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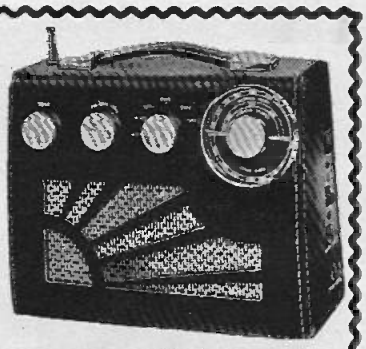

ROAMER 10 WITH VHF INCLUDING AIRCRAFT

10 TRANSISTORS. 9 TUNABLE WAVEBANDS, MW1, MW2, LW, SW1, SW2, SW3, TRAWLER BAND. VHF AND LOCAL STATIONS ALSO AIRCRAFT BAND

Built in Ferrite Rod Aerial for MW/LW. Retractable, chrome plated 7 section Telescopic Aerial, can be angled and rotated for peak short wave and VHF listening. Push Pull output using 600mw Transistors. Car Aerial and Tape Record Sockets. 10 Transistors plus 3 Diodes. Fine tone moving coil speaker. Ganged Tuning Condenser with VHF section. Separate coil for Aircraft Band. Volume on/off. Wave Change and tone Control. Attractive Case in black with silver blocking. Size 9" × 7" × 4". Easy to follow instructions and diagrams. Parts price list and easy build plans 30p (FREE with parts). Earpiece with plug and switched socket for private listening 33p extra.

Total building cost

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P. P. & Ins. 52p

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7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for MW and LW. Retractable chrome plated Telescopic aerial for Short Waves. Push pull output using 600mW transistors. Car aerial and Tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Fine tone moving coil speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9 × 7 × 4in. approx. Easy to follow instructions and diagrams. Parts Price List and Easy Build Plans 25p (FREE with parts).
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ROAMER SEVEN MK IV

7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Extra Medium waveband provides easier tuning of Radio Luxembourg, etc. Built in ferrite rod aerial for MW and LW. Retractable 4 section 24in. chrome plated telescopic aerial for SW. Socket for Car Aerial. Powerful push-pull output. 7 transistors and 2 diodes. fine tone moving coil speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning and wave change controls. Attractive case with carrying handle Size 9 × 7 × 4in. approx. Easy to follow instructions and diagrams. Parts price list and easy build plans 25p (FREE with parts).
Earpiece with plug and switched socket for private listening 33p extra.

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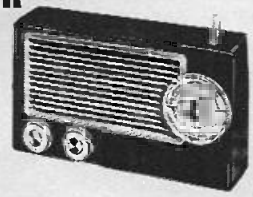
ROAMER SIX



6 Tunable Wavebands: MW, LW, SW1, SW2, SW3 Trawler band plus an extra Medium waveband for easier tuning of Luxembourg etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 3in. Speaker. 8 stages—6 transistors and 2 diodes. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2¼in. approx. Easy build plans and parts price list 25p (FREE with parts).

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POCKET FIVE

5 Tunable Wavebands: MW, LW, Trawler Band 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. Attractive black and gold case. Size 5½ × 1½ × 3¼in. Easy build plans and parts price list 10p (FREE with parts).

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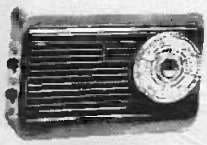

5 TRANSISTORS AND 2 DIODES

3 Tunable Wavebands: MW, LW and Trawler Band. 7 stage—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser volume control, fine tone moving coil speaker. Attractive case with red speaker grille. Size 6½ × 4½ × 1¾in. Easy build plans and parts price list 10p (FREE with parts).

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TRANS EIGHT

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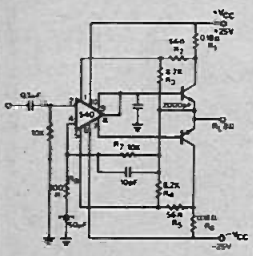
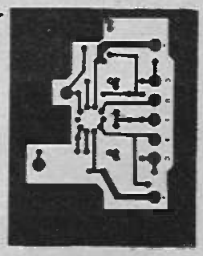
Device of the Month NE540L





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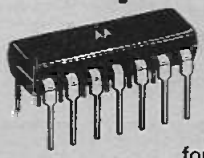

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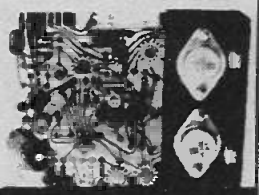

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Size	8" x 4" x 4" (5" with supply)

Low distortion parallel push-pull output stage.

NEW 160 watt version & supply **£27·90**

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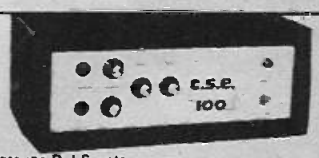
THIS IS A MUST FOR THE HOME BUILT HIGH QUALITY DISCOTHEQUE AND IS COMPARABLE TO UNITS AT OVER TWICE THE PRICE. (N.B.—Stereo only has mic Input.)

COMPLETE AMPLIFIERS

The CSE 100. £34·90 carr. free



This versatile unit is now available in a black vynide case and so represents even better value than ever delivering speech and music powers of up to 100 watts RMS and continuous signal outputs of 70 watts. Two individually controlled inputs with wide range bass and treble controls. Ideal for small groups D.J.S., etc.

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With an RMS output of 120 watts speech and music, 100 watts continuous power, four individually controlled FET input stages and wide range bass and treble controls, this amplifier has established itself as a unit offering quality and reliability at low cost.

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All prices subject to VAT at standard rate

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SAXON ENTERTAINMENTS LTD., 327-331 Whitehorse Rd., W. Croydon, Surrey. CRO 2HS.
Telephone 01-684 6385 **Hours of Business 9.30 a.m.–5.30 p.m.**

TERMS OF BUSINESS—C.W.D.: C.O.D. 35p extra: Cash by registered post, please.

TRADE & EXPORT ENQUIRIES INVITED

1 CHIP RADIO

Ferranti's latest device ZN414—gives results better than superhet. Supplied complete with technical notes and circuits. £1·85 each. 10 for £12.

Hi-Q TUNER COMPONENTS

For experimenting with the ZN414.
KIT NO. 1. Plessey Miniature Tuning Condenser with built in LW switch and 3" ferrit slab and litz wound MW coil. 72p.
KIT NO. 2. Air spaced tuning condenser 6" ferrite rod litz wound MW and LW coils. 94p
KIT NO. 3. Air spaced TC with slow motion drive 8" ferrit rod, with litz wound LW and MW coils, £1·10.
KIT NO. 4. Permeability tuner with fast and slow motion drive and LW loading coils, 50p.

12 VOLT 1½ AMP POWER PACK

This comprises double-wound 230/240V mains transformer with full wave rectifier and 2000 m/f/d/ smoothing. Price £2·20 + p. & p. 20p.

Heavy Duty Mains Power Pack. Output voltage adjustable from 15–40V in steps—maximum load 250W—that is from 6 amp at 40V to 15amp at 15V. This really is a high power heavy duty unit with dozens of workshop uses. Output voltage adjustment is very quick—simply interchange push on leads. Silicon rectifiers and smoothing by 3,000mF. Price £6·33 plus 65p post.

BALANCED ARMATURE UNIT

500 ohm. operates as speaker or microphone, so useful in intercom or similar circuits, 37p each.

MUSIC ON TAPE

A further buy enables us to offer these at an even lower price—namely 72p each or 5 for £2·50. Send for list of titles. We can't repeat when sold out.

FIRE ALARM BELL

Mains operated. Really loud ring 6" gong. Size approx. 12" × 6" × 4½". Suitable outside or inside. Heavy cast case with ½" conduit entry. Made by A.F.A. Operates off 200/240V AC. £4·13 plus 60p.

5 AMP CHANGE OVER CONTACTS 9p each. 15 amp. On/Off 10p each. 15 amp. change over 15p each. ULTRA sensitive 5 amp. change over 30p each. 10% off if 10 of a type ordered.

FLEX CABLE SNIP

3 core heavy circular T.R.S. waterproof flex, ideal for running down the garden to pool or shed. 1·5mm cores (5 amp) 100 yard coils £4·78 plus carriage 75p up to 200 miles. £1—300 miles £1·50—500 miles.

20 WATT INVERTER

Smart and Brown—For van lighting or camping etc. Will light a 2ft. 20 watt standard fluorescent tube from a 12V car battery, current approx. 2A. Very well made unit using die cast chassis. Size 11½" × 2" × 1½". Price £7·15 complete with lamp holders and tube clips.

MAINS RELAY BARGAIN

Special this month are some single, double and treble pole changeover relays. Contacts rated at 15 amps. Operating coil wound for 240V. A.C. Good British Make. Unused. Size approx. 1½ × 1". Open construction.
Single pole 28p each 10 for £2·50
Treble pole 39p each 10 for £3·47

QUICK CUPPA

Mini Immersion Heater. 350W. 200/240V. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. £1·25, post and insurance 20p. 12V car model also available. Same price. Jug heater also available £1·50 plus P. & P. 20p.

DOOR INTERCOM

Know who is calling and speak to them without leaving bed, or chair. Outfit comprises microphone with call push button, connectors and master inter-com. Simply plug-together. Originally sold at £10. Special snip price £3·85 plus 20p postage.

DIGITAL DISPLAY

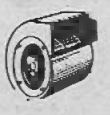
Panel mounting unit measuring approx. 3½in. × 1in. × 1½in. deep. Size of the display aperture is approx. 1½in. × 1in. Light up to 0–9. Ex equipment but unused and in perfect order. Price £1·10 each.

10 AMP. DIMMER CONTROLLER. For the control of lighting on stage or in studio or for the control of portable equipment in workshops etc. This has two 13 amp. socket outlets. Each is controlled by a 5 amp. solid state regulator. The overall length is 17", width 3½" and depth 1½". In the end is fitted a master on/off switch indicator, lamp and fuse. Price £8·25.

ZPM—MODULATION MOTOR

Could also be used to open ventilators, doors, valve, damper etc., particularly suitable for remote control. Made by Satchwell. Essentially a reversible geared motor fitted with internal limit switches to stop it at the end of its travel Size approx. 6" × 6" × 5½" and weighing approx. 10 lbs. This is extremely powerful and would lift a heavy door or open a long line of ventilators. To operate this motor you put the 50 cycle supply through a change over switch. For instance a thermostat with change-over contacts could automatically regulate the temperature in a growing house, chicken hatchery etc. An indicator on the motor graduated 0–10 shows the state of open or close. Also internally fitted is a reriable realstor, wires from this to a volt meter would give a remote indication of the open or close position. A very expensive motor if both direct from Satchwell, our price complete with step down Transformer is £16·15.

CENTRIFUGAL FAN



Mains operated turbo blower type. Pressed steel housing contains motor and aluminium impeller. Motor is 1/10th h.p. giving considerable air flow but virtually no noise. Approx. dimensions 10½in. wide × 12ins. dia. outlet into trunking 10½ × 4½in. £6·50 plus £1 post and insurance.

FORTYLITE

Fluorescent lighting units with polyester choke and finished white enamel. 40 ins model, ideal kitchen, bedroom, hallway, porch, loft etc. With tube assembled ready to instal, £2·20.

PROCESS TIME CONTROLLER

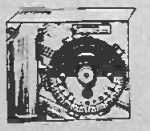
Made by Smiths. Motorised and mains driven in metal case with glass front and chrome surround. Covers a period of 18 hours. During this 18 hours the controlled device can be made to switch on for a period of 15 minutes to 3 hours. Probable cost from Smiths over £6. Special snip price £1·76 plus 20p post and insurance.

THIS MONTH'S SNIP

KETTLE ELEMENTS

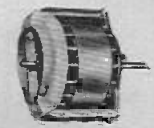
Made by the famous A.E.I. Co. Complete with washers and combined fixing ring and plug shroud. Normal 2 round pin and flat pin earth connection and overload reset push button. 2 Models—1½in. (approx.) suitable for G.E.C., Hotpoint, etc. All quick boil 2½ K.W. elements at 240v. Price £1·38p.

24-HOUR TIME SWITCH



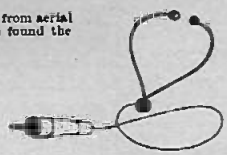
Made by Smiths, these are AC mains operated NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods for 24 hours, 5 amp changeover contacts will switch circuit on or off during these periods. £2·75. post and ins. 23p. Additional time contacts 50p pair.

PAPST MOTORS



Est. 1/40th h.p. Made for 110–120 volt working, but two of these work ideally together off our standard 240 volt mains. A really beautiful motor, extremely quiet running and reversible. £1·65 each. Postage one 23p, two 33p. 230v model 23·30.

RADIO STETHOSCOPE



Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV amplifier, anything — complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. £2·20—twin stethoset instead of earpiece 33p extra—post and ins. 20p.

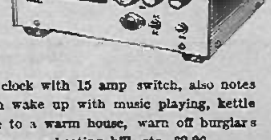
MULLARD AUDIO AMPLIFIERS

All in module form, each ready built complete with heat sinks and connection tags, data supplied.
Model 1153 500m watt power output 83p.
Model 1172 750m watt power output 94p.
Model EP9000 4 watt power output £1·66.
EP9001 Stereo preamp 22.
10% discount if 10 per type or more ordered.

1 HOUR MINUTE TIMER

Made by famous Smiths company, these have a large clear dial, size 4½in. × 3½in., which can be set in minutes up to 1 hour. After preset period the bell rings. Ideal for processing, a memory jogger or, by adding simple lever, would operate micro-switch. £1·2 8

DIGITAL COUNTER TIMER



Very stable and reliable crystal controlled circuit. Capable of work in excess of 15 MHz. Construction simplified by use of 15 integrated circuits. Complete kit with case £43·50 or construction data and price list 50p.

TIME SWITCH

Smiths mains driven clock with 15 amp switch, also notes showing how you can wake up with music playing, kettle boiling or come home to a warm house, warn off burglars keep pets warm, halve your heating bill, etc. £2·20.

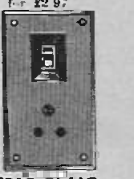
PRESSURE SWITCH

Containing a 15 amp. change over switch operated by a diaphragm which in turn is operated by air pressure through a small metal tube. The operating pressure is adjustable but is set to operate in approx. 10 in. of water. These are quite low pressure devices and can in fact be operated simply by blowing into the inlet tube. Original use was for washing machines to turn off water when tub has reached correct level but no doubt has many other applications £1·38, each.

5 PUSH BUTTON SWITCHES

Mains, suitable for audio or R.F. Each switch rated at 250v. 15 amps. 1st (black push button) closes 2 circuits, 2nd (white push button) operates one change-over, 3rd (white push button) operates one change-over, 4th (white push button) opens one circuit. Note: all depressed buttons remain down until cleared by the 5th (red button). Further note: It is a relatively easy job to alter the position of the tags thus making the switches suit your circuit. Fitted with 3 white, 1 red and 1 black button. 32p each or 10 for £2·97

5A 3-PIN SWITCHED SOCKETS



An excellent opportunity to make that bench dis board you have needed or to stock up for future jobs. This month we offer 6 British made (Hicraft) bakelite flush mounting shuttered switch sockets for only 55p plus 20p post and insurance. (20 boxes post free.)

CAR ELECTRIC PLUG

Fits in place of cigarette lighter Useful method of making a quick connection into the car electrical system. 42p each or 10 for £3·76.

EXIT SIGNS

One of our customers has pointed out how easily our box signs can be converted to exit signs. These are illuminated, having a 20W fluorescent lamp with associated control gear. The front is very thick, clear plastic. Directly on to this you can stick down the letters available at most stationers. There is room inside the box for a battery and low volt lamp in the case of power failure. Size of sign is 2ft. high × 14in. wide × 5in. deep. Solidly made from sheet steel and hammer finished in enamel. Price £3·85 plus 50p carriage per 200 miles.

SPRING COIL LEADS

As fitted to telephones, 4 core 17p each, 10 for £1·53. 3 core 11p each. 10 for £1.

LARGE PANEL MOUNTING MOVING COIL METERS

Size 5in. × 4in. Centre zero 200-0-200 micro amp. Made by Sangamo Weston. Regular price probably £8. Our price £3·85.

A.C. AMMETER

0–5 amps. flush mounting—moving iron. Ex equipment but guaranteed perfect £1·65.

CIRCUIT BOARDS

Heavy copper on 3/32 paxolin sheet, ideal for making power packs etc. as sheet is very strong and thick enough to allow copper to be cut away with hacksaw blade. 5in. × 5in. 9p each. 15in. × 5in. 26p.

PHOTO-MULTIPLIER TUBE

Hakuto Co. Ltd., Ref. No. R.450. The regular price is understood to be between £14 and £15 each. We offer these brand new and perfect for £4·50 each.

RESISTANCE WIRE

Kanthal, Nichrome etc. Approx. 2 tons of this coming in—many sizes and grades. If you are a user of this you can save yourself half the cost. Send now for our list. Sorry, not available on small size reels.

PP3 BATTERY CHARGER

Almost 3 times the life can be obtained from PP3 battery if you re-charge it from the mains —this ready to use charger with instructions only 55p.

SUB-MINIATURE MOVING COIL MICROPHONE

as used in behind the ear deaf aids

Acts also as earphone, size only ¾in. × ¾in. × ¼in. Regular price probably £3 or more. Our price £1·10. Note these are ex equipment but if not in perfect working order they will be exchanged.

PROTECT VALUABLE DEVICES

FROM THERMAL RUNAWAY OR OVER-HEATING

Thyristors, rectifiers, transistors, etc., which use heat-sinks can easily be protected. Simply make the contact thermostat part of the heat-sink. Motors and equipment generally, can also be adequately protected by having thermostats in strategic spots on the casing. Our contact thermostat has a calibrated dial for setting between 90deg. to 190deg.F., or with the dial removed range setting is between 80 to 800deg.F. Price 83p.

KITS FOR PREVIOUS PROJECTS

Unless otherwise stated, kits contain electronic parts only. The case and special items can be obtained locally. Also batteries are not included. Kits may be returned for refund if construction has not been started. We reserve the right to substitute components should deliveries be protracted so as to avoid undue delay.

If reprint of data is required add 10p.

HOME SENTINEL
"Ward off the unwanted intruder"—No elaborate setting up or wiring required. Kit of parts £4·85.

"SNAP" INDICATOR
Press your button first and your opponent is blocked also suitable for Quiz games and reaction testing. Kit of parts £1·10

RECORD PLAYER
Good quality at a reasonable price—good enough for classical records and pop. Kit of parts £6·10.

WINDSCREEN WIPER CONTROL
Wet dirty road—Drizzle—Fog—Smeared screen—Scraping wipers—combat these with add-on wiper control. Kit of parts £2·50.

FUZZ BOX
Add weird and interesting effects to guitar playing with this solid state Fuzz box. Kit of parts £2·50.

PHOTOGRAPHIC COLOUR TEMPERATURE METER
Must for colour photographer get the colours right gives quick indication of filters necessary for correction in any light. Can be used with natural or Studio lighting. Kit of parts £3·68.

ASTRON M.W. RADIO
A simple M.W. reflex circuit receiver—easy to build. £3·30.

REMOTE TEMPERATURE COMPARATOR
Measures small temperature changes in liquids or gases—fish tank, photographic solution—thermostatically controlled rooms etc. Kit £5·25.

RAIN WARNING ALARM
Keep your washing dry with this automatic alarm device Kit £2·20.

WAA WAA PEDAL
Add excitement and sound vibration to your music. Kit £3·50.

ELECTRO LAUGH
Laughter simulator also useful electronic alarm. Kits of part £2·20.

SOIL MOISTURE METER
Many plants are killed through over-watering—this meter measures soil moisture at root depth—probes can be left permanently beside the plant-indicator remotely housed could monitor several plants. Kit £3·90.

SIGNAL INJECTOR
A useful pocket instrument for fault finding in radios and amplifiers. Kit £1·10.

BABY ALARM
Keep a check on the kids—this device will give you peace of mind as you watch T.V. Kit £4·40.

SIMPLE CALCULATOR
Teaching aid for multiplication—can be used for quick checks. Kit £3·10.

POWER SUPPLY UNIT
Just right for testing low voltage circuits—a simple stabilised supply providing 0-16 volts D.C. continuously variable. Kit £5·20.

METAL LOCATOR
A simple easy to construct self-contained metal locator giving a meter indication of buried metal. Kit £5·00.

AUDIO TONE GENERATOR
Makes electronic music—covers range from 50—2000 hz. Specifically designed for use with tape recorder. Kit £3·25.

LIGHT TO SOUND CONVERTER
Produces an audio tone—the frequency of which is dependent on the light level. Kit £2·15.

SHAVER INVERTER
Provides 240v 50hz from 12 volt car battery—gives approx 10 watts which is enough for most shavers. Kit £4·35.

ELECTRONOME
Electronic Metronome with pulse frequency continuously variable from 40—225 beats per minute. Kit £2·15.

THROUGH LENS LIGHT METER
A simple light meter for use with single lens reflex camera. Kit £4·35.

MEDIUM AND LONG WAVE RADIO TUNER
A simple radio tuner for use with almost any amplifier. Kit £3·25.

INFRA RED BURGLAR ALARM
Uses an invisible, reflected beam to detect intruders when beam is intercepted—a power output is switched on for up to one minute. Kit £4·35.

MINI-ORGAN
RAIN ALARM

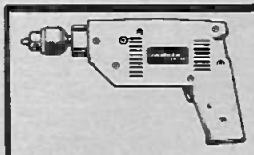
To receive parts for these and other projects featured in this issue send quoted approximate amount any cash adjustment can be made later.

THYRISTOR LIGHT DIMMER

Domestic model for any lamp up to 250 watt. Mounted on switch plate to fit in place of standard switch. Virtually no radio interferences. Price £2·95. Industrial model 5 amp module with control knob £3·30.

DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 6 feet of flex cable. Wired up ready to work. £2·50 plus 23p P. & I



PORTABLE ELECTRIC DRILL

Very superior quality made by a famous Dutch toolmaker. Model No. ASM 330. 300w—2 speed 2200/3000. With ¼" chuck and chuck key, also separate side handle and hammer facility for dealing with concrete, etc. An equivalent British made drill would cost £15·00. £10·90—similar model but without the hammer attachment £7·95. Have either model on approval for 7 days.

HORTSMAN 24 HOUR TIME SWITCH

With 6 position programmer. When fitted to hot water systems this could programme as follows:-

Programme	Hot Water	Central Heating
0	Off	Off
1	Twice daily	Off
2	All day	Off
3	Twice daily	Twice daily
4	All day	All day
5	Continuously	Continuously

Suitable of course, to programme other than central heating and hot water, for instance, programme upstairs and downstairs electric heating or heating and cooling or taped music and radio. In fact there is no limit to the versatility of this Programmer. Mains operated—Size 3" × 3" × 2" deep as illustrated but less case. Price £3·50 each.

CD CAR IGNITION

This system which has proved to be amazingly efficient. We offer kit of parts as P.W. Circuit £8·55 plus 20p p. & p. Deluxe model with prepared circuit board £7·95. When ordering please state whether for positive or negative systems.

CENTRIFUGAL BLOWER

Miniature mains driven blower centrifugal type blower unit by Woods. Powerful but specially built for quiet running—driven by cushioned induction motor with specially built low noise bearings. Overall size 4½" × 4½" × 4". When mounted by flange, air is blown into the equipment but to suck air out, mount it from centre using clamp. Ideal for cooling electrical equipment or fitting into a cooker hood, film drying cabinet or for removing flux smoke when soldering etc. etc. A real bargain at £2·95.

INTEGRATED CIRCUIT BARGAIN

A parcel of integrated circuits made by the famous Plessey Company. A once-in-a-lifetime offer of Micro-electronic devices well below cost of manufacture. The parcel contains 5 ICs all new and perfect, first-grade device, definitely not sub-standard or seconds. 4 of the ICs are single silicon chip GP amplifiers. The 5th is a monolithic NPN matched pair. Regular price of parcel well over £5. Full circuit details of the ICs are included and in addition you will receive a list of many different ICs available at bargain prices 25p upwards with circuits and technical data of each. Complete parcel only £1 post paid.
DON'T MISS THIS TERRIFIC BARGAIN.

