ohm–10 megohms. Price £125.**

H1B **AUDIO SIGNAL GENERATOR. 15c/s–50kc/s. sine or square wave. Price £30.**

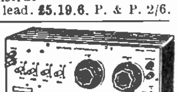
J1B **AUDIO SIGNAL GENERATOR. 15c/s–50kc/s. Price £30.**

TT1S **TRANSISTOR TESTER. £37.10.0. Carriage 10/- per item.**

MODEL ZQM TRANSISTOR CHECKER

It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc. Spec.: A: 0·7–0·9967. B: 5–200. Ico: 0–50 microamps 0–5 mA. Resistance for diode 200 Ω–1 M Ω. Supplied complete with instructions, battery and lead. **£5.19.6.** P. & P. 2/6.

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/-.

SOLARTRON MONITOR OSCILLOSCOPE TYPE 101

An extremely high quality oscilloscope with time base of 10μ/sec to 20m/sec. Internal Y amplifier. Separate mains power supply 200/250V. Supplied in excellent condition with cables, probe, etc., as received from Ministry. **£8.19.6.** Carr. 30/-.

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The latest edition giving full details of a comprehensive range of HI FI EQUIPMENT, COMPONENTS, TEST EQUIPMENT and COMMUNICATIONS EQUIPMENT..... Nearly 200 pages, fully illustrated and detailing thousands of items — many at bargain prices. FREE DISCOUNT COUPONS VALUE 10/-.

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FULL CURRENT RANGE OFFERED, BRAND NEW AND GUARANTEED AT FANTASTIC SAVINGS

SRP22 Stereo	**£5.19.6**	SP25 MK II	**£11.19.6**
*1025 Mono	**£7.10.0**	*SL55	**£11.19.6**
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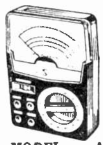
*2025 Stereo	**£7.19.6**	*SL65	**£14.14.0**
*2025T/C		AP75	**£17.17.0**
Mono/Stereo	**£8.17.6**	401	**£28. 7.6**
*3000 Stereo	**£9.19.6**	SL75	**£28.10.0**

Carriage/insurance 7/6 extra any model. WB4 Bases **£3.19.6.** Perspex covers **£3.10.0.** *Special offer base and cover available for these models at **£4.15.0.** Carr. 5/-. Full range of Garrard accessories available.

LAFAYETTE LA-224T TRANSISTOR STEREO AMPLIFIER

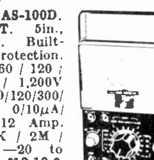
19 transistors, 8 diodes, IHF music power, 30W at 8 Ω. Response 30–20,000 ± 2dB at 1W. Distortion 1% or less. Inputs 3mV and 250mV. Output 3–16 Ω. Separate L and R volume controls. Treble and bass control. Stereo phone jack. Brushed aluminium, gold anodised extruded front panel with complementary metal case. Size 10¼ × 3 9/16 × 7 13/16in. Operation 115/230V. A.C. **£28.** Carriage 7/6.

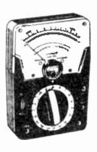
MULTIMETERS *for EVERY purpose!*



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.

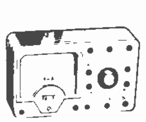
MODEL AS-100D. 100K Ω/VOLT. 5in., mirror scale. Built-in meter protection. 0 / 3 / 12 / 60 / 120 / 300 / 600 / 1,200V d.c. 0/6/30/120/300/600V a.c. 0/10μA/6/60/300MA/12 Amp. 0/2K / 200K / 2M / 200M Ω. –20 to +17dB. **£12.10.0.** P. & P. 3/6.





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-70. 30,000 O.P.V. 0/3/15/60/300/600/1,200V. d.c. 0/6/30 / 120 / 600 / 1,200V. a.c. 0/30μA / 3/30 / 300mA. 0/16K/160K 1·6M / 16megohm **£5.10.0.** P. & P. 3/-.



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 K Ω **39/6.** P. & P. 1/6.

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 / 110 / 100 / 500mA 10A d.c. 20K / 200K / 20 M Ω. **£15.** P. & P. 5/-.