GOOD COMPANION

We can now offer these again in Lc. version using Ferranti ZN414 and Mullard AP Modules 1172. Excellent tone wood cabinet. Cabinet size approx. 11in wide × 8in. high × 3in. deep. Complete assembly instructions £5·75 plus 25p post and ins.

MIGHTY MIDGET

Probably the tiniest possible radio, as described in Practical Wireless, January '73. All electronic parts £2·20 post paid.

DRILL CONTROLLER
NEW IKW MODEL

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. £1·65 plus 13p post and insurance. Made up model also available. £2·50 plus 13p post & p.

TERMS:—10% discount if ten of an item ordered, send postage where quoted—other terms, post free if order for these over £6·00 otherwise add 20p.

J. BULL (ELECTRICAL) LTD.

(Dept. E.E.), 7 Park Street, Croydon CRO 1YD

Callers to: 102/3 Tamworth Road, CROYDON.

KITS FOR PREVIOUS PROJECTS CONT. FROM LEFT HAND COL.

CASSETTE TAPE POWER SUPPLIES
Two units to power a cassette tape player or recorder one from the mains Price £2·50. Two from the car battery—price £1·40.

REACTOMATIC
A reaction testing game that can also be a quiz answering indicator. Kit £3·30.

ELECTRONIC MOUSE TRAP
A humane mouse trap—catches them alive so that you can release them in the park. Kit £3·25.

TRANSISTOR TESTER
A rapid tester for checking most transistors—tests transistors in an oscillator circuit and gives audible indication of goodness. Kit £2·15.

RADIO CONTROL TRANSMITTER
A simple single channel transmitter for the radio control of boats, aeroplanes and other models. Kit £6·15.

RADIO CONTROL RECEIVER
A single channel super regenerative receiver to work in with above transmitter. Kit £3·30.

BIT SAVER
Prolongs life of soldering iron bit—prevents pitting. Kit £1·95.

ICE WARNING DEVICE
A device that can be set to indicate 'ice' conditions or similar temperature levels. Kit £1·55.

AUDIO COLOUR UNIT
Add a colour dimension to your audio equipment. This unit will modulate three lamps in accord with Bass—middle and treble notes of any music. Kit of parts £7·20.

U.H.F. T.V. AERIAL
A simple aerial for U.H.F. to reception on your band could improve your reception immensely. Kit £1·65.

DAMP LOCATOR
Easily carried in your pocket this little unit gives visible indication of damp. Kit £1·25.

ENLARGER & EXPOSURE METER
For D.I.Y. photographer £5·00.

EGG TIMER
Simple timer with audible warning. £4·15

NEON NOVELTY
Interesting modern ornamental device £1·65.

CONNECTING WIRE
500m. coils—7 stranded flex copper P.V.C. covered. Available in popular colours:—£2·20 per coil, plus 40p post.

8" x 5" P.M. SPEAKER
15 ohm—£1·50. This is a good quality speaker by a famous maker. High flux ideal for use with our Mullard 4 watt amplifier.

3 GANG TUNING CONDENSERS.
500pf each section ideal for transmitter or communications receivers. 81p.

RECTIFIER PANELS
Contain 4 of IN40 (400v) wire ended rectifiers, a glass encased fuse, fusing current not known but believed low. Also 4 small wattage resistors at only 16p each, which is less than many shops charge for one of the rectifiers.

16 TRACK TAPE HEAD
for ¼" or 1" tape. This is a brass encased tape head and measures approx. ½" x ½" x ½". Resistance is approx. 20-0-20 ohms. These heads are beautifully made but we have no technical data. also have only a limited quantity. Price £5·50 each or 10 for £50.

RECORD PLAYBACK HEADS (TRUVOX)

Individual prices of these are:—
2 track record playback heads 87p each.
4 track record playback heads 72p each.
Erase heads are also available separately—2 track 17p—4 track 28p.

AC CONDENSERS

In addition to the normal uses as motor starters, power factor correction etc. These make very good voltage droppers for working low voltage appliances from mains. The voltage working quoted is AC and condensers are usually suitable for working on DC at 2½ times the quoted AC voltage.

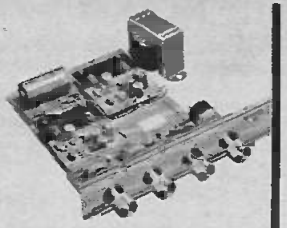
1·5 mfd 400v 28p	5 mfd 570v 66p	12 mfd 250v 77p
2 mfd 440v 33p	6·25 mfd 250v 55p	15 mfd 250v 88p
3·4 mfd 440v 44p		20 mfd 275v 99p
3·5 mfd 250v 33p	8 mfd 250v 55p	
	8 mfd 440v 83p	

TINIEST AUDIO UNIT
Although only the same size as an Oxo cube these are completely self contained and comprise microphone, 3 transistor amplifier with volume control and battery compartment and finally a dynamic earpiece. All in a plastic case. Made by Ardent (Sold, we believe at over £50 each). These are really hearing aids complete except for the ear tube but we are not selling these as hearing aids only for the micro midget parts they contain. Believed to be in perfect working order but not tested. Price £3·80 each.

QUALITY STEREO AT BUDGET PRICES!

The STEREO 20

The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm x 14 cm x 5·5 cm. This compact unit comes complete with on/off switch, volume control, balance, bass and treble controls. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet. Output power 20w peak Input 1 (Cer.) 300mV into 1M Freq. res. 25Hz-25kHz Input 2(Aux.) 4mV into 30K Harmonic distortion Bass control ±12dB at 60Hz typically 0·25% at 1 watt Treble con. ±14dB at 14 kHz



£13·48 free p. & p.

STABILISED POWER

MODULE SPM80 **£3·25**

AP80 especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. Embodies latest circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, will provide outputs of up to 1·5 amps at 35 volts. Size: 63 mm x 105 mm x 20 mm. These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Ideal for many other applications including:—Disco Systems, Public Address, Intercom Units, etc. Handbook available. 10p.

TRANSFORMER BMT80 **£2·15** p. & p. 27p.

AL50 HI-FI AUDIO AMP

50W pk 25 (RMS)

0·1% DISTORTION

- Frequency Response 15Hz to 100,000—1dB.
- Load—3, 4, 8 or 16 ohms.
- Supply voltage 10–35 Volts.
- Distortion—better than 0·1% at 1kHz
- Signal to noise ratio 80dB.
- Overall size 63 mm x 105 mm x 13 mm.

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry the AL50 was conceived to fill the need for all your A.F. amplification needs.

FULLY BUILT—TESTED—GUARANTEED.

BRITISH MADE only **£3·58** each

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise PNP devices for use in the input stages. Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

SPECIFICATION:

Frequency response	20Hz—20kHz ±1dB	Bass control	±15dB at 20Hz
Harmonic distortion	better than 0·1%	Treble control	±15dB at 20kHz
Inputs: 1. Tape head	1·25mV into 50kΩ	Filters: Rumble (high pass)	100Hz
2. Radio, Tuner	35mV into 50kΩ	Scratch (low pass)	8kHz
3. Magnetic P.U.	1·5mV into 50KΩ	Signal/noise ratio	better than +65dB
All input voltages are for an output of 250mV.		Input overload	+26dB
Tape and P.U. inputs equalised to RIAA curve		Supply	+35 volts at 20mA
within ±1dB from 20Hz to 20kHz.		Dimensions	292 x 82 x 35 mm.

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 & 1 PA100 ONLY £25·30 FREE p. & p.

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SW5—2 pole, 6 way.
SW6—3 pole, 4 way.
SW7—4 pole, 2 way.
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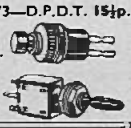

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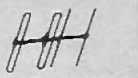

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for constructional projects. White, with lid and screws.
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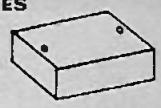

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in plain aluminium with sloping front panel.

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SF2	2in	7¼in	3¼in	66p	17½p
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2½in 8Ω
2½in 8Ω
2½in 80Ω
All at 68p each.

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in plain aluminium, ideal for mixers, instruments, etc.

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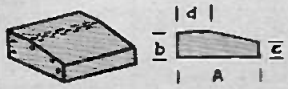

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with lids and screws

Type	L.	W.	D.	Price	p. & p.
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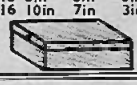
GB8*	4in	4in	1¼in	42p	16p
GB9*	4in	2¼in	1¼in	42p	14p
GB10*	5¼in	4in	1¼in	49p	19p
GB11	4in	2¼in	2in	42p	14p
GB12	3in	2in	1in	36p	15p
GB13	6in	4in	2in	57p	20p
GB14	7in	5in	2¼in	69p	21p
GB15	8in	6in	3in	89p	29p
GB16	10in	7in	3in	£1·00	29p



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Eagle SE5. 8Ω
40–16,000Hz
Complete with cable and stereo jack plug.
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10 WATT AMPLIFIER module

Input: 30mV into 10kΩ for 10W. 40 – 16,000 Hz.
Output: 3-8-16Ω
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Four core, individually screened 30p yd.
Coiled screened leads, 20 feet long £1·05 each.

MINIATURE ELECTROLYTICS

1·0μF	63V	7p	150μF	25V	8p
1·5μF	63V	7p	150μF	40V	13p
2·2μF	63V	7p	150μF	63V	15p
3·3μF	63V	7p	220μF	4V	7p
4·7μF	63V	7p	220μF	10V	7p
6·8μF	40V	7p	220μF	16V	8p
6·8μF	63V	7p	220μF	25V	13p
10μF	25V	7p	220μF	40V	15p
10μF	63V	7p	220μF	63V	22p
15μF	16V	7p	330μF	4V	7p
15μF	40V	7p	330μF	10V	8p
15μF	63V	7p	330μF	16V	13p
22μF	10V	7p	330μF	63V	26p
22μF	25V	7p	470μF	6·3V	8p
22μF	63V	7p	470μF	10V	13p
33μF	6·3V	7p	470μF	25V	15p
33μF	16V	7p	470μF	40V	22p
33μF	40V	7p	680μF	6·3V	13p
47μF	4V	7p	680μF	16V	15p
47μF	10V	7p	680μF	25V	22p
47μF	25V	7p	680μF	40V	26p
47μF	40V	7p	1000μF	4V	13p
47μF	63V	8p	1000μF	10V	15p
68μF	6·3V	7p	1000μF	16V	22p
68μF	16V	7p	1000μF	25V	26p
68μF	63V	13p	1500μF	6·3V	15p
100μF	4V	7p	1500μF	10V	22p
100μF	10V	7p	1500μF	16V	26p
100μF	25V	7p	2200μF	6·3V	22p
100μF	40V	8p	2200μF	10V	26p
100μF	63V	15p	3300μF	6·3V	26p
150μF	6·3V	7p	4700μF	4V	26p
150μF	16V	7p			

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Size	0·1 Matrix	0·15 Matrix
2½in x 3½in	25½p	18½p
2½in x 5in	28½p	28½p
3½in x 3½in	28½p	28½p
3½in x 5in	32p	35p
17in x 2½in	87p	66p
17in x 3½in	£1·18	94p

Spot face cutter—44p
Pins, either size, pack of 36—21p
Edge connectors:
24 way, 0·1—37½p
24 way, 0·15—37½p
36 way, 0·1—48½p
16 way, 0·15—25p

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Single, less switch, 15p
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Tandem, less switch, 44p
5kΩ, 10kΩ, 25kΩ, 50kΩ, 100kΩ, 250kΩ, 500kΩ, 1MΩ, 2MΩ

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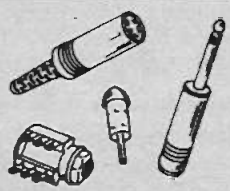
suitable for transistor radios and similar light current equipment. Input 240V. A.C.
Output: PP6—6V D.C.; PP9—9V D.C.
Price £1·65 plus 15p p. & p.

PLUGS

Car aerial	15½p
Co-axial	10p
D.I.N. 2 pin (speaker)	11p
D.I.N. 3 pin	15p
D.I.N. 4 pin	15½p
D.I.N. 5 pin, 180°	14½p
D.I.N. 5 pin, 240°	16½p
D.I.N. 6 pin	16½p
Jack, 2½mm unscreened	10p
Jack, 2½mm screened	11p
Jack, 3½mm unscreened	9p
Jack, 3½mm screened	13p
Jack, ¼in unscreened	13p
Jack, ¼in screened	22p
Jack, stereo, unscreened	22p
Jack, stereo, screened	38p
Phono, plastic top	5½p
Phono, plated metal	13p
Wander, red or black	3½p
Banana 4mm, red or black	6½p

LINE SOCKETS

Car aerial	15½p
Co-axial	19p
D.I.N. 2 pin (speaker)	16½p
D.I.N. 3 pin	17½p
D.I.N. 5 pin, 180°	17½p
D.I.N. 5 pin, 240°	17½p
Jack, 3½mm	16½p
Jack, ¼in screened	54p
Jack, stereo, screened	37p
Phono, plated metal	15½p



SOCKETS

Car aerial	9p
Co-axial, surface	9p
Co-axial, flush	10p
D.I.N. 2 pin (speaker)	11p
D.I.N. 3 pin	10p
D.I.N. 5 pin, 180°	10p
D.I.N. 5 pin, 240°	10p
Jack, 2½mm	11p
Jack, 3½mm	11p
Jack, ¼in unswitched	16½p
Jack, ¼in switched	18½p
Jack, stereo, switched	26p
Phono, single	5½p
Phono, 2 on a strip	7½p
Phono, 3 on a strip	10p
Phono, 4 on a strip	11p
Wander, single, red or black	5½p
Wander, twin strip	7½p
Banana 4mm red, or black	6½p

TRANSFORMERS

all with 0-250 Volt primaries.

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MM6 6V, 500mA+6V, 500mA.
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LT3 12V, 1·5A—96p plus 28p p. & p.
LT4 12V, 3A—£1·45 plus 33p p. & p.
LT5 9–0–9V, 0·5A—83p plus 23p p. & p.
LT6 12–0–12V, 1A—£1·04 plus 29p p.&p.

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MT60/2 0–5–20–30–40–60V, 2A—£3·25 plus 37p p. & p.

Charger
CT/01 1A—£1·16 plus 28p p. & p.
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Secondaries 0–5–11–17V.
Speaker Matching 3–8–16Ω
Example: 16Ω speaker to 8Ω amplifier.
99p plus 22p p. & p.

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For Philips and similar cassette recorders.
PU12 power unit for connection to 12V + or — E cars, giving 7½V stabilised output—£3·55+16p p. & p.
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Both units are complete with cables and 5 pin D.I.N. plug.

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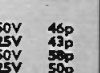
Low impedance dynamic with remote control switch. Fitted 2½mm and 3½mm plugs. £2·20 plus 15p p. & p.



ELECTROLYTICS

1μF	450V	21p	1000μF	50V	46p
2μF	450V	22p	2000μF	25V	43p
4μF	350V	15½p	2000μF	50V	58p
8μF	450V	18½p	2500μF	25V	50p
16μF	450V	20p	2500μF	50V	66p
25μF	25V	7½p	3000μF	25V	53p
25μF	50V	11p	5000μF	25V	66p
32μF	450V	30p	5000μF	50V	£1·21
50μF	50V	11p	8–8μF	450V	20p
100μF	50V	12p	8–16μF	450V	22p
250μF	25V	15½p	16–16μF	450V	30p
250μF	50V	19p	16–32μF	450V	69p
500μF	25V	20p	32–32μF	450V	54p
500μF	50V	27½p	50–50μF	350V	42p
1000μF	25V	30p			

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Dual-in-line or Zig-Zag (Dual), 14 and 16 pin
Our Price 1p per pin

Slider Pots

Single	Dual	log
10K	10 + 10K	or
25K	25 + 25K	lin
50K	50 + 50K	
100K	100 + 100K	Knobs
30p	50p	10p.

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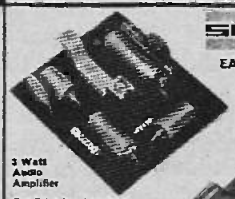
E298 ZZ/06	18p			VA1055S	10p
GL16 £1				VA1034	10p

Resistors

¼ watt 5% Carbon Film – low noise Hi-Stabs
All E24 values 1p each plus p. & p. 7p for up to 50 Resistors and a further 2p for each additional 50. Deduct 33⅓% for 100 of one type or 25% for mixed orders over £1 in value.

1 W	10% Carbon Composition	3p each
2 W	10% Carbon Composition	6p each
2½ W	5% Wire wound	9p each
5 W	Wire wound	9p each
10 W	Wire wound	10p each

plus p. & p. 7p for up to 25 resistors plus 1p for each additional 25.



3 Watt Audio Amplifier
Our Price inc. handbook £3·40

10+ less 15%
25+ less 25%
100+ less 33½%

5 Watt Audio Amplifier
Our Price £3·99
Less quantity discount.

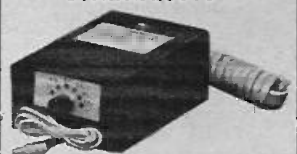
FM TUNER chassis fully transistorised 9 volt operation. **OUR PRICE £9·25**
Matching stereo decoder £4·97
Ask for model list No. 11.

Potentiometers

5KΩ	50KΩ	500KΩ
10KΩ	100KΩ	1MΩ
25KΩ	250KΩ	2MΩ

log or lin less switch (& 1KΩ lin)	12p
log or lin with switch	24p
dual less switch	40p
dual with switch 10K, 100K & 1M log only	62p
10K log + 10K antilog less switch	40p

Eliminators



9 volt @ 20mA (PP3)	£1.26
6 volt @ 50mA	£1.50
9 volt @ 50mA	£1.50
6 + 6 volt, 50mA	£2.50
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7½ volt for cassette recorders	£2.00
6, 7½ or 9 volt	£3.00
3, 4½, 6, 7½, 9, 12 @ 500mA (illus.)	£3.99
Car Battery Converter fully stabilised to provide 6, 7½ or 9 volts	£4.99

(p. & p. 15p on all types)

Presets

Vertical or Horizontal

0·1 watt 5p	0·25 watt 7p			
100	1K Ω	10K Ω	100K Ω	1M Ω
250	2·5K Ω	25K Ω	250K Ω	2·5M Ω
500	5K Ω	50K Ω	500K Ω	5M Ω

Capacitors

disc ceramic		low voltage		
·01μF 18v	5p	0·1μF	30v	5p
·022μF 18v	5p	0·22μF	6v	5p
·047μF 12v	5p	0·47μF	3v	5p
ceramic plate		30V		
1000pf	10p	4700pf		10p
2200pf	10p	10,000pf		10p

Ceramic – plate	63V (C333)	
1·8pf	8·2pf	33pf	120pf
2·2pf	10pf	39pf	150pf
3·3pf	12pf	47pf	180pf
3·9pf	15pf	56pf	220pf
4·7pf	18pf	68pf	270pf
5·6pf	22pf	82pf	330pf
6·8pf	27pf	100pf	

all 5p. each

mylar film	100V				
1000pf	2p	·01μF	3p	·068μF	4p
2000pf	2p	·02μF	3p	·1μF	4p
5000pf	2p	·04μF	3p	·2μF	5p
		·05μF	3p		

polystyrene	160V				
10pf to 10,000pf in multiples of 10, 15, 22, 33, 47 & 68.				3p each	
metallised polyester	250V (C280)				
·01μF	3p	·068μF	3½p	·47μF	8p
·015μF	3p	·1μF	4p	·68μF	11p
·022μF	3p	·15μF	4p	1μF	13p
·033μF	3p	·22μF	5p	1·5μF	20p
·047μF	3p	·33μF	6½p	2·2μF	24p

metallised polyester	400V (C281)				
·01μF	4½p	·047μF	6p	·22μF	10p
·015μF	4½p	·068μF	6p	·33μF	14p
·022μF	4½p	·1μF	7p	·47μF	15p
·033μF	5½p	·15μF	8p		

silvered mica 1% (>50pf) 500V			
2·2pf–820pf	7p	4·7nF–5600pf	19p
1nF–2·2nf	9p	6800pf–·01μF	29p
2·7nF–3·6nF	18p		

mixed dielectric	600V				
·01μF	7p	·047μF	7p	·22μF	16p
·022μF	7p	·068μF	8p	·47μF	24p
·033μF	7p	·1μF	8p	1μF	33p

mixed dielectric	1000V				
1000pf	6p	6800pf	9p	·1μF	12p
2200pf	6p	·01μF	9p	·22μF	22p
3300pf	6p	·022μF	9p	·47μF	30p
4700pf	6p	·047μF	12p		

Ceramic					
12KV.d.c.		8KV.d.c.		HI-K 750V.	
10pf	9p	200pf	9p	1000pf	5p
15pf	9p	220pf	9p	1500pf	5p
22pf	9p	250pf	9p	2000pf	5p
68pf	9p	270pf	9p	3000pf	5p
82pf	9p	300pf	9p	5000pf	5p
100pf	9p	750V DISC		10,000pf	5p
120pf	9p	470pf	5p	feed-	
140pf	9p	1000pf	5p	through	
150pf	9p	5000pf	5p		
180pf	9p	10,000pf	5p	1000pf	5p

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(10)	4"	x 5¼"	x 1½"	40p	8p
11	4"	x 2½"	x 2"	35p	8p
12	3"	x 2"	x 1"	32p	9p
13	6"	x 4"	x 2"	50p	10p
14	7"	x 5"	x 2½"	58p	12p
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16	10"	x 7"	x 3"	85p	20p

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AC127	15p	BC149	10p	BF272	33p	OC170	23p	2N1893	39p
AC128	15p	BC157	12p	BFY50	24p	OC171	39p	2N2926	all 19p
AC176	15p	BC158	10p	BFY51	21p	ZTX107	15p	2N3053	23p
AC187	25p	BC158	12p	BRY39	36p	ZTX108	12p	2N3054	50p
AC187K	25p	BC169	15p	BSX21	26p	ZTX109	15p	2N3055	48p
AC188	25p	BC268	15p	BSY95A	14p	ZTX300	12p	2N3702	12p
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AD140	48p	BD132	78p	MPF102	48p	ZTX303	28p	2N3705	10p
AD149	69p	BD131/2M.P.		MPF103	37p	ZTX304	25p	2N3706	10p
AD161 AD162	80p		149p	MPF104	37p	ZTX341	28p	2N3707	15p
AF114	18p	BF160	21p	MPF105	49p	ZTX500	15p	2N3708	12p
AF115	18p	BF167	20p	MPF106	45p	ZTX501	15p	2N3709	12p
AF116	18p	BF173	20p	OC28	48p	ZTX502	28p	2N3710	12p
AF117	18p	BF180	25p	OC35	48p	ZTX503	17p	2N3711	12p
AF139	28p	BF181	30p	OC44	15p	ZTX504	50p	2N3819	35p
BC107	10p	BF184	25p	OC45	15p	ZTX531	25p	2N3903	15p
BC108	10p	BF185	25p	OC71	11p	2N697	18p	2N3904	17p
BC109	10p	BF194	15p	OC72	17p	2N706	12p	2N3905	21p
		BF195	15p	OC76	15p	2N708	15p	2N3906	12p

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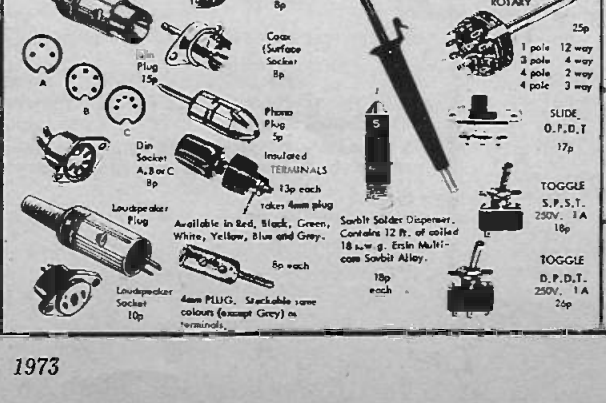

Mullard & Siemens Electrolytics

CAP μF	VOLTAGE 4	6.3	10	16	25	40	63
1	—	—	—	—	—	—	6p
1·5	—	—	—	—	—	—	6p
2·2	—	—	—	—	—	—	6p
3·3	—	—	—	—	—	—	6p
4·7	—	—	—	—	—	—	6p
5·6	—	—	—	—	6p	6p	6p
10	—	—	—	6p	—	6p	6p
15	—	—	—	8p	—	6p	6p
22	—	—	6p	—	6p	—	6p
33	—	8p	—	6p	—	8p	—
47	6p	—	8p	—	8p	8p	8p
68	—	6p	—	8p	—	—	10p
100	8p	—	8p	—	8p	8p	12p
150	—	—	—	8p	8p	10p	15p
220	6p	—	8p	8p	10p	12p	18p
330	8p	—	8p	10p	—	—	21p
470	—	8p	10p	—	12p	18p	40p
680	—	10p	—	12p	18p	21p	—
1000	10p	—	12p	18p	21p	40p	60p
1500	—	12p	18p	21p	—	—	—
2200	—	18p	21p	40p	45p	55p	83p
3300	21p	—	—	—	—	—	—
4700	—	21p	—	80p	75p	93p	—

CAP μF	VOLTAGE 16	25	40	64
500	—	—	33p	40p
1250	—	—	50p	—
1600	—	—	—	75p
2000	40p	50p	—	—
2500	—	—	75p	93p
3200	50p	—	—	—
4000	—	75p	93p	—
6400	75p	93p	—	—

Quantity Prices on application.

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1; 2; 4; 8nF	450V	14p	32μF	450V	20p
16μF	450V	15p	50μF	350V	20p
8 + 8μF	450 W.V	18p	32 + 32μF	350 W.V	25p
8 + 16μF	450 V.W	20p	32 + 32μF	450 W.V	43p
16 + 16μF	450 V.W	25p	50 + 50μF	350 V.W	35p

everyday electronics

PROJECTS...
THEORY.....

PRINTED CIRCUITS

The so-called "printed" circuit board has for long been the standard method of assembly used in industry for large quantity production of electronic equipments. Each printed circuit board is unique, for it comprises a wiring pattern created exclusively for one particular circuit design. Once the master has been proved and tested, mass production is an easy process without any possibility of errors creeping into individual boards. Thus the chance of sub-standard products emerging from a production line is reduced to the very minimum.

Ideal for mass production, yes. But does the printed circuit technique have any special advantages to offer to the private constructor? On the face of it it might well seem that the initial preparatory work is hardly warranted in the case of one single item of equipment, and the average constructor is normally concerned with building just "one off". A high productivity rate is certainly not one of the needs that have to be met.

Yet many private constructors do use this technique on occasions in preference to a standard breadboard or wiring board.

PRACTICAL—AND ATTRACTIVE

Without a doubt the p.c.b. has an increasing value as the size and complexity of the circuitry increases. The danger of wiring errors is considerably reduced, and components are more readily mounted in position since their individual locations are precise and are easily recognised.

Yet there are also other considerations. The finished p.c.b. has a stamp of individuality about it and an appearance which is usually more pleasing to the eye than the regimented pattern of a general purpose wiring board. Though just how important such aesthetic effects are is, of course, a matter for each individual to decide.

One undeniable fact is that a knowledge of the printed circuit technique and some practice in its application are useful and valuable acquisitions for any constructor.

REAL AND IMAGINARY

From an essentially practical matter to something more "in the mind". When one tries to envisage electrons—to say nothing of "holes"—the imagination is indeed put to quite a severe test.

It is not at all essential to understand the principles underlying the operation of a transistor or other semiconductor device in order to use it in an applied circuit. But as likely as not, the newcomer to electronics will eventually find his curiosity getting the better of him, and will begin wondering what makes these tiny devices tick.

Well it is not an easy subject, certainly not at the first encounter. But we feel the series commencing this month will provide a good basic insight into the semiconduction phenomenon—the mechanism which is the real hidden "works" of solid state electronics.

Fred Bennett.

Our July issue will be published on Friday, June 15

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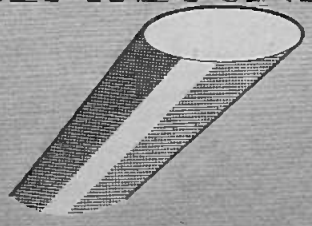
VOL. 2 NO. 6 JUNE 1973

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES



mini ORGAN

A three octave "probe" operated portable instrument by D. B. Stiles

"I WANT an electric organ" said my six-year-old daughter. Visions of Wurlitzer and Hammond consoles crossed my sight.

"Would you like to play a guitar?" I asked, thinking of two old guitars in the attic.

"Aunty has an electric organ" she said accusingly.

In conversation with a friend it transpired that his son also aspired to ownership of an "electric organ". The result of these desires is contained in this article in the hope that it may save someone from having to purchase an expensive organ.

Approximate cost of components including V.A.T.

£4·75 plus case and battery

BASIC OSCILLATOR

The basis of the Mini Organ, it was decided, should be as simple as possible. One of the simplest oscillators can be made using a unijunction transistor; it has the attraction that the frequency can be altered over a fairly wide range merely by varying the value of one resistor.

The basic oscillator and its waveforms are shown in Figs. 1 and 2. An extensive coverage of the unijunction transistor is not within the scope of this article; suffice it to say that a capacitor charges via R_c until the "pinch" voltage is reached. At this point the capacitor discharges rapidly through the emitter/base 1 junction of the device. The rising edge of the emitter sawtooth waveform (a) is determined by the value of R_c and C_a and the trailing edge is dependent upon the value of C_a and the emitter/base 1 resistance.

Short pulses are produced at b1(b) and b2(c) when the capacitor voltage rises to the value of the "pinch" voltage. It was decided not to use

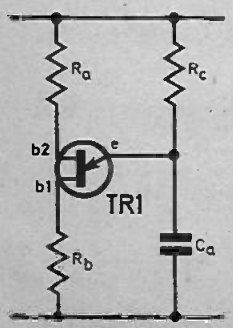
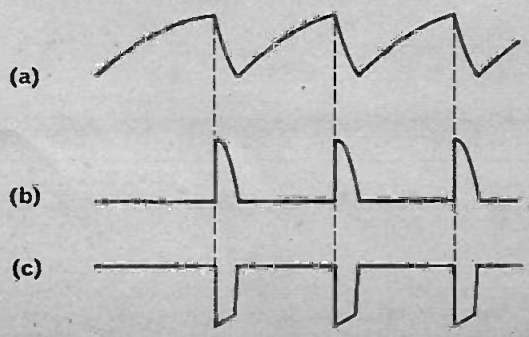


Fig. 1. (left) The basic unijunction oscillator circuit.

Fig. 2 (right) Waveforms associated with the oscillator.



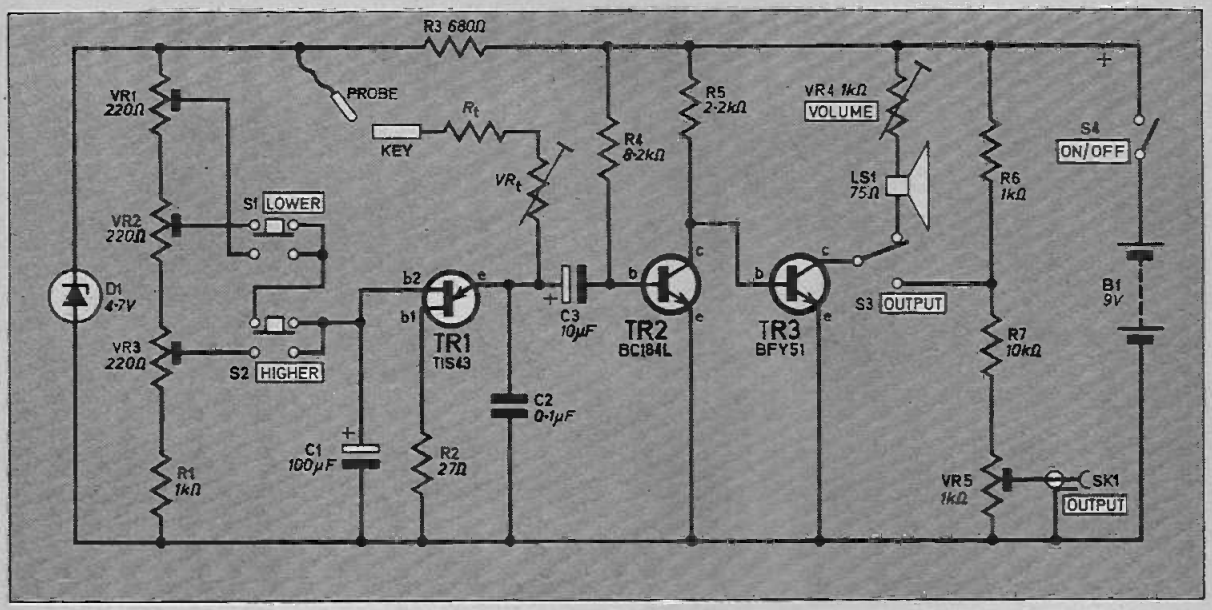


Fig. 3. Circuit diagram of the Mini Organ. Various values for R_t and VR_t for corresponding notes are given in Table 1.

these outputs as the sound was thought to be too staccato due to the short duration of the pulses. The emitter waveform seemed to be more promising, but for reasons explained later it was desirable to have a "square" waveshape rather than a sawtooth: TR2 (Fig. 3) accomplishes this.

FREQUENCY

The frequency of a unijunction oscillator is almost a linear function of the *CR* product. From the formula for the inter-semitone step for the standardised "concert pitch", the value of timing resistors for the circuit were calculated. A value of 15 kilohms was used as a starting point for the higher end of the scale.

As is probably known, the frequency of a note doubles for a complete octave step; thus it was to be expected that the value of timing resistor would halve, since the product of *CR* gives a time, and time is the inverse of frequency. This is shown in the formulae:

$$f = \frac{1}{t} \qquad t = C \times R \times K$$

where f is the frequency, t is time, *C* and *R* are the timing elements, and K is the constant for the oscillator under given conditions.

The results of the calculations are shown in Table 1. In practice it is easier to "tune" an oscillator using trimmer resistors rather than with fixed resistors due to the large tolerances involved. It is not sufficient to say that a 5 per cent error in the pitch would not be noticed by the average child or, indeed, adult.

The values obtained for Table 1 were used to determine the values of fixed and variable resistors shown. The instrument may be tuned "by ear" against any convenient piano, guitar, etc, simply by adjusting the trimmers, starting with VR_B and working down the scale.

A rather more accurate method of tuning the organ is the method I chose; being rather tone deaf, and with a fairly large stock of resistors to hand I fed the output of the organ into a convenient frequency counter and replaced the trimmers with fixed resistors until the counter read the correct frequency. For those with access to a frequency counter I can recommend this method of calibration, particularly if you, too, are tone deaf.

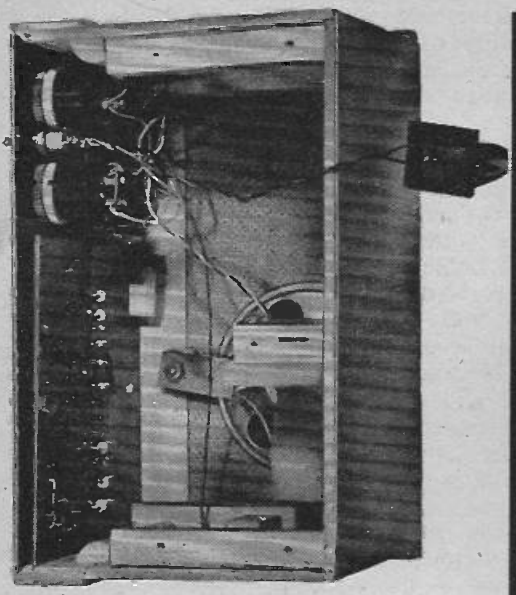
MULTI-OCTAVE VERSION

It is possible, by altering the value of base 2 voltage to the unijunction transistor whilst keep-

Table 1: Resistor Values For Various Notes

Note	C	C♯	D	D♯	E	F	F♯	G	G♯	A	A♯	B	C
Frequency	261·6	277·2	293·7	311·2	329·7	349·2	370·0	392·0	415·4	440·0	466·2	493·9	523·3
Resistance Value (kΩ)	30·0	28·3	26·8	25·2	23·8	22·5	21·2	20·0	18·9	17·8	16·8	15·9	15·0
Fixed Resistor (kΩ)	27	27	24	24	22	20	20	18	18	16	16	15	15
Trimmer (kΩ)	4·7	4·7	4·7	4·7	4·7	4·7	4·7	4·7	2·2	2·2	2·2	2·2	—

The resistor and trimmer associated with each note take their designations from that note, e.g. fixed resistor for D is 24kΩ and its designation is R_D, similarly the trimmer will be 4·7kΩ and VR_D.



Photograph of the prototype Mini Organ.

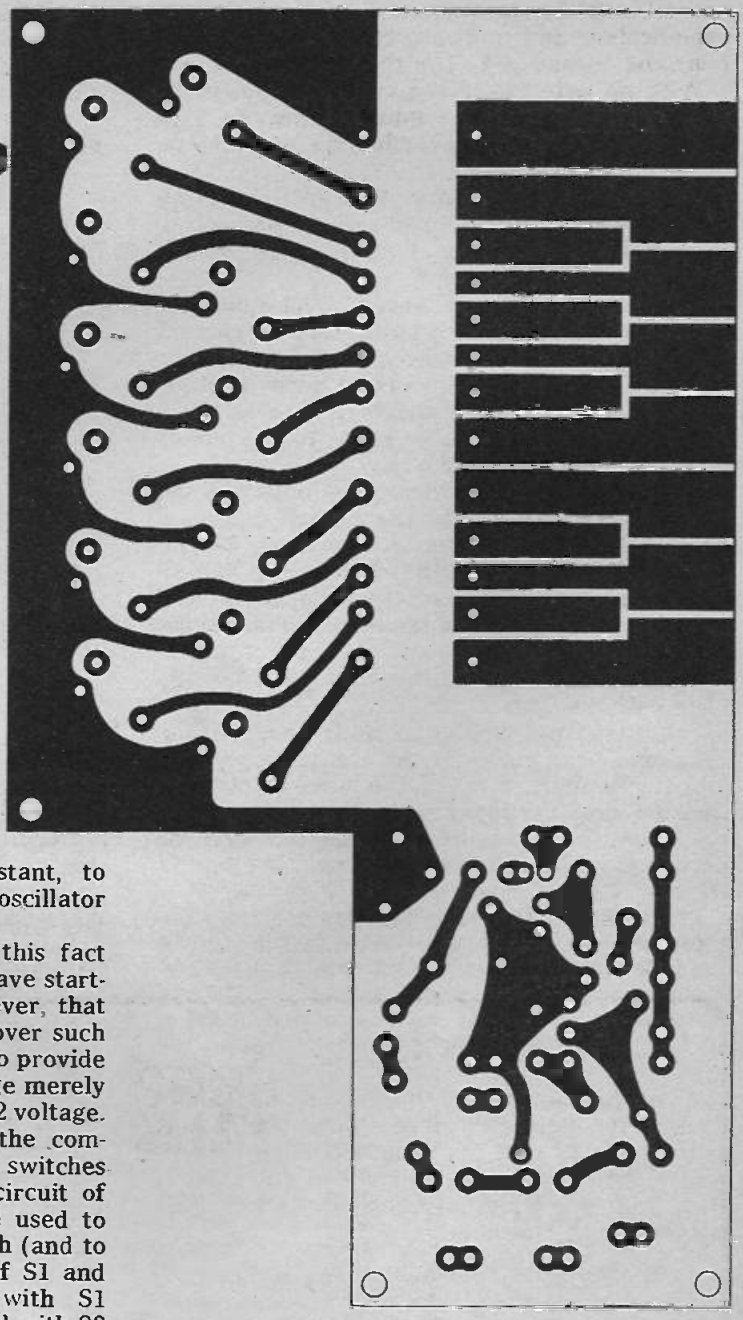


Fig. 4 (right) The layout of the printed circuit panel underside, shown full size.

ing the emitter supply voltage constant, to change the basic frequency of the oscillator shown in Fig. 1.

Initially it was proposed to utilise this fact to tune the one-octave organ to the octave starting at "middle C". It was found, however, that it was possible to alter the frequency over such a wide range that it would be feasible to provide a full octave above and below this range merely by switching in different values of base 2 voltage.

To provide the full three octaves the components VR1, VR2, VR3, R1, and the switches S1, and S2 were added to the basic circuit of Fig. 1 (see Fig. 3). The trimmers are used to tune the three octaves to standard pitch (and to each other). In the normal positions of S1 and S2 the centre range is selected; with S1 depressed a lower octave is selected and with S2 depressed a higher one. Depression of both switches simultaneously results in the higher octave being selected.

KEYBOARD

As was stated at the beginning, the original design concept of the organ was that it should be both simple and inexpensive. A full set of keys, it was found, would be too expensive for such a simple design; making the keys was too complex.

A simple solution to the problem was to etch the key-pattern onto the printed circuit component board. The resulting layout is shown in Fig. 4; if necessary the keyboard and oscillator/amplifier sections may be transferred to different relative positions or divorced from each other completely. The probe used on the keys can be of any suitable insulated metal object from a wander plug to a piece of brass rod in an old ball-pen case.

OUTPUT AMPLIFIER

Transistor TR2 (Fig. 3) is an overdriven amplifier, and is used to convert the sawtooth waveshape from the emitter of TR1 to a reasonable facsimile of a square wave. It was decided that

normal amplifier techniques were unnecessarily complicated, and a direct coupling was made from the output of TR2 to the base of TR3.

With no note keyed the current supplied by R4 holds TR2 "on", or conducting heavily. This in turn holds TR3 non-conducting, so that no current flows through the speaker coil. This serves two purposes, first that of conserving power from the battery, and second, preventing the possible overheating of the speaker coil due to a continual power supply to it.

When the oscillator is "keyed", TR2 is momentarily turned off by each pulse, causing current to be supplied to the base of TR3 by R5. This turns TR3 on, allowing a current pulse of about 120 milliamps to flow through the speaker coil. This causes the speaker to emit strange noises which children appear to enjoy.

Adults, on the other hand, may object to the weird noises produced by the device, and shout phrases like "Turn it down!" or worse. To this end a volume control (VR4) has been provided.

The pulse amplitude at the collector of TR3 does not diminish, but the power available to the speaker coil does. In fact, the output power diminishes to somewhat less than 30 milliwatts r.m.s with adjustment of VR4.

For masochists who enjoy noisy children provision has been made for the unit to be plugged into the family hi-fi via SK1. **It must be stressed that the amplifier input "low" terminal must be connected to the amplifier chassis, and that the chassis must be connected to earth,** because of the open keyboard and probe used.

The collector of TR3 is disconnected from the speaker system by S3 and reconnected to the network of R6, R7 and VR5. Resistor R6 provides the collector load, whilst R7 and VR5 drop the voltage output to about 0 to 0·5 volt r.m.s. If this output is too high to be easily adjusted by VR5 then R7 may be increased.

POWER SUPPLY

Because of the low quiescent current of the organ it is eminently suitable for battery operation. Due to the open contact type of keyboard it is inadvisable to operate the instrument from a mains derived source! **Under no circumstances can the unit be operated from a "battery eliminator"** type of device, since most of these are not isolated from the mains supply in any way, and a fatal shock could result.

The frequency of the oscillator is somewhat voltage-sensitive. To ensure that the basic note does not alter too much with battery voltage changes, the oscillator supply voltage is stabilised by means of a Zener diode D1.

The 120mA current pulses when the oscillator is keyed originally caused the battery voltage to drop by about 700 millivolts. Despite the Zener stabilizer this change was acting on the oscillator to cause false operation. To overcome this the value of C1 was increased to its present value, but it should be noted that only the larger battery types should be used.

CONSTRUCTION

Commence construction of the unit by cutting and making the printed circuit board to the design shown in Fig. 4. This should be carried out with reference to the *Making P.C. Boards* article in this issue (page 300).

Having completed the board, checked it and

Components....

SEE SHOP TALK

Resistors

R1	1kΩ	R_D=	24kΩ
R2	27Ω	R_E	22kΩ
R3	680Ω	R_F	20kΩ
R4	8·2kΩ	R_F=	20kΩ
R5	2·2kΩ	R_G	18kΩ
R6	1kΩ	R_G=	18kΩ
R7	10kΩ	R_A	16kΩ
R_{C1}	27kΩ	R_A=	16kΩ
R_{C1}=	27kΩ	R_B	15kΩ
R_D	24kΩ	R_C	15kΩ

Capacitors

C1	100μF elect. 12V
C2	0·1μF
C3	10μF elect. 12V

Variable Resistors

VR1	220Ω	VR_D	4·7kΩ
VR2	220Ω	VR_D=	4·7kΩ
VR3	220Ω	VR_E	4·7kΩ
VR4	1kΩ TV type preset	VR_F	4·7kΩ
VR5	1kΩ	VR_F=	4·7kΩ
VR_{C1}	4·7kΩ	VR_G	4·7kΩ
VR_{C1}=	4·7kΩ	VR_G=	2·2kΩ
VR_A	2·2kΩ	VR_B	2·2kΩ
VR_A=	2·2kΩ		

All horizontal p.c. mounting, miniature skeleton presets, except where stated.

Switches

S1, S2 d.p.d.t. pushbuttons (Radiospares miniature type or similar—2 off)
S3 s.p.d.t. toggle switch.
S4 s.p.s.t. toggle switch.

Semiconductors

D1 4·7V 400mW Zener diode
TR1 TIS43 unijunction transistor
TR2 BC184L silicon *npn*
TR3 BFY51 silicon *npn*

Miscellaneous

LS1 75Ω or 80Ω, approximately 300mW miniature loudspeaker
B1 9V battery—see text
SK1 coaxial socket and plug to suit
Single sided copper clad paxolin or fibreglass panel 6¾ inches by 3¾ inches. Materials for case (see text) 6BA fixings, wire, connectors for B1, bannana plug or similar for probe.

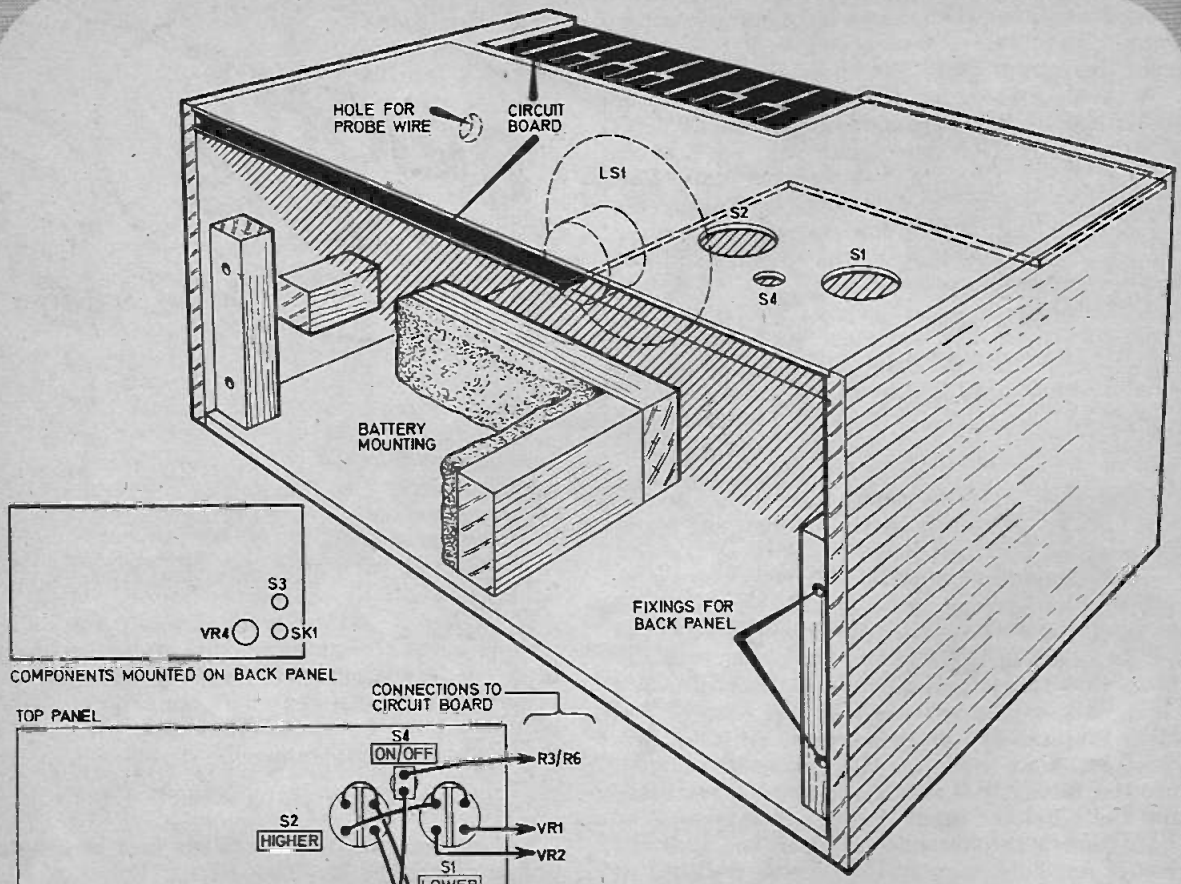


Fig. 7. (above) Layout and basic construction of the case. The size of the top is determined by the circuit board and thickness of the wood. The case is four inches high.