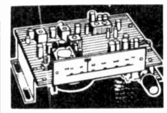
MODEL TE-10A. 20k Ω/Volt, 5/25/50/250/500/2,500 V, d.c. 10 / 50 / 100 / 500 / 1,000V. a.c. 0/50μA/2·5 mA./250mA. d.c. 0/6K/6 megohm. –20 to +22dB. 10–0, 100 mfd. t 0 0·100–0·1 mfd. **69/6.** P. & P. 2/6.

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/60/K/600K/6 Meg. **£4.17.6.** P. & P. 3/-.

MODEL TE12. 20,000 O.P.V. 0/0·6/30/120/600/1,200 / 3,000 / 6,000V d.c. 1/6/30/120/600/1,200V a.c. 0 / 60μA / 6 / 60 / 600MA. 0 / 6K / 600K / 6meg./60. Megohm 50PF. 2 MFD **£5.19.6.** P. & P. 3 6.

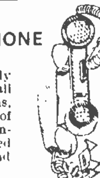
LAFAYETTE
57 Range Super 50,000 O.P.V. Multimeter. D.c Volts 125V-1,000V A.c. Volts 1·5V-1,000V D.c. Current 25μA-10 Amp. Ohms. 0·15 Meg Ω dB.—20 to +81dB. Overload Protection. **£12.10.0.** Carr. 3/6.

★ TRANSISTORISED FM TUNER ★



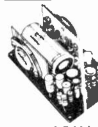
6 TRANSISTOR HIGH QUALITY TUNER. SIZE ONLY 6 × 4 × 2½in. 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88–108 Mc/s. Ready built ready for use. Fantastic value for money. **£6.7.6.** P. & P. 2/6. Stereo multiplex adaptors **99/6.**

TRANSISTORISED TWO-WAY TELEPHONE INTERCOM



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. **£6.9.6.** P. & P. 3/6.

SINCLAIR EQUIPMENT



Z12 12 watt amplifier, **89/6**
PZ4 Power Supply Unit **89/6**
Stereo 25 Preamp., **£9.19.6**
Q14 Speakers, **£7.19.6**
Micromatic Radio Kit, 49/6. Built **59/6**

NOW IN STOCK IC/10 **59/6**
ALL POST PAID

SPECIAL OFFER
Two **Z12** Amps., **PZ4** Power Supply, **Stereo 25** Preampli ier, **£22,** or with two **Q14** speakers, **£37**

NEW SINCLAIR 2000 SYSTEM

35 watt Integrated Amplifier **£29.** Carr. 5/-. Self powered F.M. Tuner. **£25.** Carr. 5/-.

PEAK SOUND PRODUCTS

Full range of Amplifiers, Kits, Speakers in stock.

ECHO HS-606 STEREO HEADPHONES

Wonderfully comfortable. Lightweight adjustable vinyl headband. 6ft. cable and stereo jack plug. 25–17,000 cps. 8 ohm imp. **67 6** P. & P. 2/6.

HOSIDEN DH04S 2-WAY STEREO HEADSETS

Each headphone contains a 2½in woofer and a ½in tweeter. Built in individual level controls. 8 Ω imp. 25–18,000c/s. with cable and stereo plug. **£5.19.6.** P. & P. 2/6.

RECORDING HEADS

COSMOCORD ½-track heads. High imp. record/playback **65/-.** Low imp. erase **20/-.** **MARRIOTT** ½-track heads. High imp. record/playback **65/-.** Low imp. erase **20/-.** Post extra.

RACAL MA.168 TRANSISTORISED DIVERSITY SWITCH. Brand New Condition **£15.** Carr. 10/-.

AMERICAN TAPE

First grade quality American tapes. Brand new Discount on quantities.