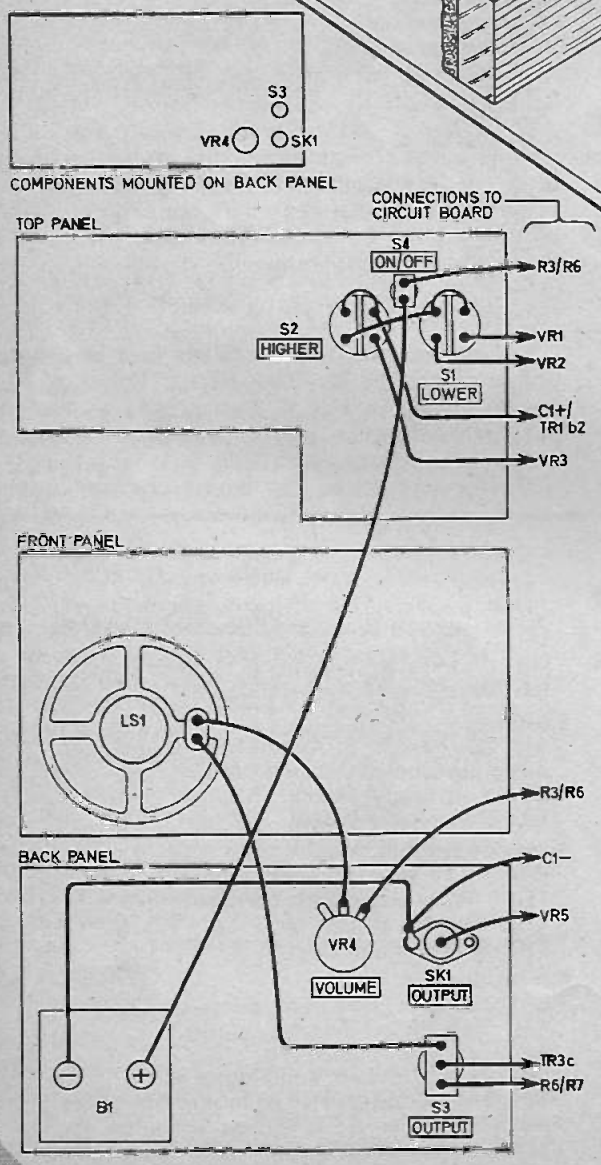


Fig. 6. (left) Wiring of the components mounted in the case and connections to the circuit board.

mini ORGAN

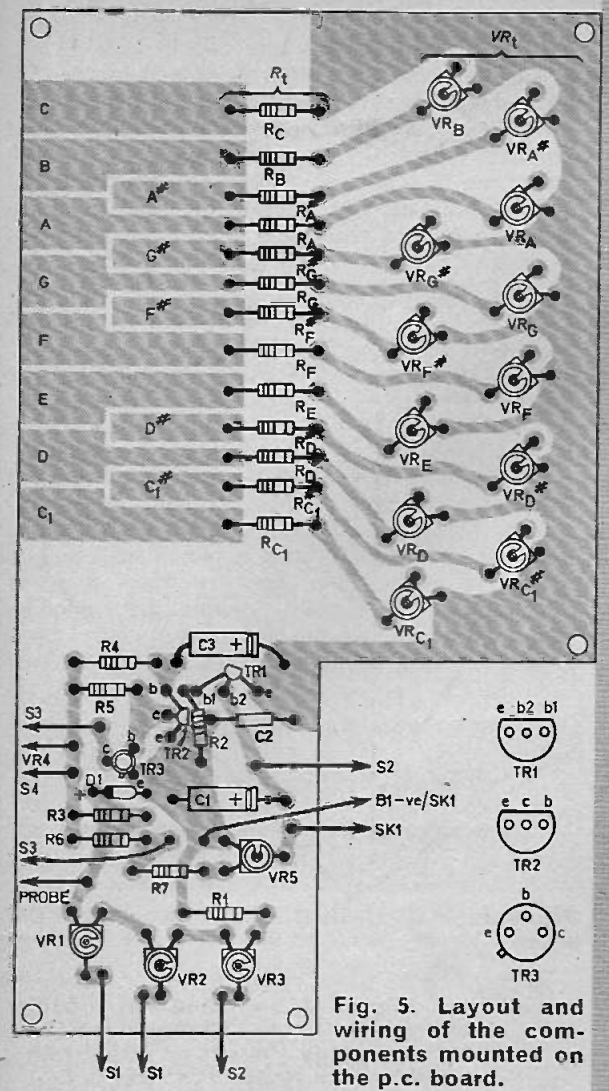


Fig. 5. Layout and wiring of the components mounted on the p.c. board.

drilled the holes, the components and flying leads can be attached as shown in Fig. 5. Note that the copper areas on the back of the board are shown tinted (as if looking through the board) in Fig. 5. Solder the transistors in after all other connections have been made, using a heat shunt on each lead as it is soldered.

Check the board and components against Fig. 5 paying particular attention to the transistor lead connections, diode polarity and capacitor polarities as shown. This is easily done by holding the board in front of a light so that the components can be checked and the image of the copper can be seen through the board. Finally wire up the complete unit as shown in Fig. 6 construct the case (Fig. 7) and install the electronics.

To test the unit switch on and place the probe on one of the key positions, check that all the notes are operable—including the upper and lower octaves and finally tune the organ by adjustment of the presets as mentioned earlier. ▣

When drilling the component locating holes in a small, home made printed circuit, secure the board to the smooth side of a larger piece of hardboard using double-sided Sellotape.

The hardboard will support the brittle Paxolin and you can drill quickly and smoothly through it into the hardboard, making clean holes with less risk of breaking the fragile twist drill. Afterwards prise the circuit board and hardboard apart with a thin blade or a tab of tape left projecting from the "sandwich". Double-sided tape proves useful in many situations and a reel of 1 inch width is a handy addition to the hobbyist's toolkit.

E. Mullis
Dunmow, Essex.

The problem of overheating, oxidising, and eroding of soldering iron bits has always caused me concern, and annoyance. After trying various methods, including switched reduced voltage, I eventually devised a simple, long lasting, and foolproof method which kept the iron hot, but not too hot, and served the additional purpose of an iron bench stand and heat shunt.

Manufacture and construction; a length of heavy duty conduit is sawn to the desired length, and compressed near one end in the vice to produce a constriction in which the iron bit will rest. Secure the tube to the bench in a convenient place by means of two conduit clamps (the stand off type) and you have an almost everlasting, convenient iron stand and shunt; I used the same one for 30 years.

Incidentally I regularly notice in "radio books" different methods of heat shunts when soldering transistors, no doubt all the methods have some merit, but the one I use is to hold the transistor wire with a pair of small medical forceps of the self locking type, with these you can safely wave the transistor around and then present it accurately to any pinpoint, the forceps can usually be obtained as "throw outs" once personal contact has been established.

J. Hardman
Thornton-Cleveleys,
Lancashire.

Instead of using long nosed pliers as a heat shunt use a hair grip "the type with a spring in". This gives a free hand for holding the solder.

P. Ransey
Berks.

Easy step by step instructions.

by J. A. Nekrews

THE printed or etched circuit is used in virtually every piece of commercial electronic equipment produced these days. In fact projects detailed in this and other technical journals sometimes provide a ready designed layout to assist the amateur constructor in the production of his own printed circuit board.

Not all constructors are familiar with the techniques involved, especially the relative newcomer to solid-state circuitry, so if you are one of the many constructors who would like to attempt this most satisfying branch of our hobby, but you are not too sure where to start, read on.

REQUIREMENTS

The complete newcomer to this field may be well advised to start with one of the proprietary "printed circuit kits" currently available from suppliers who advertise in the technical journals from time to time.

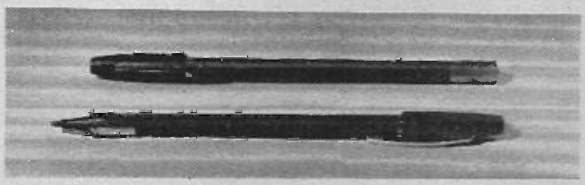
These kits usually provide everything necessary to complete an etched circuit, including an instruction leaflet detailing the use of the etchant supplied.

However, all the "ingredients" are available separately and you will need;

(a) copper clad s.r.b.p. or fibreglass board
(b) resist
(c) solvent
(d) etchant

The copper clad board is available from the larger component retailers as well as several smaller firms who specialize in printed circuits. The board is generally sold in "stock size" pieces.

For the resist there are two main choices: small jars or tins of plastic enamel paint used by model makers or the special printed circuit pens available such as the Dalo Marker and the G.S.P.K. P.C. pen.



Photograph of the Dalo Marker pen used in this article.

Turpentine or white spirit makes an excellent solvent for removal of the paint and this also is readily available. Special solutions are available to remove the pen type resist or alternatively a light abrasive paste can be used such as Solvol Autosol—sold in garages.

There are several chemical agents used as etchants for printed circuits, one of the most common being ferric chloride.

The author has found this etchant to be reliable and efficient as well as relatively easy to obtain. Your local chemist should be able to supply this, if not then you must resort once more to mail order component suppliers.

Ferric chloride is normally supplied in powder or crystalline form for dissolution in water. A suitable etching solution for a board size 3in. by $2\frac{1}{2}$in. can be made by adding about four heaped teaspoonfuls of ferric chloride powder to a quarter pint of luke warm water. For these conditions the etching time will be about 45 minutes.

A point worth mentioning here is to always add the chemical to the water, never add the water to the chemical.

Ferric chloride should be treated with some care as it will burn the skin and clothing if contact is prolonged. When using ferric chloride

make sure that it does not come in contact with the eyes. If some is spilt on clothing or comes in contact with the skin it should be washed off under running cold water as quickly as possible.

LAYOUT DESIGN

It is preferable, in fact almost a necessity to have all the components on hand and to design your circuit to suit the components, rather than have to shop around to find components to suit your design.

The author's experience has proved standard 0·1 inch graph paper to be an ideal medium on which to formulate a design.

Now to get to the actual design, the method is best described using a simple example such as the circuit of the Beta Fuzz as described in E.E. January 1973, see Fig. 1.

First of all decide on an approximate size for the completed board, and here you must be realistic; if you are striving for microminiaturization with discrete components then this system is not for you.

Getting back to the drawing board, first of all draw the outline of the board on the graph paper leaving the right-hand side blank just in case it is not possible to fit the complete circuit on the size of board originally desired. Conversely it may be found that the board could be made smaller if required.

Next, working from left to right on the circuit diagram and using the actual components as templates, mark the positions of all the components and connections using pencil until a satisfactory layout is produced.

Then, using coloured crayon or better still a felt-tip pen, shade in the interconnections to form a pattern similar to that shown in Fig. 2. It is common practice to have the "live" supply line along the top and an earth or zero volt line at the bottom just as in conventional circuit diagrams, see Fig. 2.

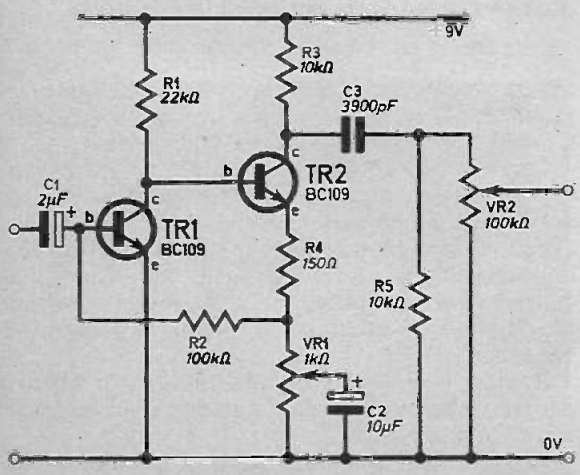


Fig. 1. The circuit diagram of the Beta Fuzz to be put on to the printed circuit board.

Remember that you are working from the topside i.e. the unclad side of the board, therefore all *components and connections* are to be viewed from the *topside*. This is of particular importance with transistors and integrated circuits.

The resulting drawing should look something like Fig. 2. In this case, space was of no importance so a neat functional layout was obtained.

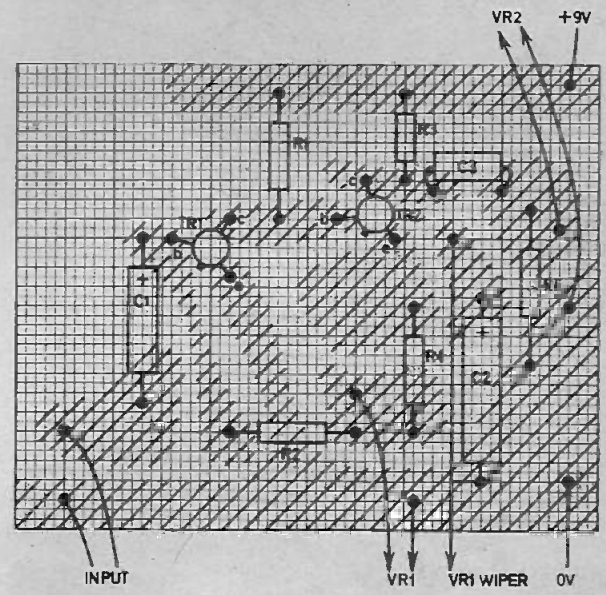


Fig. 2. The final design of printed circuit layout on graph paper.

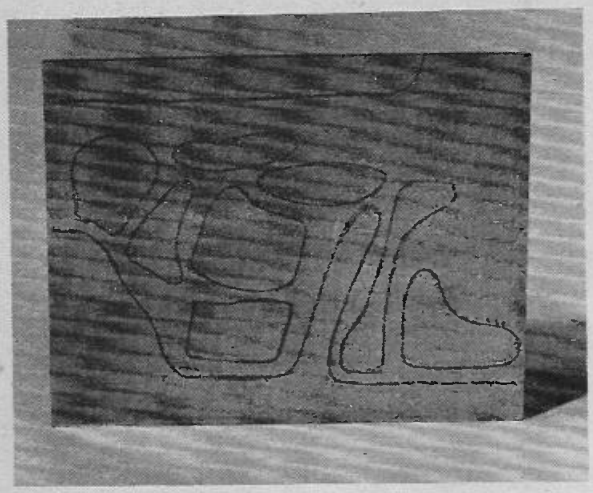
CLEAN BOARD

A piece of copper clad board should now be cut to the required size, a fretsaw or hacksaw is very handy for this, and the edges carefully filed smooth. The board should then be thoroughly and scrupulously cleaned. Ordinary household scouring powder such as Vim or Ajax makes an excellent job of this, after which be careful not to touch the copper surface as fingerprints leave greasy marks which could impair the etching action.

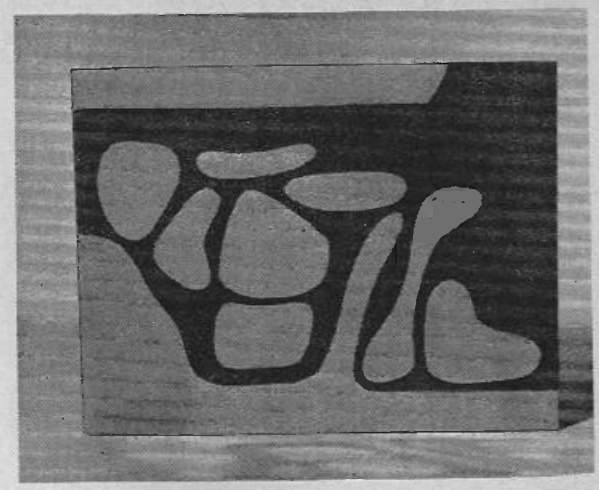
TRANSFER

Using the pattern of Fig. 2 we shall make the *master drawing* of the printed circuit—this is the pattern given with most printed circuit articles and which is usually full sized so that a direct transfer can be made to the board. The areas shown in black are the areas of copper strip to remain on after the etching process.

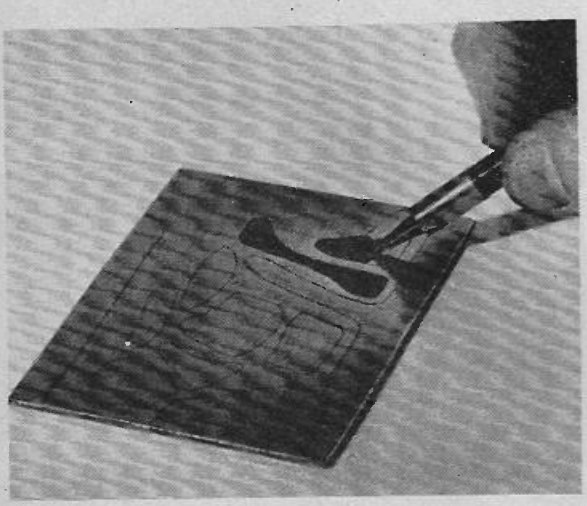
Place a piece of carbon paper (face side up) on the bench and then place your pattern of Fig. 2 on top of it. Run a soft pencil over the outline of the pattern so that a mirror image of the latter is produced on the reverse side. This "mirror image" is the master drawing. Shade in the areas of copper to be left on after etching, this will be helpful later. See Fig. 3.



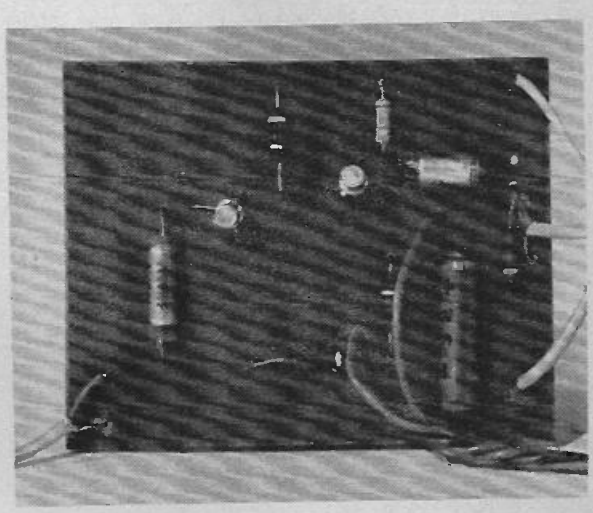
A. The carbon paper tracing from the master drawing on the copper side of the board.



D. The board after etching with resist cleaned off.

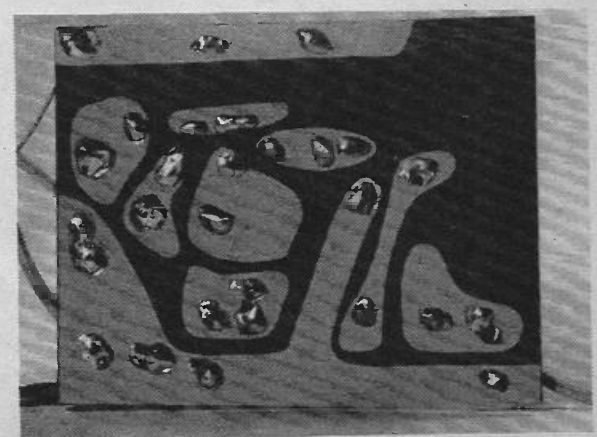


B. Using a printed circuit marker pen to fill in the areas of copper to remain after etching.



E. The components mounted in position.

C. The board dry and ready for etching.



F. The underside of the completed board.

Fig. 3. The master drawing of the printed circuit board (full size).

Now place the carbon paper face side down on the copper clad side of the board (cut to size) and then place the master on top of this and align correctly with the board. Secure this in position with paper clips or Sellotape and then run a pencil over the outline of the master to produce the same on the copper. The result of this is shown in photograph A.

If using paint, such as Airfix or Humbrol (as used for painting models), paint in the areas of copper to remain (with reference to the master drawing) with a fine artists brush and leave to dry. Make sure there are no uncovered spots or "pin pricks", if there are, cover in.

If using one of the printed circuit pens, fill in the appropriate areas of the board according to the master drawing using the nib of the pen as shown in photograph B.

In both cases, ensure the edges of the resist are sharp and clean otherwise a ragged and diffuse type edge will result which looks unprofessional; allow the paint or pen resist to dry completely; photograph C shows the board ready for etching.

ETCHING

The following method of etching was selected for its simplicity and reliability. A Pyrex or photographic developing dish, large enough to allow the board to lie flat inside, is filled approximately half an inch deep with the ferric chloride solution, and the board is placed copper side upwards in the solution. This must then be constantly agitated. The etching process is complete after about 45 minutes.

The need for constant agitation cannot be overstressed as failure to do this results in the ferric chloride molecules combining with the copper forming an inactive coating on the surface of the board and halting the etching action. If the board is left in the solution too long the etchant may start to undercut the painted areas, so be warned.

Once the etching process is finished, the board should be removed from the solution, well rinsed in fresh water and dried. The resist can now be removed using the solvent or light abrasive, leaving a neat and professional looking printed circuit board (see photograph D).

DRILLING AND COATING

Once the board is etched there remains the job of drilling the holes. This process needs to be carried out with care, otherwise the copper may be lifted from the board and then a new board has to be made.

With reference to the master drawing, mark the positions of all holes to be drilled on to the copper clad side of the board, and then carefully drill these with a 1/32in. diameter drill.

Drill slowly and apply minimum pressure to ensure that the drill breaks through the board cleanly; this will help to give the board a professional appearance; don't forget to drill the mounting holes before component assembly.

At this stage, if desired, the remaining copper on the board, thoroughly cleaned, can be coated with a thin layer of solder to protect the copper from oxidation. This also gives a neater appearance to the back of the board.

As an alternative to this, a coating of varnish may be applied to the back of the board after the components are soldered in position.

MOUNTING COMPONENTS

All component wires should be bent at right angles to the component body so that their bent leads exactly span the distance between the holes that have been allocated them. They should then be inserted in these holes such that the body of the component clears the board by about 1/16in. and then the leads cut off so they protrude only about 1/16in. beyond the copper. They should then be soldered in this position. See photographs E and F.

It is important to carry out the soldering of each component swiftly, as prolonged heat on the board (from the soldering iron) may cause the copper lamination to come adrift.

Transistors and other semiconductors should, as usual, be left until last, and when being soldered in position a heat shunt should be used.

CONCLUSION

In cases where several boards of the same design are required, special light-sensitive laquer is available. This process requires the design to be painted on a piece of thin acetate sheet. With this method an unlimited number of boards of the same design may be produced. ▣

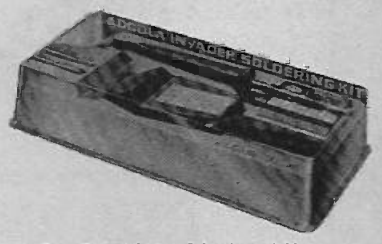
FREE!
COMPETITION
...Win this VISCOUNT Audio System!
100 other prizes for Runners-up

This fantastic Viscount Audio System can be yours—free! It's the first prize in this exciting competition, open only to EVERYDAY ELECTRONICS readers. The system comprises the new RTVC Viscount III P102 stereo amplifier, two duo type III speakers and a Garrard SP25 Mk III turntable mounted on a perspex covered plinth. It's selling for around £70!

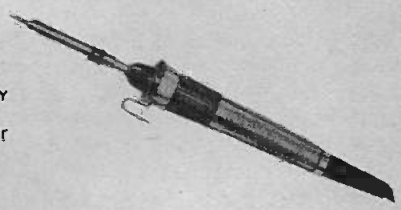
The competition is all about soldering and so, appropriately, are the rest of our prizes. Just take a look at this list of soldering goods making up the 100 runner-up awards:

From Adcola Products Ltd. Soldering kits, soldering irons and iron stands.
From Antex (Electronics) Ltd. Soldering kits and soldering irons.
From Multicore Solders Ltd. Soldering handbooks, wire strippers and solder dispensers.

The Viscount Audio System



An Adcola soldering kit



An Antex thermostatically controlled soldering iron

HOW TO ENTER

Listed below are eight points which make for successful and efficient soldering. All you have to do is place them in what you consider to be their order of importance in contributing to a perfect soldered connection. For example, if you consider that "Use non-corrosive flux cored solder" is most important of all, write C in the box marked 1st on your entry coupon. The key letter of your second choice goes into the box marked 2nd, and so on for all eight.

Complete the coupon, all in ink or ball-point, with your full name and address, then post it in a sealed envelope to:

EVERYDAY ELECTRONICS SOLDERING COMPETITION,
16 GARRICK STREET,
LONDON, WC2E 9PR.

IMPORTANT

Another free entry coupon for this competition will appear in the July EVERYDAY ELECTRONICS.

The closing date for entries—Friday, July 27th, 1973—gives you ample time to wait for our next issue and then post two different attempts together in one envelope.

A Parts to be soldered should be cleaned and tinned.
B Use soldering iron of correct size and weight.
C Use non-corrosive flux cored solder.
D Use soldering iron with tip of correct size.
E Maintain heat on joint until solder flows evenly over it entirely.
J Keep tip of iron "wet" with solder.
K Use soldering iron of correct temperature and wattage.
L Make good mechanical contact prior to soldering.

FREE ENTRY COUPON

1

Please post to:
EVERYDAY ELECTRONICS
SOLDERING COMPETITION,
16 GARRICK STREET, LONDON WC2E 9PR

My order of importance for the eight features is listed on the right. In entering the competition, I agree to the rules as final and legally binding.

1st	
2nd	
3rd	
4th	
5th	
6th	
7th	
8th	

NAME .....
(Mr./Mrs./Miss)

ADDRESS .....
(Block letters)

.....

.....

Closing date for entries: Friday, July 27, 1973

CUT ALONG THIS LINE

COMPETITION RULES

There is no entry fee, but each attempt must be fully completed in ink on the proper printed coupon cut from Everyday Electronics, and bear the entrant's own full name and address.

Every accepted entry will be examined and the first prize, as described, will be awarded to the entrant who, in the opinion of an expert panel of judges, and in any one attempt, has shown the most skill and judgement in listing the eight features in order of importance. The other prizes will be awarded to the senders of the 100 next best attempts in order of merit. No entrant may win more than one prize.

In the event of a tie or ties for any of the prizes, a further eliminating contest will be conducted by post between the tying competitors to determine such winner/s or winning order.

Any entry which does not comply with the printed instructions or is received after the closing date will be disqualified, as will any received mutilated or illegible, incomplete, bearing alterations, or with more than one key letter in each space. No responsibility will be accepted for entries lost or delayed in the post or otherwise.

The judges' decision, and that of the Editor of Everyday Electronics in all other matters affecting the competition, is final and legally binding. No correspondence can be entered into.

The competition is open to all readers in Great Britain, Northern Ireland, and the Channel Isles except employees (and their families) of IPC Magazines, the printers of Everyday Electronics or any company associated with the prizes.

The winners will be notified, and the result announced in the earliest possible issue of this magazine.

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July issue on sale Friday June 15

SEMICONDUCTORS

ONE INTRODUCTION

J.B. DANCE M.Sc.

THIS series has been written to provide a very simple explanation of how common semiconductor devices function. No knowledge of mathematics or of the details of chemical bonding will be required in order to understand any part of the series. It is only necessary to know that, when a voltage is applied across a material, the electrons in the material are attracted towards the positive electrode and the positive charges towards the negative electrode.

This first part of the series introduces the basic principles of the semiconductor and semiconductor materials but later in the series it will be orientated more towards understanding the functioning of the various devices.

Simple ways of testing the various devices will be described in later articles, partly because the carrying out of such tests is very instructive for the beginner. The only equipment which will be required for the tests is a suitable meter, a battery and a few resistors.

CONDUCTION

All materials contain negative charges—electrons—and an approximately equal number of positive charges. The number of these charges in a small amount of matter is enormous (about one million million million million [10^{24}] in one gram of a substance).

A material will conduct electricity if it contains electric charges which are *free to move* under the influence of an applied voltage. The moving charges "carry" the current, since an electric current is merely a movement of electric charge.

Current flow in a material may consist entirely of electrons moving towards the positive electrode (anode) of the applied voltage and in some cases it consists only of positive charges moving towards the negative electrode (cathode) of the applied voltage, whilst in other circumstances both the electrons move to the cathode and the positive charges move to the anode at the same time. Any charges which are free to move will do so.

Metals are very good conductors of electricity because they contain very large numbers of *free* electrons, the word "free" implying that the electrons are able to move. Conduction in a metal is illustrated in Fig. 1.1a.

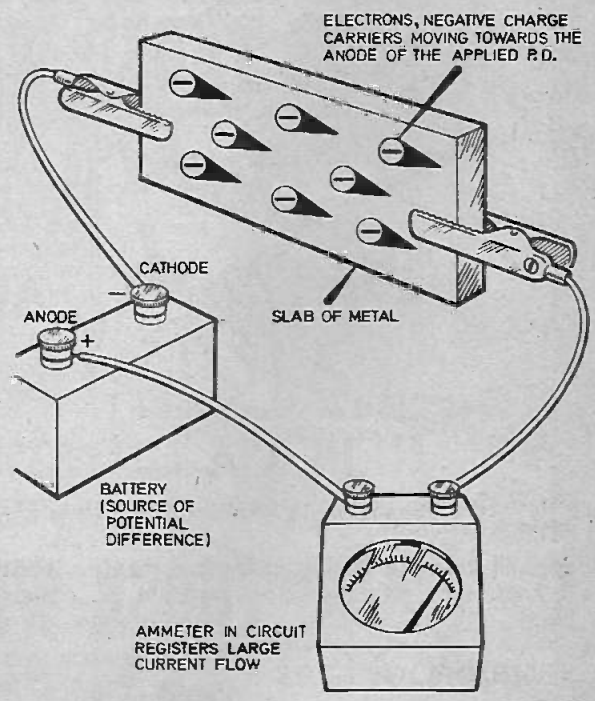


Fig. 1.1a. Schematic of conduction in a metal, movement of electrons.

Solutions of acids, alkalies and salts are also good conductors of electricity, since they contain very large numbers of positive and negative charged particles (or ions as they are called) which are free to move. Conduction in such a solution is depicted in Fig. 1.1b.

A similar type of conduction occurs in the familiar yellow street lamps where an electric current passes through a gas which contains large numbers of electrons and positively charged sodium ions.

Insulators, such as glass, Perspex, air, etc., contain electrons and positive charges, but virtually all of these charges are firmly bonded to the atoms of the material and are not free to move when a voltage is applied across the substance. Insulators will not therefore conduct electricity unless an extremely high voltage is

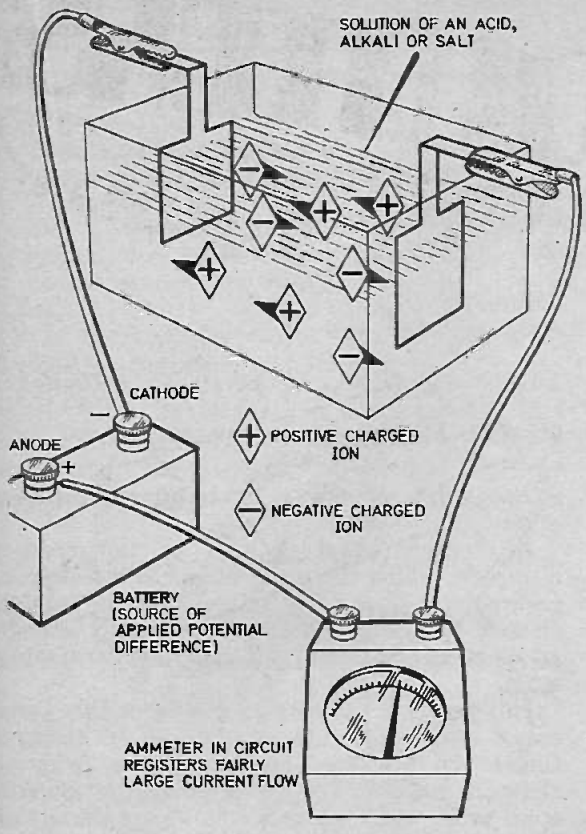


Fig. 1.1b. Electrical conduction in a solution, ionic movement.

applied across a very thin layer of the material so that some electrons are wrenched from their bonds.

SEMICONDUCTORS

Semiconductors form a class of substances intermediate between metals and insulators. The best known semiconductor materials are the hard grey brittle elements, germanium and silicon.

Such materials contain some electrons which are free to move, but the number of these mobile electrons is far far less than in a metal. Semiconductor materials will therefore pass a *small* current when a potential difference is applied across them, as depicted in Fig. 1.1c.

For example, metallic copper conducts about a million times better than germanium and about a thousand million times better than silicon.

The number of free electrons in a pure semiconductor material increases very rapidly as the temperature rises. At higher temperatures there is more energy in the material and this enables more electrons to break away from the bonds which secure them to a particular atom. As a "rule of thumb", it can be stated that the number of free electrons in a pure semiconductor material is doubled for each 10 degree

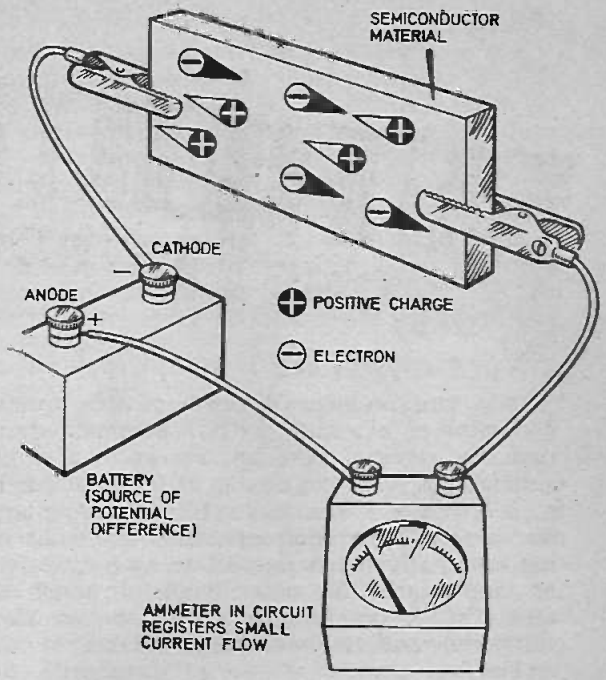


Fig. 1.1c. Schematic of electrical conduction in a semiconductor.

centigrade rise in temperature.

Electrons which are at some time free, become bonded to atoms, and other electrons break their bonds and become free so that the total number of free electrons in a piece of material remains fairly constant with time.

Pure germanium contains many more free electrons per unit volume than pure silicon at the same temperature. In general germanium devices cannot operate at temperatures much above 90 degrees centigrade, since at higher temperatures the number of electrons in the material becomes so great that the current cannot be controlled.

Silicon devices can operate at temperatures up to about 180 degrees centigrade. Some semiconductor materials, such as gallium arsenide, contain fewer free electrons than silicon at a given temperature and can therefore be used at even higher temperatures.

Conduction in a *pure* semiconductor material is known as **intrinsic conduction**, the word intrinsic merely showing that the conduction is taking place in the pure material itself.

IMPURITIES

Most *chemicals* are regarded as being pure if the total impurity content is less than one part in a thousand or even one part in a hundred.

However, the material used in semiconductor devices must contain a far smaller impurity concentration than this. Typically, the pure germanium and silicon used for manufacturing semiconductor devices contains less than one part of impurity in ten thousand million parts

of the material.

The preparation of materials in such extreme degrees of purity cannot be achieved by normal chemical methods, special techniques have been perfected to enable the required materials to be prepared at a suitable level of purity.

It is useless preparing such a pure material unless it is kept pure throughout the life of the device. Semiconductor devices are therefore sealed in metal (with insulated leads), glass or a suitable plastic material so that no impurities can reach the semiconductor material itself.

SINGLE CRYSTALS

Most semiconductor devices not only require materials of extreme purity, but also require that the material shall be present as a single crystal. A crystal contains an orderly pattern of atoms in three dimensions extending throughout its volume, whilst non-crystalline materials do not have such an orderly pattern extending over an appreciable distance. Impurity atoms or atoms which are in such a position that they spoil the pattern, constitute defects in the crystal.

N-TYPE MATERIAL

A semiconductor material contains few free electrons. If certain impurities (such as arsenic or antimony) are introduced into the crystal in extremely minute concentrations (typically one impurity atom in many millions of atoms of the semiconductor material), the number of free electrons (and hence the conductivity) is greatly increased.

Each atom of the impurity material can release an electron relatively easily. At normal temperatures almost all of these electrons are free to move in the crystal.

Semiconductor materials containing such impurity atoms are known as **n-type** or negative carrier materials, since conduction takes place by means of negative charge carriers, that is, electrons.

The atoms of arsenic, antimony or a similar element which donate the electrons are known as **donor** atoms.

P-TYPE

Certain other types of impurity atom such as aluminium, indium and phospherous, also have a profound effect on the conductivity of a semiconductor material when they are added to it in minute amounts. These atoms are known as **acceptor** atoms, since each atom of such an element can readily accept one electron from a neighbouring atom of the semiconductor material.

HOLES

Let us consider how conduction takes place in a material containing acceptor atoms. In Fig. 1.2 a single row of atoms is considered for simplicity.

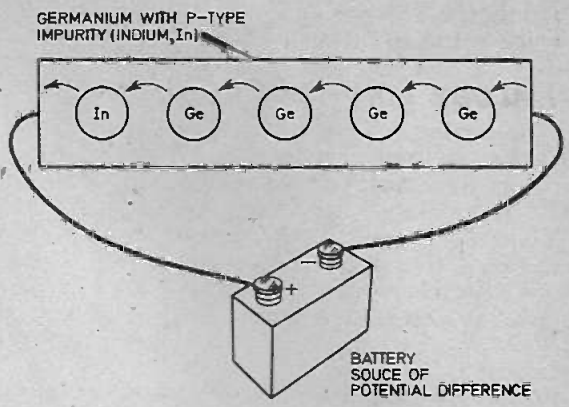


Fig. 1.2. Conduction in p-type germanium.

An indium atom is next to the positive electrode, whilst the other atoms in the row are germanium. Under the influence of the applied electric field, the indium atom readily accepts an electron from the neighbouring germanium atom.

This leaves a vacancy or a **hole** in this germanium atom which can be filled by an electron. Under the influence of the electric field, an electron moves from the adjacent germanium atom to fill the vacancy as shown by the arrow. Similarly the new hole thus formed is in turn filled by an electron from the next atom.

Finally, an electron moves from the negative plate to fill the hole formed in the last germanium atom, and the electron which first moved into the indium atom now moves into the positive electrode. This whole process can be repeated indefinitely.

HOLE CONDUCTION

We have seen that conduction in a semiconductor material containing acceptor atoms actually consists of a *movement of electrons* from the cathode to the anode.

However, it is often easier to consider that one hole is moving from the anode to the cathode rather than to consider that the process consists of the movement of a large number of electrons in the opposite direction. This type of conduction is therefore known as **hole conduction.**

Holes behave as if they are positive charges. In Fig. 1.2 the holes move to the right, that is from the anode to the cathode, in the same direction as a positive charge would move.

Materials containing acceptor atoms are therefore called **p-type** materials, since conduction occurs by a movement of the hypothetical positive charge carriers known as holes.

In case any reader is in doubt about the matter, perhaps it should be made quite clear

that the hole is *not* equivalent to the positron (which is the antiparticle of the electron).

ANALOGY FOR HOLE CONDUCTION

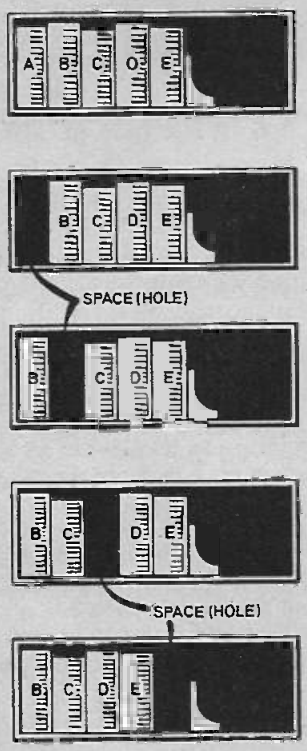
The analogy shown in Fig. 1.3 may make the process of hole conduction clearer. Let us imagine a bookshelf containing five books, ABCD and E.

Book A is removed (by an external force) for reference, thus leaving an empty space or hole at the left hand end of the shelf.

Book B is moved into this space, and then the rest of the books, one at a time, are moved to the left.

Although each of the books have been moved, the net effect is the same as if a hole (that is, a book space) had moved from the left hand side to the right hand side in the opposite direction to the movement of the books.

Fig. 1.3. An analogy showing movement of a hole.



DOPING

The addition of donor or acceptor impurities to a semiconductor material is known as **doping**. A material is said to be lightly doped if it contains few impurity atoms per unit volume and heavily doped if it contains a relatively large number of impurity atoms.

BOTH TYPES OF IMPURITY

If a semiconductor material contains both donor and acceptor atoms, electrons from the donor atoms will fill holes in the acceptor atoms. If the donor atoms are more numerous than the acceptor atoms, there will be more electrons than there are holes to be filled. The material will therefore be *n*-type.

Similarly, if there are more acceptor than donor atoms, there will not be enough electrons to fill all of the holes. The material will therefore be *p*-type.

As electrons tend to fill any holes they may meet as they pass through the semiconductor crystal, the number of holes in an *n*-type material will be less than the number of holes in the same volume of the pure semiconductor material.

Similarly, the number of electrons in a *p*-type material is less than in the pure semiconductor material, since the electrons keep tumbling into the more numerous holes where they are no longer free to move.

SUMMARY

As shown in Fig. 1.4, an *n*-type material contains mobile electrons. As the material is normally electrically neutral, there must be an equal number of positive charges to balance the charges of the electrons. However, these positive charges are fixed in position, as indicated by the broken circles around them.

In the case of *p*-type material, the positive holes are free to move, whilst the negative charges are fixed in position.

The very small number of holes in an *n*-type material and the free electrons in a *p*-type material are not shown in Fig. 1.4 since their numbers are so small. These charges are known as **minority carriers** because their numbers are far smaller than that of the carriers of opposite charge.

Thus the electrons in *n*-type material and the holes in *p*-type material may be referred to as **majority carriers**.

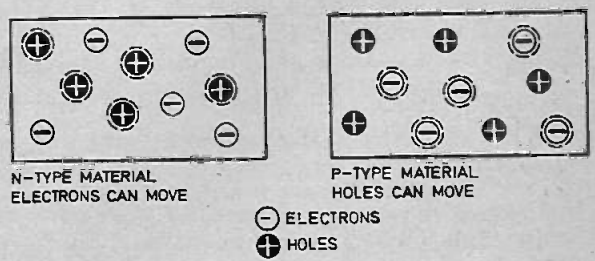


Fig. 1.4. N and p-type semiconductor materials. The broken circles show "fixed" charges.

The vast numbers of neutral atoms in any crystal are not shown in Fig. 1.4 since they play no part in the conduction process.

Suitably doped semiconductor materials employed in carefully designed devices have made modern miniature electronics possible.

Next month: Semiconductor diodes.

RAIN ALARM

A very useful device for the busy housewife.

by C. Embleton

GREAT BRITAIN is well known for its bad weather, and when the busy housewife hangs out her washing to dry, she often has to dash out and bring her washing in again as the rain starts to fall.

Sometimes she is busy in another part of the house, and by the time she realises that it is raining, the washing is quite wet again.

One answer to this problem is to install an electronic device which attracts the attention of the housewife before it is too late.

The Rain Alarm described here sounds an audible alarm as soon as the first few drops fall.

THE CIRCUIT

The complete circuit diagram of the Rain Alarm is shown in Fig. 1.

The circuit consists of a Veroboard sensor, a trigger circuit loaded with a relay, and a two transistor oscillator.

When rain falls on the sensor, the rain drop in effect connects the free end of R1 to the positive supply rail which causes a positive potential to be applied to the gate of the thyristor CSR1.

This immediately turns on the thyristor and causes current to flow through the relay RLA and the latter is energised. The thyristor does not turn off, this can only be done in this circuit by switching off the supply.

When the relay is activated, its contacts cause the oscillator circuit to be "made" and hence the audible alarm is heard through the loudspeaker.

The oscillator, which is of the relaxation type, functions in the following way: when the relay contacts close and make the circuit, a positive bias is applied to the base of TR1 and to the emitter of TR2.

This positive bias switches on TR1 via R2 and this conducts a negative voltage to the base of TR2.

Because TR2 is a *pnp* transistor, this negative voltage switches on TR2. When TR2 conducts, it causes current to flow through the loudspeaker.

This positive signal is then passed back to the base of TR1 via C1 and the whole process is repeated producing a continuous tone for the whole time the relay contacts are closed. The pitch of the tone can be altered by changing the value of capacitor C1; increase C1 to decrease the pitch and vice versa.

The light dependent resistor PCC1 in series with the Veroboard sensor is included so that the alarm will not sound if it happens to rain during the night and the unit is switched on.

When the l.d.r. is subjected to dark conditions, its resistance is very high, in the order of megohms, and this prevents the gate of the thyristor receiving enough current for it to "fire."

Approximate cost of components including V.A.T.

£3·00

Components....

Resistors
R1 330Ω
R2 10kΩ
¼ watt ± 10% carbon

SEE SHOP TALK

Capacitors
C1 0·1μF

Semiconductors
TR1 2N3704 silicon *npn*
TR2 OC72 germanium *pnp*
CSR1 CRS1/25-600 or any similar 1A device
PCC1 ORP12 or similar

Relay
RLA Post Office type 3000 with 400Ω coil or similar (see text)

Miscellaneous
S1 On/off toggle or slide
LS1 3 ohm to 20 ohm loudspeaker
B1 9V battery PP7
Veroboard: 0·1in. matrix 5in. x 2½in., 0·15in. matrix 8 x 7 holes; battery connectors; 4-way terminal block; 4BA nuts, bolts and spacer; ¾in. diameter dowel; length of two core cable; suitable case.

In daylight conditions, the resistance of the l.d.r. is very low, and does not prevent the thyristor from firing.

RELAY AND LOUDSPEAKER

The relay used in the prototype was a Post Office type 3000 with a coil resistance of 400 ohms. It is not essential to use this exact type as any 9V relay with a coil resistance of 100 to 400 ohms will suffice.

If desired, the relay can be used to switch heavier loads, i.e. a power alarm, the limit of power being determined by the rating of the relay contacts.

The loudspeaker used in the prototype had an impedance of 3 ohm, but this is not critical as any speaker up to 20 ohms will do.

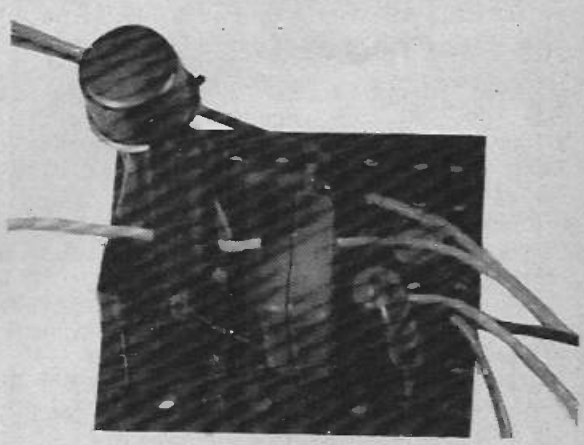
CONSTRUCTION

Begin construction by cutting to size the Veroboard, 8 x 7 holes x 0·15in. matrix and making the necessary cut-outs on the reverse side, see Fig. 2.

Next, mount all the components as detailed in Fig. 2 leaving the transistors until last. Use a heat shunt on the legs of the transistors when soldering them in position.

Obtain a suitable case—the prototype used an old sandwich tin with lid—and fix the components RLA, LS1, S1, and the two-way terminal block in position. The layout shown in Fig. 3 is not critical and may be changed to suit individual requirements.