3in. 225ft. L.P. acetate	3/6
3¼in. 600ft. T.P. mylar	10/-
5in. 600ft. std. plastic	8/6
5in. 900ft. L.P. acetate	10/-
5in. 1,200ft. D.P. mylar	15/-
5¾in. 1,200ft. L.P. acetate	12/6
5¾in. 1,200ft. L.P. mylar	16/-
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2N2905A	8/-	2N5305	7/6	ASY53	5/-	BFY25	5/-	NKT212	5/6	ZTX108	3/6
2N2906	8/-	2N5306	8/-	ASY54	5/-	BFY26	4/-	NKT213	6/6	ZTX109	3/6
2N2906A	8/-	2N5307	7/6	ASY62	5/-	BFY29	10/-	NKT214	4/6	ZTX300	4/-
2N2907	8/-	2N5308	7/6	ASY63	5/-	BFY30	10/-	NKT215	4/6	ZTX301	4/-
2N2923	4/-	2N5309	12/6	ASY72	5/-	BFY36	5/-	NKT216	6/6	ZTX302	5/-
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1S5	4/3	20P4	18/6	DL94	6/-	EL90	4/6	PENA4	12/6	UCC85	6/9
1T4	2/9	25L6GT	5/-	DL96	7/-	EL500	12/6	PFL200	11/9	UCF80	7/3
3S4	5/9	25U4GT	11/6	DY86	5/9	EM80	7/6	PL36	9/9	UCH42	11/6
3V4	6/-	30C1	6/6	DY87	5/9	EM81	7/6	PL81	7/3	UCH81	6/3
5U4G	4/6	30C15	13/-	EABC80	6/6	EM84	6/6	PL82	6/6	UCL82	6/9
5Y3GT	5/9	30C17	16/-	EAF42	10/-	EM87	7/6	PL83	6/6	UCL83	11/6
5Z4G	7/6	30C18	11/6	EB91	2/3	EY51	7/6	PL84	6/6	UF41	10/6
6/30L2	12/-	30F5	16/-	EBC33	8/-	EY86	6/6	PL500	13/-	UF80	7/-
6AL5	2/3	30FL1	13/9	EBC41	9/6	EZ40	8/-	PL504	13/6	UF85	6/9
6AM6	2/9	30FL12	14/6	EBF80	6/9	EZ41	8/-	PL508	23/6	UF89	6/9
6AQ5	4/6	30FL14	12/-	EBF89	6/3	EZ80	4/6	PM84	7/6	UL41	10/9
6AT6	4/-	30L1	6/6	ECC81	3/9	EZ81	4/9	PX25	10/6	UL44	20/-
6AU6	4/6	30L15	14/-	ECC82	4/9	GZ32	8/9	PY32	10/-	UL84	7/-
6BA6	4/6	30L17	15/6	ECC83	7/-	GZ34	9/9	PY33	10/-	UM84	6/6
6BE6	4/9	30P4	12/-	ECC85	5/-	KT61	8/9	PY81	5/3	UY41	7/6
6BJ6	8/6	30P12	13/9	ECC91	3/-	KT66	16/-	PY82	5/3	UY85	5/9
6BW6	13/-	30P19	12/-	ECC804	12/-	N78	17/6	PY83	5/9	VP4B	10/-
6F13	3/6	30PL1	13/9	ECF80	6/6	PABC80	7/-	PY88	6/9	W119	7/-
6F14	9/-	30PL13	15/6	ECF82	5/9	PC86	10/3	PY800	7/6	Z77	2/9
6F23	14/3	30PL14	15/6	ECH35	6/-	PC88	10/3	PY801	6/9	AC107	3/6
6F25	13/-	35L6GT	8/6	ECH42	12/6	PC96	8/6	R19	6/6	AC127	2/6
6J6	3/-	35W4	4/6	ECH81	5/3	PC97	8/6	R20	12/6	AD140	7/6
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6X5GT	5/9	CL33	18/6	EF39	4/9	PCF80	6/6	U191	12/6	OC44	2/3
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7C6	6/9	DAC32	7/3	EF80	4/6	PCF86	11/6	U251	14/6	OC71	2/6
10F1	14/-	DAF91	4/3	EF85	5/3	PCF200	13/6	U301	10/6	OC72	2/6
10F18	7/-	DAF96	6/6	EF86	6/3	PCF800	13/6	U329	14/6	OC75	2/6
10P13	15/6	DF33	7/9	EF89	5/3	PCF801	6/9	U801	19/6	OC81	2/3
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12AU6	4/9	DF96	6/6	EF94	4/6	PCF805	11/6	UAF42	10/3	OC82	2/3
12AU7	4/9	DH77	4/-	EF183	5/9	PCF808	12/-	UB41	6/6	OC82D	2/6
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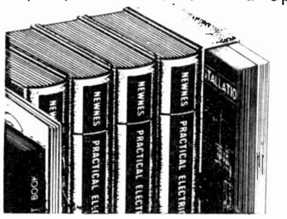