With these components firmly fixed in position, wire up to the Veroboard as shown in Fig. 3 and then fix the board to the case using a 4BA nut, bolt and insulated spacer.



Photograph of the completed component board

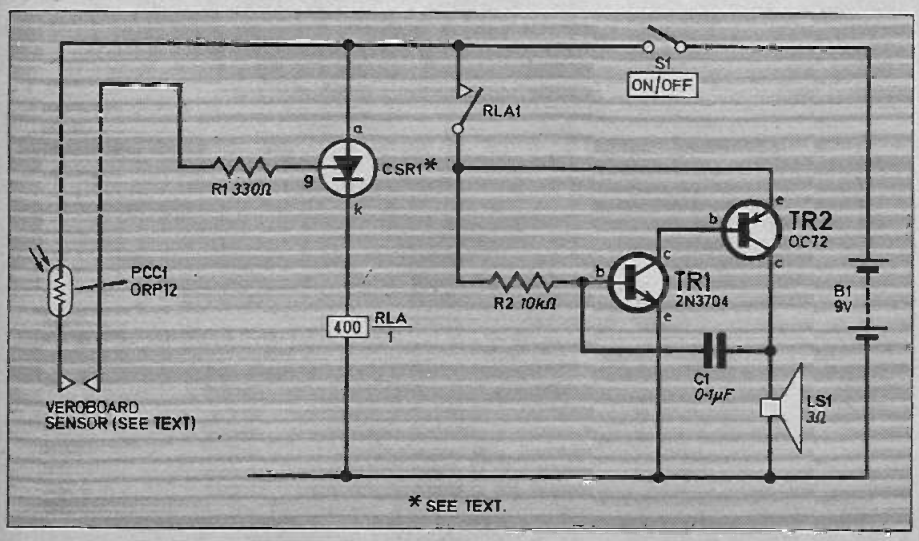
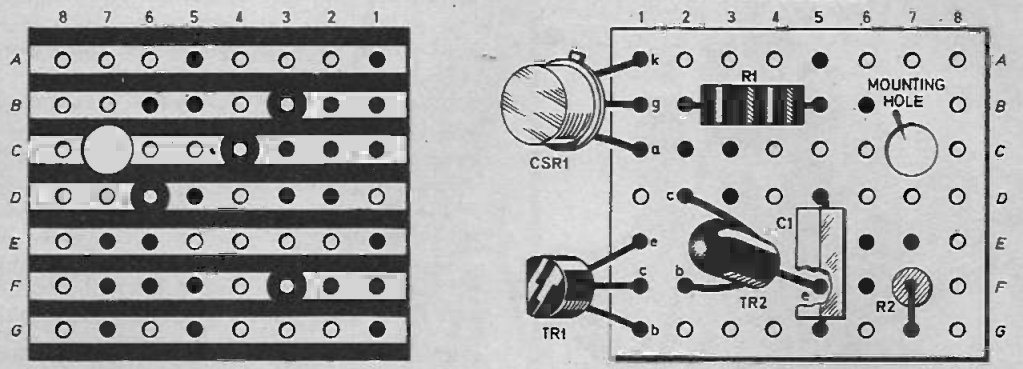


Fig. 1. The complete circuit diagram of the Rain Alarm. The l.d.r. prevents the alarm from sounding in dark conditions, i.e. at night.

RAIN ALARM

Fig. 2 (below). The layout of the components of the Veroboard.



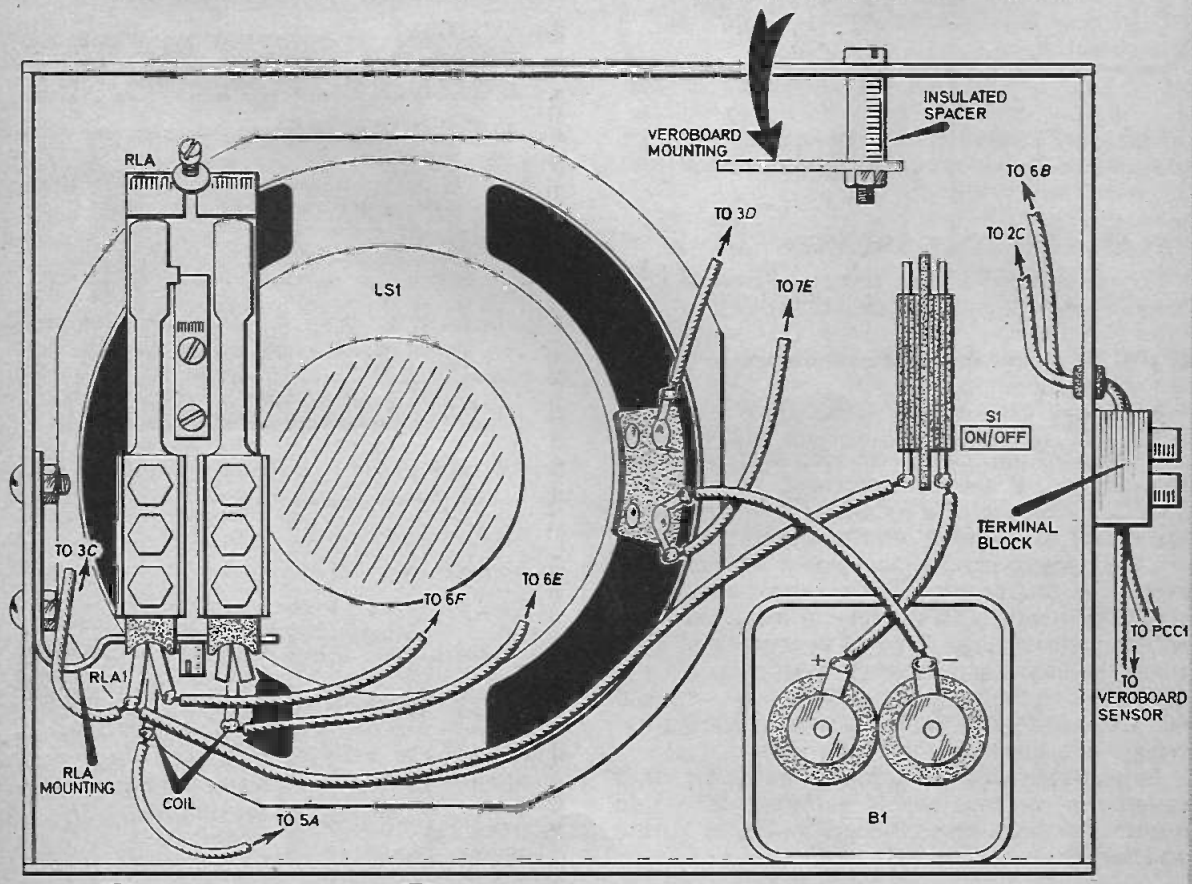


Fig. 3. (above). The complete wiring diagram of the Rain Alarm. Shown left are the thyristor and transistor lead outs viewed from the underside.

SENSOR

The sensor of the Rain Alarm should be made from a piece of 0·1in. matrix Veroboard. The size used in the prototype was 5in. x $2\frac{1}{2}$in.

The sensor is shown in Fig. 4 and the Veroboard has alternate strips joined at each end forming an interlocking finger pattern.

It is necessary to use 0·1in. board to obtain the required sensitivity.

Wire up the l.d.r. to the Veroboard and the two-way terminal block and then glue to a piece of $\frac{3}{4}$in. diameter dowel. Araldite is a suitable adhesive.

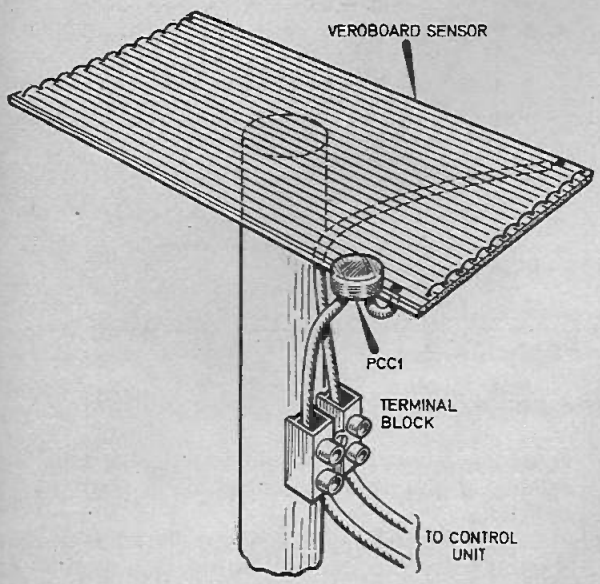


Fig. 4. Details of the Veroboard sensor.

TESTING

Before testing, check all wiring in the main control case. If satisfied, proceed.

Join, by means of a length of two-core cable, the sensor to the main unit and switch on.

Under bright conditions, place a wetted finger across the copper strips of the sensor and a tone should be heard from the loudspeaker; this tone will persist when the finger is removed and even when the board is completely dried.

To remove the tone, the unit must be switched off. Immediately switching on again should not trigger the alarm if the board is dry.

Repeat the above test procedure under dark conditions—no tone should be heard. If you do not obtain these results, check out your wiring and rectify.

MOUNTING AND USE

The sensor should be mounted somewhere in the garden such that it will not be sheltered from rain or daylight. It is recommended that the sensor should be mounted at an angle so that the rain will run off; the photocell must be uppermost.

The control unit is mounted in the house so that its tone can be heard anywhere in the house when it is raining. Join the two parts by means of a suitable length of two core cable.

The unit is switched on when the laundry is hung out to dry and the alarm will sound when the first few drops of rain fall.

To reset the alarm, the unit is switched off by switch S1 and, assuming it has stopped raining, the switch can be switched on again after the sensor has become dry. If the sensor is not dry the alarm will continue.

The Rain Alarm can be left on permanently, hence the purpose of PCC1, since the current drain with no rain is minute, the battery should last for a couple of months or more.

Finally the sensor board should be cleaned every couple of months to ensure maximum sensitivity. ▣

What do you know?

RESISTORS

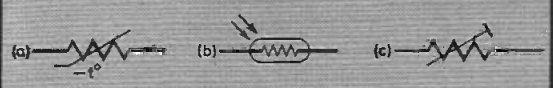
1 What are the missing numbers in this series, and what is the series called?
1·0, 1·2, 1·5, ? 2·2, ?

2 What is the overall tolerance of two ±5 per cent tolerance resistors wired in series?

3 What does the pink band on some carbon resistors mean?

4 What are the following resistor values?
(a) 4K7; (b) 1RO; (c) red, red, red; (d) yellow, mauve, gold; (e) 4M7K

5 What do the following symbols represent?



ANSWERS

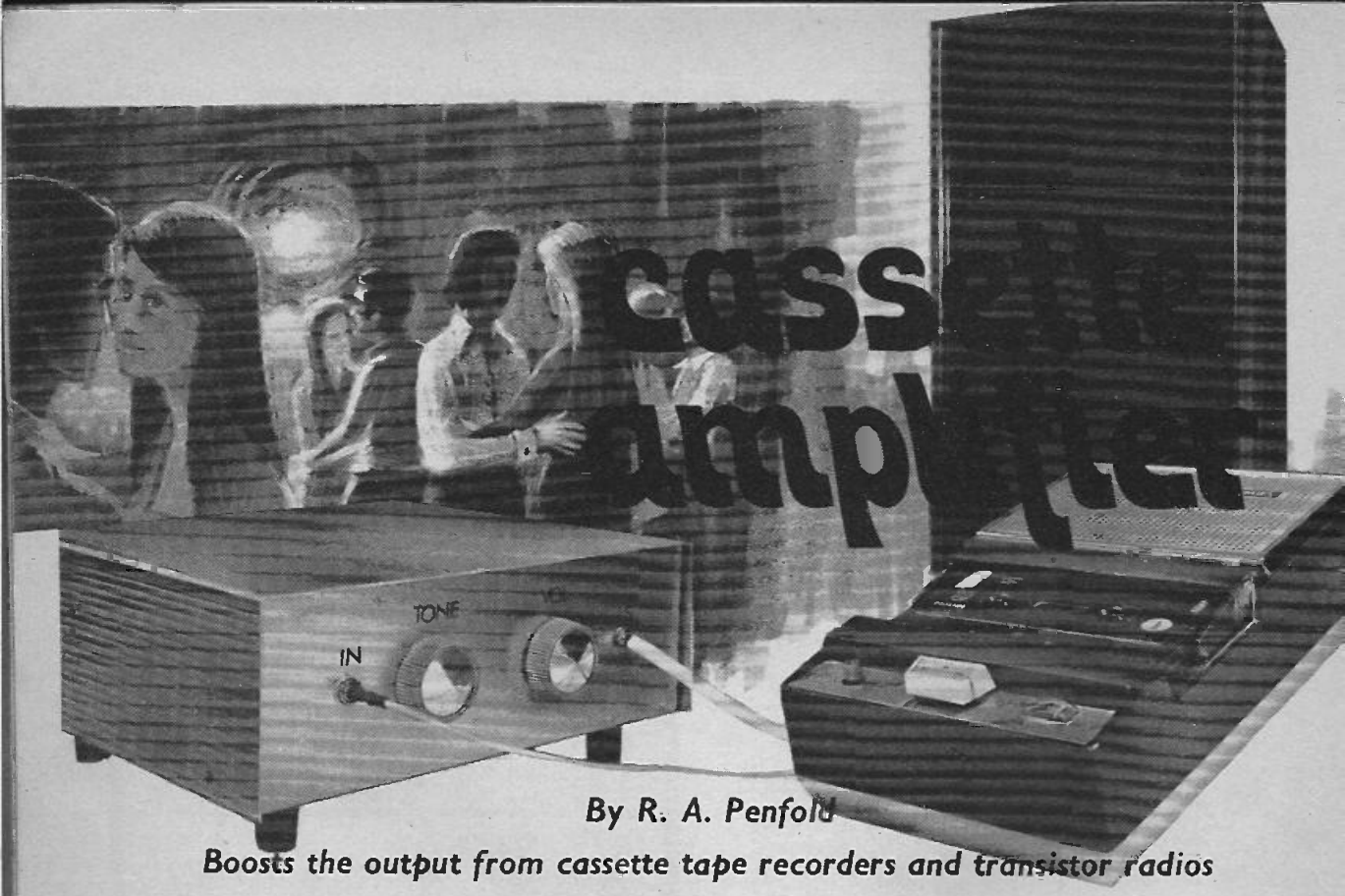
1 1·8 and 2·7. They are preferred resistance values in the series designated E12. The series continues 3·3, 3·9, 4·7, 5·6, 6·8, 8·2 and their decades e.g. 47kΩ.

2 ±5 per cent—addition of the tolerance does not occur, e.g. a 100Ω 5% resistor having a true value of 105Ω, plus another similar resistor, equals 210Ω which is still within 5% of the new total.

3 The pink band signifies a high stability resistor.

4 (a) 4·7kΩ (b) 1Ω (c) 2·2kΩ (d) 4·7Ω (e) 4·7MΩ (The last letter, represents the tolerance e.g. M=±20%, K=10%, J=±5%, H=±2·5%, G=±2%, F=±1%.)

5 (a) A thermistor (temperature dependent resistor) (b) A light dependent resistor (or photoconductive cell) (c) A variable preset resistor.



cass amp

By R. A. Penfold

Boosts the output from cassette tape recorders and transistor radios

DUE to their small size, low cost, and portability, cassette tape recorders have become extremely popular. These do, however, usually suffer from having a rather limited output power (typically 500 milliwatts), and only a small internal speaker. The quality of the output is not therefore all one would desire.

It was therefore decided to construct an amplifier which would boost the output of the recorder to two or three watts, which is sufficient for most domestic requirements.

While it was originally intended to modify the recorder to take the output from it's volume control circuit, so as to obtain a virtually noise, and distortion free signal, this was not found necessary, and perfectly satisfactory results were obtained by taking the output from the earphone socket.

The amplifier can be used in the same way with small pocket radio receivers.

CIRCUIT THEORY

A circuit diagram of the cassette recorder amplifier is shown in Fig. 1, VR1 is the volume control, which consists of a variable voltage divider. The full input signal voltage will be present across VR1; the slider can tap all, or part of this voltage.

Capacitor C1 is a d.c. blocking capacitor which feeds the alternating input to the base of TR1. The voltage set at the base of TR1 by the biasing resistors, R1 and R2 would be altered with the setting of the volume control if C1 were to be omitted.

Transistors, TR1 and TR2 are wired as a Darlington pair. The Darlington pair is a method of connecting two transistors together in such a way that they in effect form a single transistor with a gain equal to that of the product of the gains of the two transistors—approximately 20,000 in this case.

OUTPUT STAGE

Resistors R1 and R2 bias the Darlington pair so that about half the supply voltage appears at TR2 collector.

Transistors TR3 and TR4 form the complementary class B output stage.

The output transistors are used in the common collector (also known as the emitter follower)

Approximate cost of components including V.A.T. £4·50 plus case

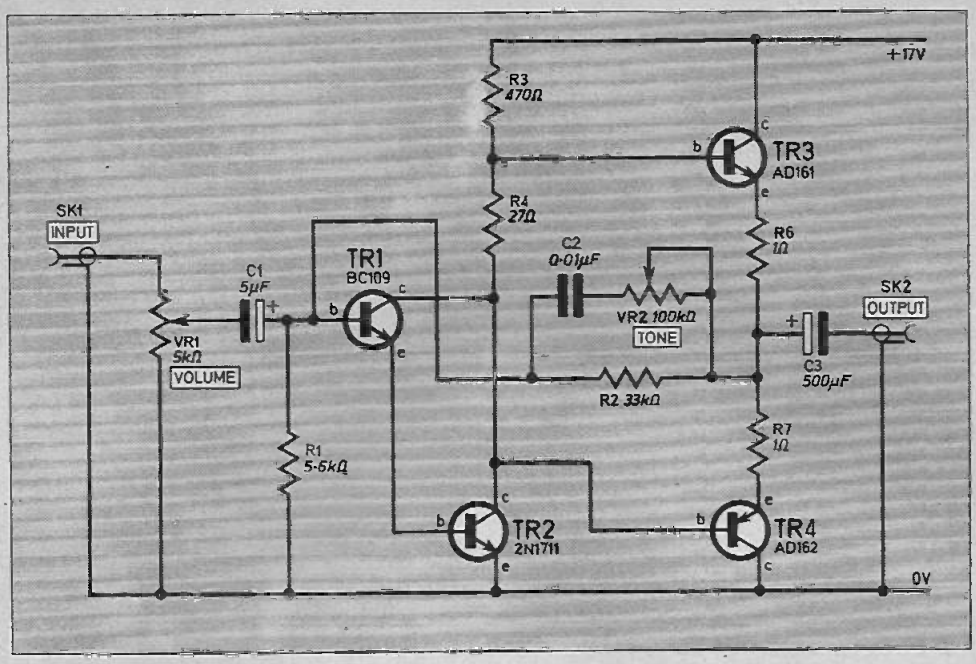


Fig. 1. Circuit diagram of the Cassette Amplifier.

configuration. An emitter follower has almost exactly unity voltage gain, but has considerably more current available at the output (the emitter) than is put in at the base. It has a very low output impedance compared to the input impedance. The output transistors are thus able to match the 500 ohms output of TR2 to the 8 ohms impedance of the speaker.

OUTPUT STAGE OPERATION

It will be easier to understand the operation of the output stage if reference is made to the skeleton circuit diagram, Fig. 2.

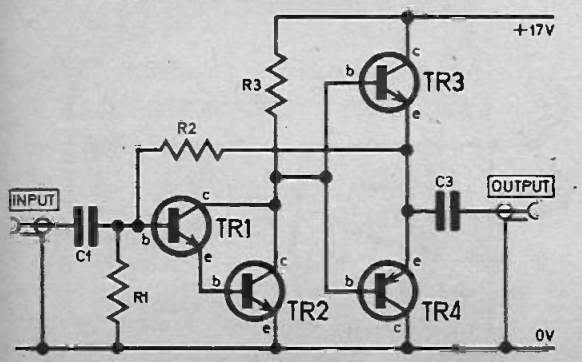
With no input signal applied to the amplifier, the voltage at TR3 and TR4 emitters will be the same as that at their bases (approximately half the supply voltage). The transistors are in effect working from two separate 8·5 volt supplies. As the output transistors stand, only leakage currents will flow, as their bases are in effect earthed.

If we now consider a positive pulse applied at TR1 base, this will cause TR2 to conduct more heavily, the voltage at TR3 and TR4 bases falling in consequence. This will cause the voltage at TR3 base to in effect fall below "earth", and TR3 will remain cut off. However, the base of TR4 will now in effect be above "earth", and it will conduct heavily. The voltage at its emitter will drop for the duration of the pulse, and then return to normal.

If a negative pulse is now applied at the input, TR2 will conduct less heavily, causing the voltage at TR3 and TR4 bases to increase. Now TR4 will be cut off, while TR3 conducts for the duration of the pulse, causing the voltage at the output to swing to a high level, and then back to normal. Thus TR4 amplifies positive input half cycles, while TR3 amplifies negative input half cycles.

The capacitor between the output, and the loudspeaker LS1 is required to block direct currents from entering the speaker.

Fig. 2. Basic amplifier diagram.



EXTRA COMPONENTS

Comparing the circuit of Fig. 1 with the skeleton circuit of Fig. 2, it will be noticed that in Fig. 2, R4, R6 and R7 are omitted.

Resistor R4 is required in order to minimise cross-over distortion.

This distortion is due to the fact that a germanium transistor (which the output transistors are) will not begin to conduct between its collector, and emitter terminals until about 0·2 volts is present at its base. When it is just turning on it has rather a non-linear characteristic; R4 is used to give a small biasing voltage to the output transistors, and so overcome cross-over

distortion, reducing it to an unnoticeable level.

Resistors R6 and R7 are current limiting resistors, which are required as a precaution against damage to the output transistors due to what is termed "thermal runaway".

NEGATIVE FEEDBACK

The biasing resistors for the Darlington pair obtain their biasing current from the output, and the biasing will alter as the output voltage fluctuates. This is in order to give negative feedback to the circuit. Negative feedback is required in order to reduce distortion. It also greatly reduces the gain of the circuit, but the distortion is reduced by a greater amount than the required signal.

Providing the amplifier is perfectly linear, the feedback will be linear also, and its only effect will be to reduce the gain of the amplifier.

No amplifier yet designed is completely linear, and thus the feedback will not be linear either. As the feedback is negative, however, this non-linearity will be in opposition to the non-linearity of the amplifier, and will tend to cancel out the distortion.

TONE CONTROL

In the output from the tape recorder there will be a certain amount of high frequency noise, known as tape hiss. Potentiometer VR2, and capacitor C2 form a simple tone control which can greatly reduce the high frequency response of the amplifier, and consequently this noise.

POWER SUPPLY

A stabilised mains power supply giving about 17V at up to 500 mA is incorporated in the amplifier. A circuit diagram of this is shown in Fig. 3. Switch S1 is the on-off switch which is ganged with the volume control, VR1. The mains transformer, T1, reduces the mains supply of 240V down to 12-15V. This refers to the r.m.s. value, and the peak value will be a little over 1·4 times this.

The bridge rectifier D1-D4 converts the alternating currents from the mains transformer to a pulsating direct current.

Transistor TR5 is connected as an emitter follower. Resistor R5 and D1, the Zener diode, are used to hold the base of TR5 at 18V. In an emitter follower circuit using a silicon transistor, (such as TR5) the emitter voltage will be the same as base voltage, minus about 0·5 to 1 volt. The voltage at the output is thus stabilised at about 17 to 17·5 volts. Capacitor C5 smooths the output in the same way as C4, giving an almost ripple free output.

CONSTRUCTION

The unit is housed in a home made aluminium case measuring approximately 7 by 6 by $2\frac{1}{2}$ inches. This is made in two sections, one forming the base, front, and rear, and the second forming the sides and top. The two are fastened together by four self tapping screws. Details of the case are given in Fig. 4. It is made from 18 or 22 s.w.g. aluminium sheet.

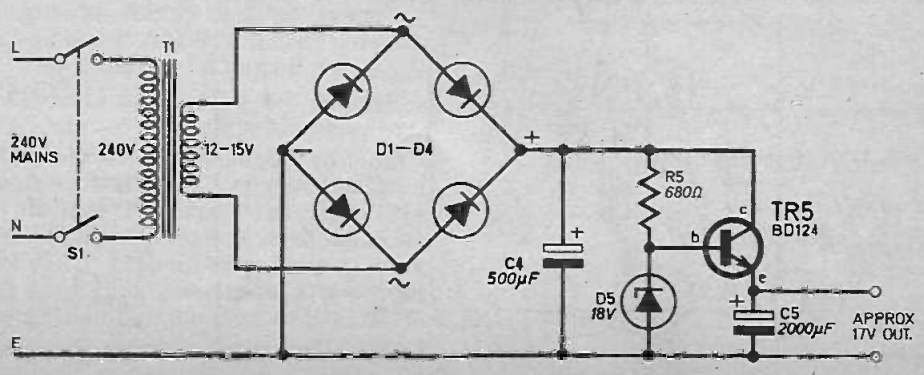
The three power transistors, TR3, TR4, and TR5 are mounted on the rear of the case. TR3, and TR5 must be insulated from the case using the insulating mica washers and plastic bushes supplied with the AD161/162 matched pair. The AD162 (TR4) case, which is the connection to it's collector, is connected to the negative supply, which is in turn connected to the case. There is therefore little point in insulating this transistor from the case. The spare insulating set should be used for the BD124 transistor, TR5.

No dimensions are given for the positioning of the mounting holes for the power transistors, in Fig. 4, as these are best found by using a mica insulating washer as a template—taking care not to damage the washer.

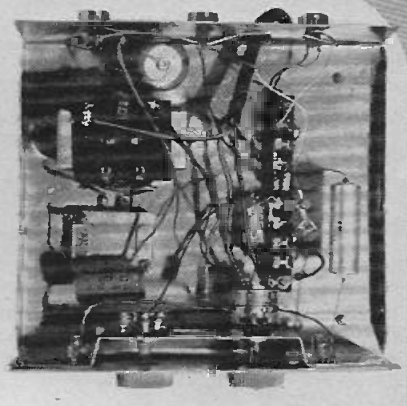
No exact dimensions are given for the mounting of T1, the 8-way tag strip, or the bridge rectifier, only their approximate positions being given. This is because the mountings for these components can vary tremendously. Usually the components themselves can be used as templates.

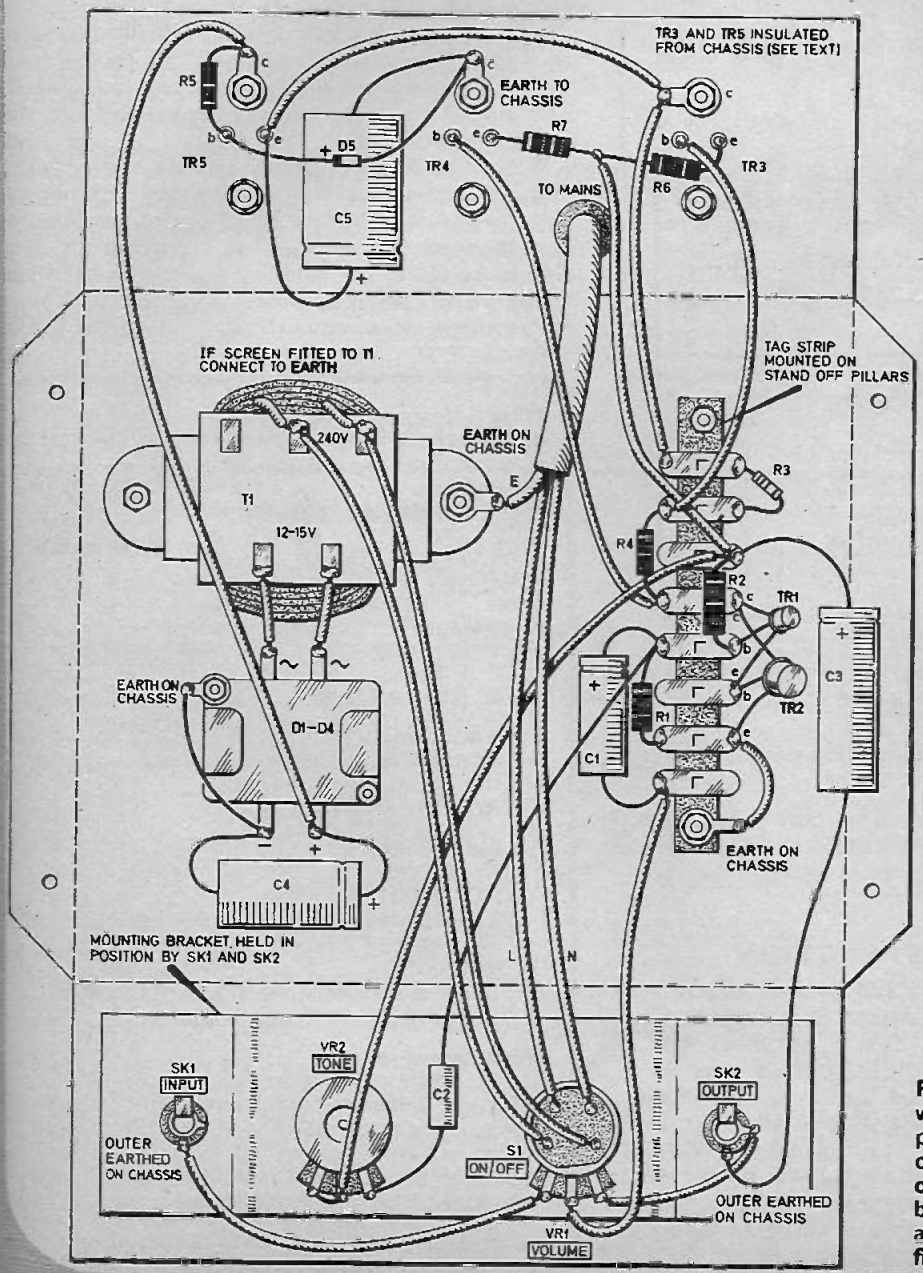
As well as details of the case, Fig. 4 also gives constructional details of the mounting bracket

Fig. 3. The stabilized power supply for the amplifier.



cassette amplifier





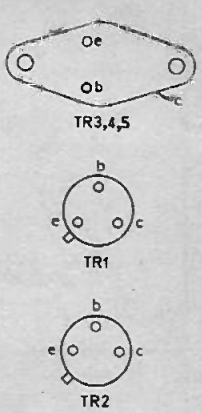


Fig. 5. Layout and wiring of the complete amplifier. The case is shown flat for clarity. It should be bent to shape before any components are fitted.

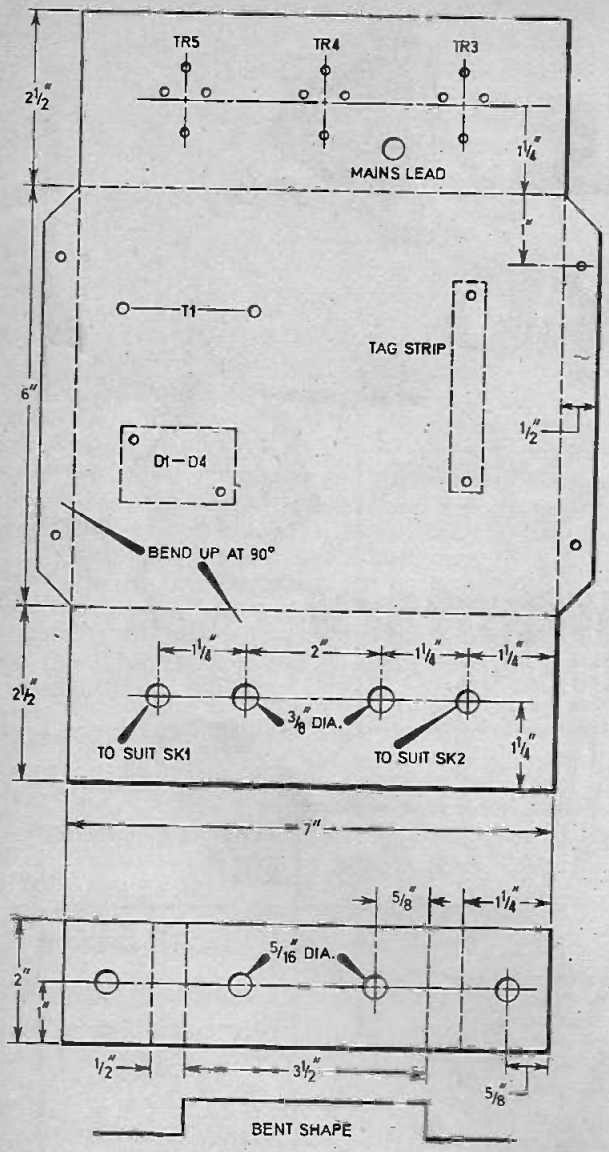


Fig. 4. Case construction details.

for VR1, and VR2. Details of how this is fixed are shown in Fig. 5. This bracket is to enable the control knobs to fit flush against the front panel.

ELECTRICAL CONSTRUCTION

Full wiring details of the complete unit are given in Fig. 5. It is important to make sure that no mistakes are made, as any incorrect wiring could result in ruining components, and as a mains supply is involved, could be dangerous.

The wiring up of the tag strip should be undertaken first and is quite easy, providing each of the component leads, and each tag is tinned with solder, before wiring is commenced. The connection to the negative supply is made to a solder tag on one of the tag strip mounting bolts.

The tag strip must be mounted on stand off insulators, so as to prevent the connections underneath the strip from being short circuited through the metal case. Use a heat shunt when soldering in the transistors and finally wire up the remaining circuitry.

The amplifier should be connected to the mains supply by way of a three core mains lead and a three pin plug fused at 1 amp. Check the wiring carefully before switching on.

USING THE AMPLIFIER

An external loudspeaker is required, and this should have an impedance of 8 ohms, and be capable of handling at least three watts. This is plugged into the output socket.

To connect the amplifier, and the cassette recorder, a screened lead about 18 inches long with a 3·5 mm. jack plug at each end is required. The output from the recorder is taken from the earphone socket.

Best results will probably be obtained with the volume control on the recorder set fairly high, so as to obtain a low degree of background noise. If a tone control is fitted on the recorder, this should be set to the midway point, and then the tone control on the amplifier is set for the lowest background noise, consistent with a good treble response. ▣

Components....

SEE SHOP TALK

Resistors

R1	5·6kΩ	R5	680Ω
R2	33kΩ	R6	1Ω
R3	470Ω	R7	1Ω
R4	27Ω	All ¼W ± 10%	

Capacitors

C1	5μF elect. 25V	C4	500μF elect. 25V
C2	0·01μF	C5	2,000μF elect. 25V
C3	500μF elect. 25V		

Potentiometers

VR1 5kΩ log. carbon with d.p.d.t. ganged mains switch (S1)
VR2 100kΩ lin. carbon

Semiconductors

TR1 BC109
TR2 2N1711
TR3 AD161 } matched pair (including mica
TR4 AD162 } washers and plastic bushes)
TR5 BD124
D1–D4 24V, 500mA metal bridge rectifier
D5 18V, 400 mW Zener diode

Miscellaneous

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The X25

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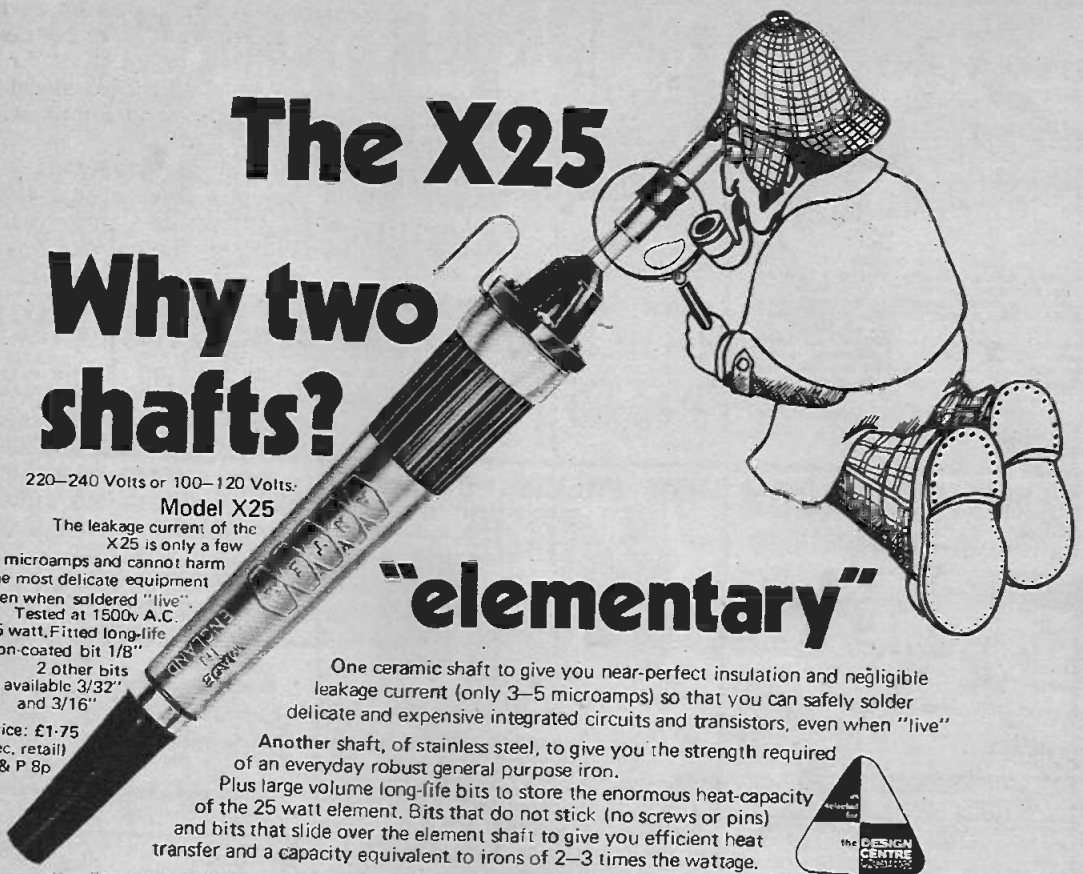

220–240 Volts or 100–120 Volts.

Model X25

The leakage current of the X25 is only a few microamps and cannot harm the most delicate equipment even when soldered "live". Tested at 1500v A.C. 25 watt. Fitted long-life iron-coated bit 1/8" 2 other bits available 3/32" and 3/16"

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4 other bits available 1/8", 3/16", 1/4" and 3/64".
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All prices mentioned are exclusive of V.A.T.

MODEL CN

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Voltages 240, 220, 110, 50 or 24.
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Voltages 240 or 220.
PRICE: £1·70 (rec. retail). P&P 5p

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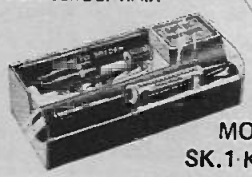

MODEL SK.1 KIT

Contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, stand and "How to Solder" booklet.
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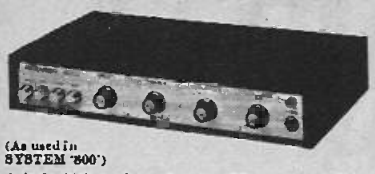
PREMIER 800 STEREO AMPLIFIER



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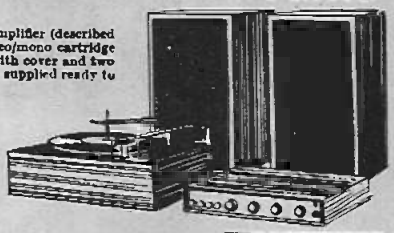

SYSTEM "TWO"

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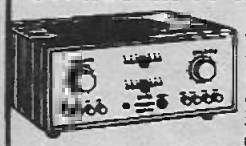

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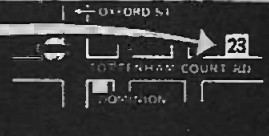


DEMO CIRCUITS

7 By MIKE HUGHES

The Differential Amplifier

As its name implies the **differential amplifier** operates by amplifying *differences* between two input signals. This operation is frequently required to show very small variations in quite large levels of electronic signal between that produced by a standard—or reference—and a variable. Imagine an application where you want to measure minute differences in lighting level that can be detected by a couple of photo-electric cells, one of which is illuminated by a standard level.

SIMPLE DIFFERENTIAL AMPLIFIER

The simplest form of differential amplifier is shown in general form in Fig. 7.1. Sometimes this circuit is called a **long tailed pair**—those who can remember valves will no doubt recall the term—because the emitters of both transistors terminate in a single emitter resistor (R4); this resistor forming the "tail" to the pair.

Imagine that the circuit in Fig. 7.1. is broken at the point *C*. Transistor TR1 becomes a straightforward common emitter amplifier biased into a quiescent operating condition by the potential divide effect of R1 and R2. If the transistors are silicon types the potential at point *B* will be 600mV less than the potential set at *A* and the current that flows between collector and emitter will produce a voltage drop across R3 giving a quiescent potential at the collector of TR1.

If we now reverse the operation and imagine that the circuit is broken at point *B*, TR2 is biased in exactly the same way as TR1 and if h_{FE} and the forward base/emitter drop are the same in both cases and identical biasing resistors are used, the quiescent potential at TR2's collector will be the same as at TR1 collector. Assuming both transistors are operating independently with separate emitter resistors a voltmeter (ME1) connected between the collectors would show a voltage difference of zero.

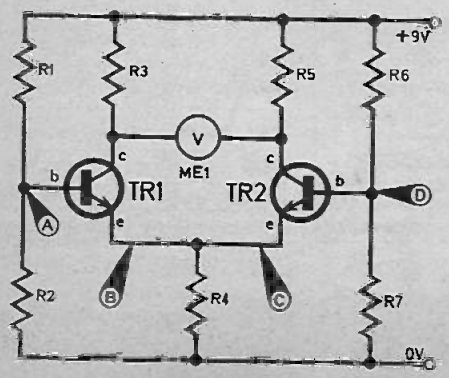
Imagine what would happen if a single emitter resistor is shared by the two transistors as shown in Fig. 7.1. The resistor (R4) having a value exactly half that of the imaginary independent resistors. Assuming both transistors are absolutely identical in every parameter and that all equivalent resistors have the same value, the circuit would act in the same way as before; the potential at *B* would equal that at *C*. *A* would equal *D* and the quiescent collector potentials would be the same.

Each transistor would be able to draw the same emitter current as before because we have halved the value of the emitter resistor and it will have twice the current flowing through it.

If we now reduced the value of R6 the potential at *D* will increase and more base current will flow in TR2. Several things now happen simultaneously, the potential at *C* will rise to become 600mV less than *D* and the potential at TR2's collector will fall because we are passing more base current; however that is not all! Because *C* and *B* are the same point (electrically) the potential at *B* will also rise; there will be less current drawn into the base/emitter circuit of TR1 and TR1 will conduct less between collector and emitter and thus its collector potential will rise.

Notice that there is a "see-saw" action; TR2's collector voltage falls and TR1's rises. Increasing the value of R6 to a value greater than R1 would produce the opposite effect. If R1 and R6 were photo conductive cells and R1 was illuminated by a standard source you can see that, provided both cells have identical photo-resistive characteristics, our circuit would show up differences in lighting levels falling on the two cells. The difference would be seen both in magnitude and direction if a centre zero meter was used as the voltmeter (ME1).

Fig. 7.1. Circuit of the simple differential amplifier.



PRACTICAL CIRCUIT

We have, of course, assumed ideal characteristics so far and unfortunately it is impossible to get perfectly matched transistors—or for that matter resistors. Our practical circuit takes this into account and we compensate for slight differences in emitter current drawn by the two transistors with VR1 in Fig. 7.2.

As there is no centre zero meter on the Demo Deck a diode bridge is used to feed ME1; the diodes ensure that current always flows the same way through the meter, irrespective of whether TR1's collector is more positive than TR2's or vice versa. We therefore will not be able to see the direction of difference signals.

Wire up the circuit of Fig. 7.2 on the Demo Deck (Fig. 7.3) but initially make sure the circuit is broken at point X and temporarily connect a shorting link between both transistor bases (this is for setting up purposes to ensure that both transistors have identical bias conditions while we compensate for variations in their parameters). Set VR2 to the top of its track so that plenty of bias current is available; if you have a multimeter measure the collector potentials and see if you can tell whether both transistors are passing identical current—one will almost certainly be conducting more than the other.

Imbalance will be shown on ME1 but the direction of imbalance will not be obvious. The difference in collector currents is caused by slight differences between the transistors' base/emitter voltage drops and can be compensated for by adjustment of VR1. The latter should be set so that ME1 reads zero and it should then stay at zero irrespective of what bias current is then applied to both transistors from VR2.

Remove the shorting link and connect up the photo conductive cell (PCC1) together with R6 and R7. The bias on TR2 will now be dependent on the amount of light falling on PCC1 and this —almost certainly—will be different from the last bias setting we had on TR1 from VR2; as a result ME1 will show a large deflection. Carefully re-adjust VR2 until ME1 again reads zero; thus restoring identical bias currents on both sides. Any *small* variations in lighting level on PCC1 will now show a positive indication on ME1 and the reading can be made extremely sensitive by shorting out the voltmeter series resistor R3.

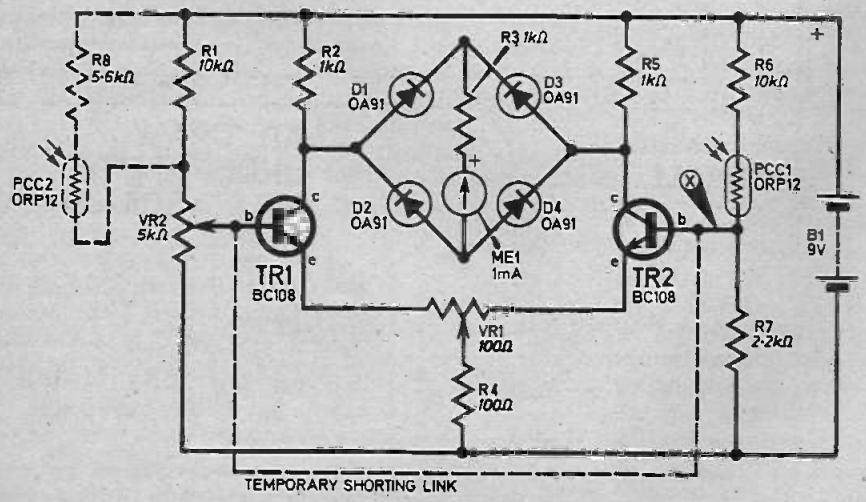


Fig. 7.2. (above) The practical differential amplifier circuit.

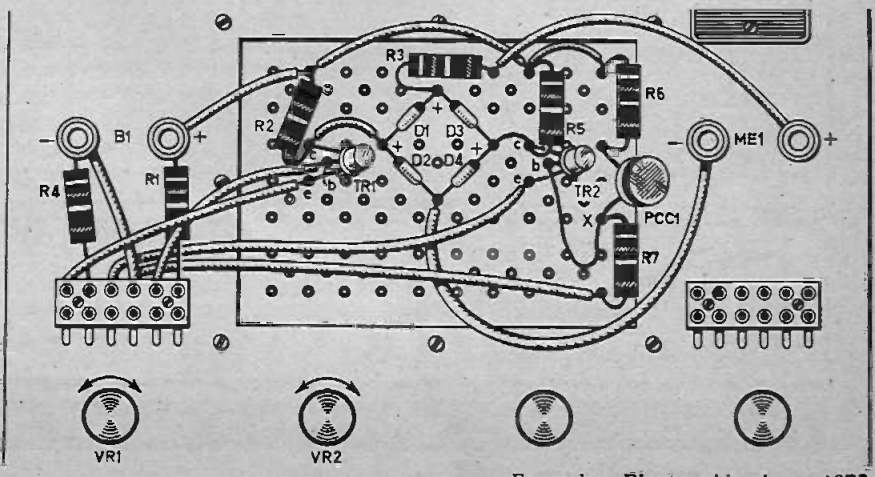


Fig. 7.3. (right) Layout and wiring of Fig. 7.2 on the Demo Deck.

PHOTOMETER

If you have another ORP12, try experimenting with a simple photometer by discarding R1 and re-connecting R8, PCC2 and VR2 as shown in Fig. 7.2. When identical illumination falls on PCC1 and PCC2 adjust VR2 so ME1 reads zero; from then on any differences in light level on the two cells will show as an indication on ME1.