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RESISTORS

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	**16d**	**11d**	**13d**
C	$\frac{1}{8}$W	5%	4·7 Ω–1M Ω	E24	**2·5d**	**2d**	**1·75d**
C	$\frac{1}{4}$W	10%	4·7 Ω–10M Ω	E12	**2·5d**	**1·75d**	**1·5d**
C	$\frac{1}{2}$W	5%	4·7 Ω–10M Ω	E24	**3d**	**2·25d**	**2d**
MO	$\frac{1}{2}$W	2%	18 Ω–1M Ω	E24	**9d**	**8d**	**7d**
C	1W	10%	4·7 Ω–10M Ω	E12	**4d**	**3·25d**	**3d**
WW	1W	10% $\pm\frac{1}{20}$ 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 each ohmic value and power rating. (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 ½ 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 **9/–**, Motorola 2N5459 (MPF105) **9/6** each.

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MEDIUM ELECTROLYTICS. Axial leads: Values (μF/V): 50/50 **1/9**; 100/25 **1/9**; 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 **7/–**; 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.

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2N2926G	**2/6**	BC149	**4/3**
2N3053	**5/6**	BC153	**10/–**
2N3054	**14/3**	BC154	**11/–**
2N3055	**16/6**	BC157	**3/9**
2N3391A	**5/6**	BC158	**3/6**
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2N3703	**3/3**	BC167	**2/6**
2N3704	**3/9**	BC168	**2/3**
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POTENTIOMETERS: Min. enclosed, carbon track and wiper contact only **2/6**; Values—Lin: 1k, 2·5k, 5k, etc., to 10M; Log: 5k, 10k, 25k, etc., to 5Mohm. Min. with double-pole switch, insulated spindles only **5/6.** Values—Lin: 25k, 50k, 100k; Log: 3k, 5k, 10k, 250k, 500k, 1M, 2M. 3W wirewound Lin. tracks 50 ohm to 100kohm, **7/4** each.

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	(Min.)							(Small)		
6·4V	6·4	25	50	100	200	320	640	1,000	1,600	2,500
10V	4	16	32	64	125	200	400	640	1,000	1,600
16V	2·5	10	20	40	80	125	250	400	640	1,000
25V	1·6	6·4	12·5	24	50	80	160	250	400	640
40V	1	4	8	16	32	50	100	160	250	400
64V	0·64	2·5	5	10	20	32	64	100	160	250
Prices: 1/-				10d. each			1/3	1/6	1/9	2/6

	(Large)					(Multiples)		
25V	800	1,250	2,000	4,000	6,400	500V	8–8μF	6/6
40V	500	800	1,250	2,500	4,000	500V	16–16μF	7/6
64V	320	500	800	1,600	2,500	350V	32–32μF	7/3
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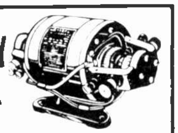

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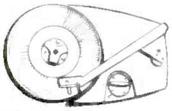

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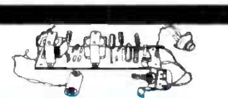

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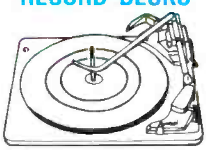

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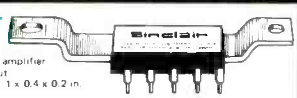

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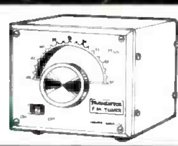

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