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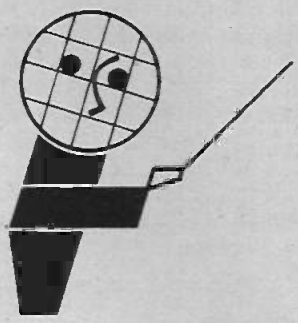

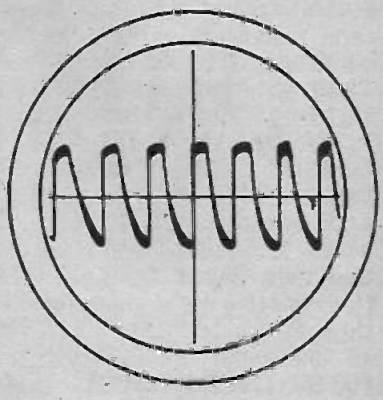

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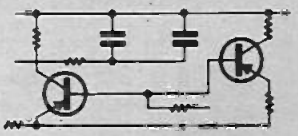

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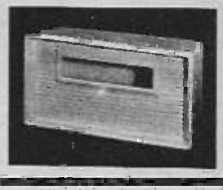

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SN7413	32p	29p	SN7444	1·43p	1·37p	SN7482	97p	95p	SN74111	1·37p	1·27p
SN7416	47p	43p	SN7445	2·00p	1·92p	SN7483	1·20p	1·15p	SN74118	1·10p	1·05p
SN7417	47p	43p	SN7446	1·07p	1·02p	SN7484	1·10p	1·05p	SN74119	1·47p	1·37p
SN7420	16p	15p	SN7447	1·10p	1·03p	SN7485	3·96p	3·85p	SN74121	44p	41p
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307	TO99	69p	748c	TO99	41p
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Electrolytic Capacitors

4 VOLT		16 VOLT		40 VOLT	
47µF	6½p	15µF	6½p	47µF	6½p
100µF	6½p	33µF	6½p	100µF	9p
220µF	6½p	68µF	6½p	150µF	10p
330µF	6½p	150µF	8p	220µF	11p
1000µF	13p	220µF	9p	470µF	17p
4700µF	29p	680µF	17p	680µF	25p
		1000µF	17p	1000µF	25p
		1500µF	25p	2200µF	44p
		2000µF	43p		
6·3 VOLT					
33µF	6½p				
68µF	6½p				
150µF	6½p	**25 VOLT**			
470µF	11p	10µF	6½p		
680µF	13p	22µF	6½p		
1500µF	18p	47µF	6½p		
2200µF	18p	100µF	8p		
3300µF	26p	150µF	8p	**63 VOLT**	
		220µF	10p	1µF	6½p
		470µF	13p	2·2µF	6½p
10 VOLT		680µF	20p	4·7µF	6½p
22µF	6½p	1000µF	22p	6·8µF	6½p
47µF	6½p	2200µF	39p	10µF	6½p
100µF	6½p	5000µF	68p	22µF	6½p
220µF	8p			68µF	10p
330µF	10p			100µF	11p
470µF	10p	**40 VOLT**		150µF	13p
1000µF	11p	6·8µF	6½p	220µF	19p
1500µF	20p	15µF	6½p	330µF	22p
2200µF	24p	33µF	6½p	470µF	26p
				1000µF	44p

Transistors

AC107	16p	BC138	38p	BF260	29p	OC44	14p
AC126	14p	BC142	33p	BF329	18p	OC45	14p
AC127	18p	BC143	33p	BF330	18p	OC70	23p
AC128	13p	BC144	30p	BF390	37p	OC71	14p
AC142K	22p	BC145	26p	BFX84	28p	OC72	14p
AC141K	20p	BC147	9p	BFX85	35p	OC81	14p
AC176	15p	BC148	9p	BFX86	32p	OC83	22p
AC187	18p	BC149	9p	BFX87	28p	OC84	28p
AC187K	20p	BC153	18p	BFX88	28p	TIP29A	53p
AC188	18p	BC154	17p	BFY50	21p	TIP30A	64p
AC188K	20p	BC157	13p	BFY51	17p	TIP31A	64p
ACY17	24p	BC158	12p	BFY52	17p	TIP32A	73p
ACY18	21p	BC159	14p	BFY64	39p	TIP33	£1·95
ACY19	25p	BC167	13p	BFY90	72p	TIP34A	
ACY20	22p	BC168	11p	BSX20	19p		£1·54
ACY21	23p	BC169	11p	C407	22p	TIP35A	
ACY22	18p	BC177	15p	C426	33p		£2·53
ACY39	68p	BC179	15p	C428	31p	TIP36A	
AD140	40p	BC182L	9p	C450	17p		£3·19
AD142	44p	BC183L	9p	MP8111	35p	TIP41A	79p
AD143	39p	BC184L	9p	MP8112	42p	TIP42A	91p
AD149	38p	BC186	33p	MP8113	35p	2N706	18p
AD150	60p	BC212L	11p	MP8121	33p	2N930	23p
AD161	29p	BC213L	11p	MP8122	44p	2N1131	22p
AD162	29p	BC214L	11p	MP8123	50p	2N1132	28p
AD M/P	50p	BC258	9p	NKT211	28p	2N1613	22p
AF114	14p	BC259	9p	NKT212	28p	2N1711	26p
AF115	14p	BC267	14p	NKT214	25p	2N2904	40p
AF116	14p	BC268	15p	NKT217	35p	2N2904A	
AF117	14p	BC300	40p	NKT261	28p		44p
AF118	92p	BC301	32p	NKT271	20p	2N2905	46p
AF124	27p	BC302	30p	NKT274	20p	2N2924	18p
AF139	39p	BC303	50p	NKT275	25p	2N2926	10p
AF239	41p	BC304	40p	NKT403	71p	2N3053	26p
AL100	77p	BCY70	17p	NKT405	83p	2N3054	55p
AL102	66p	BCY71	37p	NKY603F		2N3055	52p
AL103	55p	BCY72	17p		66p	2N3405	44p
ASY26	31p	BD123	66p	NKT613G		2N3643	57p
ASY27	40p	BD130	50p		83p	2N3702	9p
AU103	99p	BD131	68p	NKT674	26p	2N3703	9p
AU110	£1·10	BD132	90p	NKT677G		2N3704	9p
AU111	77p	BD135	42p		24p	2N3705	9p
BC107	9p	BD136	50p	NKT713	32p	2N3706	9p
BC108	9p	BD141	£1·87	NKT773	27p	2N3707	9p
BC109	9p	BD142	50p	OC19	55p	2N3708	9p
BC113	15½p	BF159	33p	OC20	55p	2N3709	9p
BC116	16p	BF173	29p	OC23	33p	2N3710	9p
BC125	16p	BF177	28p	OC25	28p	2N3711	9p
BC126	25p	BF178	29p	OC28	33p	2N3794	17p
BC132	18p	BF179	35p	OC29	33p	2N3819	28p
BC134	16p	BF194	15p	OC35	38p	40361	50p
BC135	16p	BF195	17p	OC36	38p	40362	50p
BC137	16p	BF244	27p	OC41	14p	40636	50p

Diodes & Rectifiers

IN914	8p
IN916	8p
IN4148	8p
1S44	10p
IN4007	22p
1S113	17p
1S120	17p
1S121	15p
1S130	9p
1S131	11p
1S132	18p
1S920	8p
1S922	9p
1S923	13p
1S940	6p
AA119	11p
AA129	11p
AAZ13	11p
AAZ15	14p
AAZ17	14p
BA100	16p
BA102	25p
BA115	8p
BA144	14p
BA145	22p
BA154	14p
BAX13	14p
BAX16	14p
BAY18	19p
BAY31	9p
BY100	19p
BY126	16p
BY127	19p
BYX10	24p
OA5	19p
OA9	11p
OA10	24p
OA47	9p
OA70	8p
OA73	11p
OA79	8p
OA81	9p
OA85	11p
OA90	8p
OA91	8p
OA95	8p
OA200	11p

VOLUME CONTROLS

Potentiometers
Carbon track 500 Ω to 2·2M Ω
Log or Linear
Single 18p. Dual gang (stereo) 44p
Single type with D.P. switch 18p extra.

SLIDE POTENTIOMETERS

58mm, TRACK
SINGLE GANGED, LOG or LIN 1k to 1M. 45p each
TWIN GANGED, LOG or LIN 1k to 500k. 66p each.

CARBON SKELETON PRESETS

Small high quality type (linear only).
All values 100·5 meg ohms.
·1 watt 5½p each
·2·5 watt 6½p each

VEROBOARD

	0·15 Matrix	0·1 Matrix
2½in × 3¾in	19p	26p
2½in × 5in	23p	28p
3¾in × 3¾in	28p	28p
3¾in × 5in	33p	32p
5in × 17in (plain)	94p	—

Vero Pins (bag of 36), 22p
Vero cutter, 50p; Pin insertion Tools (0·1 and 0·15 matrix) at 61p.

SLIDE SWITCH

SPST 11p each. D.P.D.T. 13p each.

MINIATURE NEON LAMPS

240V or 110V 1–4 5p, 5 plus 4½p each.

MINITRON DIGITAL INDICATOR TYPE 3015F

Reads 0–9 and decimals
(Data Sheet on request)
ONLY £1·50
16 DIL Socket 33p
Driven by 7447 £1·05

MULLARD POLYESTER'S

MULLARD POLYESTER CAPACITORS C280 SERIES

250V P.C. mounting: 0·01µF, 0·015µF, 0·22µF, 3½p. 0·33µF, 0·047µF, 0·068µF, 4p. 0·1µF, 4½p. 0·15µF, 0·22µF, 5½p. 0·33µF, 7p. 0·47µF, 9½p. 0·68µF, 12p. 1·0µF, 14p. 1·5µF, 22p. 2·2µF, 27p

MULLARD POLYESTER CAPACITORS C296 SERIES

400V: 0·001µF, 0·0015µF, 0·0022µF, 0·0033µF, 0·0047µF, 2½p. 0·0068µF, 0·01µF, 0·015µF 0·022µF, 0·033µF, 3½p. 0·047µF, 0·068µF, 0·1µF, 4½p. 0·15µF, 6½p. 0·22µF, 8½p. 0·33µF, 12p. 0·47µF, 14p.
160V: 0·01µF, 0·015µF, 0·22µF, 0·033µF, 0·047µF, 0·068µF, 3p. 0·1µF 3½p. 0·15µF, 4½p. 0·22µF, 5½p. 0·33µF, 6½p. 0·47µF, 8½p. 0·68µF, 12p. 1·0µF, 14½p.

RECTIFIERS

P.I.V.	1 AMP	1·5 AMP
50	IN4001 4½p	PL4001 8p
100	IN4002 4½p	PL4002 9p
200	IN4003 5½p	PL4003 10p
400	IN4004 8½p	PL4004 10p
600	IN4005 8p	PL4005 13p
800	IN4006 9p	PL4006 15p
1000	IN4007 10p	PL4007 20p

BRIDGE RECTIFIERS

P.I.V.	1 AMP	2 AMP	5 AMP	10 AMP
50	33p	53p	£1·76p	£2·20p
100	35p	57p	—	—
200	37p	60p	£1·88p	£2·31p
400	40p	64p	£2·15p	£2·42p
600	44p	68p	£2·42p	£2·75p
800	49p	—	—	—

THYRISTORS

PIV	50	100	200	300	400
1 Amp	28	25	41	44	53
3 Amps	44	50	60	—	66
7 Amps	—	96	1·01	—	1·24

RESISTORS

¼ watt 5% carbon 1p each
¼ watt 10% carbon 1p each
1 watt 10% carbon 2½p each
Range 10 ohms to 4·7 meg.
½ watt m/o 2% 3p each
Range 10 – 1 meg ohms

BARGAIN PACKS

Unmarked Packs
Pack of 25 IN4148 55p

Pack of 10
BC108 55p
BC107 55p
(Plastic can)

Pack of 10 Plastic BC109 55p

Pack of 10
BC169 55p
(unmarked) but tested

2N2646 (unmarked) 38p each

Pack of 10
2N2926G 55p
unbranded but tested

Unmarked but fully tested 2N3055
1–9 33p
10 plus 27p

FULLY MARKED TYPES

AD161, AD162 M/P
1–9 59p
10 plus 53p

BC107–BC108 BC109
1–9 9p
10–99 8p
100 plus 6½p

BC 182L:·3·4·212·4
1–9 9p
10 plus 8p

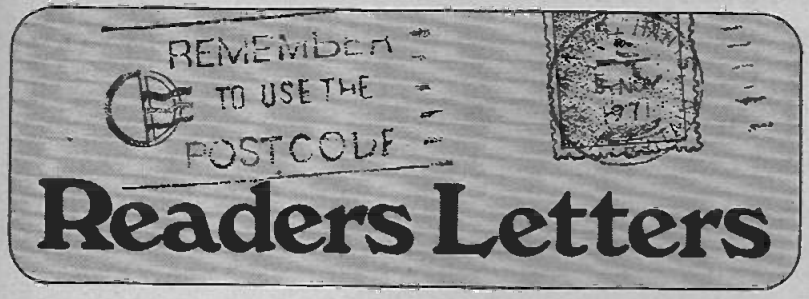
AC127 or AC128
1–9 13p
10 plus 12p
100 plus 11p

ZENER DIODES

400 M/W 5% Miniature
BZY 88 Range
All voltages
3·3–33 Volt 9p each

1 watt 5%
All voltages
6·8–200 Volts 14p each

10 watt 5%
All Voltages
7·5–100 Volts 51p each



Readers Letters

Transistor Point

As a complete beginner to electronics at the time of buying the first issue of EVERYDAY ELECTRONICS, I found great difficulty in differentiating between transistors of types *pnp* and *npn* as shown on circuit diagrams.

I therefore devised a method of remembrance by saying that *pnp* = *point in plate*.

The "point" and "plate" referred to of course, being the "emitter" and "base" respectively of the standard transistor configurations. Knowing this, it follows, that if the "point" is away from the "plate" then the transistor is of type *npn*.

Possibly this sounds rather elementary, but I find it useful even now and hope other readers may also.

C. C. Cullen,
Thetford.

Volume

I have completed the *Audible Indicator Warning* unit and am very pleased with the result, but it seems to be too loud. Would it be possible to install a volume control?

J. Welch,
Shoreditch.

The volume may be reduced by putting a low value resistor in series with LS1—try 100 ohms.

Guitar Impedance

Ref. your *General Purpose Amplifier*. I note you refer to guitars as being in the 200 ohms (impedance?) category. Well this just 'aint so. With one exception, every guitar I have ever owned, used, or experimented with has had a d.c. resistance of between 10 kilohms and 50 kilohms. So the nominal impedance must be at least that high. The exception has a measured resistance of 10 megohms. No, I don't understand it either, but it works well into a high impedance valve (EF 86) amplifier.

This fallacy about guitars is repeated regularly in your family of magazines and just does not have any factual basis, except perhaps for the home-made pick-ups featured at various times. I would suggest you check this with any reputable guitar manufacturers, and stop this rather silly "old wives tale."

If you treat a guitar as a rather inefficient ceramic cartridge you won't go far wrong. (Still a good mag. though.)

A. Gamble,
Ormskirk.

We have unfortunately, misled some readers. The text stated "Two inputs are provided one being rated at 5mV which is suitable for low level signal sources such as 200 ohm microphones or guitars." By this we did not mean 200 ohm guitars but simply that a guitar could be inputted into the low level socket. Most guitar pick-ups are around 50 kilohms impedance.

Ruminations
By Sensor

The I.C. and the Haggis

I wrote recently in "Ruminations" (April 1973) drawing some comparisons between an integrated circuit and a haggis. I concluded the piece by observing that I had yet to hear an address to the I.C!

A reader in Hull has written one for me, based somewhat irreverently, on the Lord's Prayer. With apologies to anyone who may be offended, I offer a "Creed for Semiconductor Men."

"I believe in epitaxial growth, in the planar technology, and the diffusion of silicon."

Are You Receiving Me?

When reading of the increase in telephone tapping, room "bugging" and other forms of snooping taking place these days, I began to wonder if it will ever be possible to "listen in" to an animal's mind. The thought was prompted by watching the dog, asleep in front of the fire, her paws twitching, nose wrinkling, ears moving, as she presumably, dreamed of a great chase.

It is easy enough to detect brain waves by means of an electronic encephalograph, but what a fascinating world might be opened to us if we could share the visual, alfactory, and other sensations experienced by the animals, birds and insects which share our planet.

Some very complex equipment would be needed to translate, for our appreciation, the pleasurable sensations of the dog on finding a putrefying old bone.

The possibilities are almost limitless. I can visualise the family sitting gathered around the equipment in the evenings (the television ignored) and experiencing, say—"The life of the honeybee—from brood chamber to outcast, edited and condensed on tape to a two hour, never to be forgotten, experience."

Or, if you want thrills, what about "Be the horse that won the Grand National—jump Bechers Brook, feel the bit in your mouth as you clear Valentine's."

I would like to experience the soaring flight of an eagle, or the across the globe flight of the arctic tern, to join in the migration of the wild geese, or go with the salmon, down to the sea.

Impossible, do you say? I don't think so, much stranger things have happened. Perhaps, in the next ten years, we shall see suitable circuits and constructional details in EVERYDAY ELECTRONICS! There are snags of course, I would not wish my own "brain waves" to become available without my consent. And there would be many organisations that would attempt to obtain information of this kind—for our own good, of course!

MANY readers may be surprised to find that they can make their own printed circuit panels and, provided you follow our instructions, the result is well worth a little time and care.

There are one or two firms selling p.c. board "construction kits" and these are generally excellent to start off with. The alternative—which will probably be cheaper if a number of boards are likely to be made—is to buy the board, resist and etchant individually in reasonable quantities.

SHOP TALK

By Mike Kenward

There seems to be something of a shortage of single sided copper clad paxolin or fibreglass board at the moment, but the larger suppliers should be able to help if your local dealer cannot. Incidentally, the fibreglass board is more expensive but should preferably be used where heat or moisture are present, e.g., for car gadgets that are fitted under the bonnet.

The resist can be either paint (Humbrol model type) available from model shops, or you can use one of the p.c. resist pens. A recently announced pen is now available from G.S.P.K. (Sales) Ltd., Hookstone Park, Harrogate, HG2 7BU, Yorkshire. The pen is priced at 60p and postage and packing are 10p. The ease with which such a pen can be used probably makes it worth the extra cost.

Having talked about the p.c. board we can now look at this month's projects and first at the one that uses a p.c. board both for component mounting and to form a "keyboard!"

Mini Organ

There should be little trouble with component buying for the *Mini Organ*—the p.c. board may be difficult to get but this has been mentioned above. Other problems should be limited to some resistors—try Electrovalue of 28 St. Jude's Way, Englefield Green, Egham, Surrey, for these—and the two push-button type switches. One of the larger suppliers should be able to help with the push-buttons although they may not be exactly the same style as those shown in the photographs.

Small 75 ohm speakers are generally available for about 50p.

Cassette Tape Amplifier

Looking through the ad's in a recent issue we were amazed at the price differences for a matched pair of AD161/162's as used in the *Cassette Tape Amplifier*. Although these are not that expensive, the prices vary by relatively large amounts; it just shows that it can be worth looking around even for transistors!

Aside from the above note there are no particularly helpful hints we can give for buying. The bridge rectifier can be almost any type of adequate ratings—there are a number of different types available from advertisers.

Incidentally, the current quoted for both the transformer and the rectifier are the minimum ratings—if the one you get is quoted as having a higher current rating, this is suitable.

Rain Alarm

If we keep publishing straightforward designs like the *Rain Alarm* the need for this page may disappear since we find it difficult to give advice on buying components that are all readily available. A case for this unit can be any suitable box or can be made up from an aluminium chassis and a wood or perspex front panel.

New Products

Not a completely new product but an improved version of a well-known existing amplifier; the Radio and TV Components, Viscount III. This amplifier has been uprated from 14 to 20 watts r.m.s. per channel with no price increase (except for V.A.T. of course).

However, if a complete Viscount audio system is purchased, the V.A.T. increase is not passed on to the customer.

The latest amplifier, designated the R102, has a frequency response of 40Hz to 40kHz±3dB and incorporates f.e.t. input stages, the price of the amplifier is £24·20.

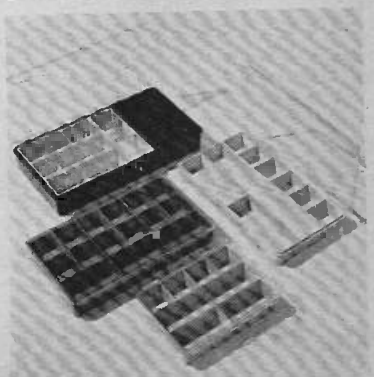
Readers of E.E. have a chance to win one of these amplifiers, together with a record deck and speakers, in this month's competition—see page 304 for details.

Kabi (Electrical & Plastics) Limited of Cranborne Road, Potters Bar, Herts., have introduced a new series of compartment trays which have a wide range of uses. The range comprises four sizes. $5\frac{1}{4} \times 7 \times 1\frac{1}{2}$ inches, $6 \times 10\frac{5}{8} \times 1\frac{1}{2}$ inches, $6 \times 10\frac{3}{4} \times 1\frac{1}{2}$inches and $6\frac{1}{4} \times 12 \times 2$ inches.

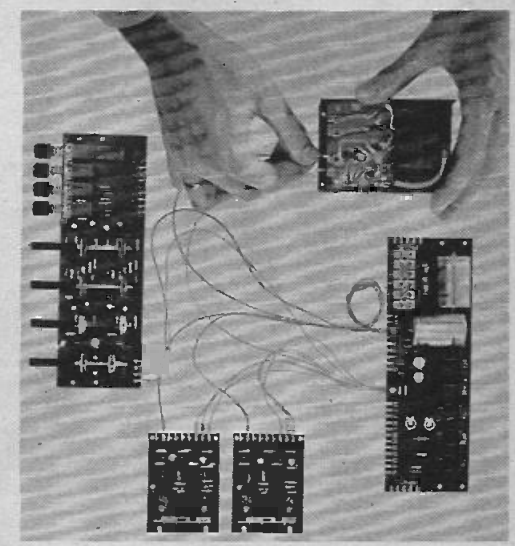
All models except the last quoted have fixed compartments of various sizes and all are formed in strong plastic which will give long service in normal usage (see photograph).

The largest model has moveable compartment modules, each module being capable of subdivision, so that compartments of virtually any size up to the total dimensions of the tray can be formed.

The trays are ideal storage units for electronic components—and, in fact, anywhere where small parts have to be stored. Most are available in a range of colours at prices ranging from 45p to £1·50 each according to size. The trays are complete with clear plastic lids, having a hinge and snap fixing, and could accommodate small tools as well as components.



Project 605 the new simple way to assemble Sinclair high fidelity modules



For several years now you have been able to assemble your own high fidelity system to world beating standards using Sinclair modules. We have progressively improved these technically but hitherto the method of assembly at your end has remained the same – there has been no alternative to a soldering iron. Now for those who prefer not to solder, there is an alternative – Project 605.

In one neat package you can now obtain the four basic Project 60 modules plus a fifth completely new one – Masterlink – which contains all the input sockets and output components you previously bought separately. Also in the Project 605 pack are all the inter-connecting leads, cut to length and fitted at each end with plugs which clip straight onto the modules, eliminating soldering completely. The pack contains everything you need to build a complete 30 watt stereo amplifier together with a clear well illustrated Instruction Book. All you have to do is to arrange your modules in the plinth or case of your choice and then clip them together – the work of a few minutes.

Your hi-fi system will, as we said, match the finest in the world and you can add to it at any time to increase power or extend the facilities. For example a superb stereo FM Tuner unit is obtainable for only £25.

Guarantee If within 3 months of purchasing Project 605 directly from us, you are dissatisfied with it, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter. No charge for postage by surface mail. Air mail charged at cost.

sinclair

Sinclair Radionics Ltd., London Road
St. Ives. Huntingdonshire PE17 4HJ.
Telephone: St. Ives (04806) 4311
Reg. No. 393594

Specifications

Output – 30 watts music power (10 watts per channel R.M.S. into 3Ω).
Inputs – Mag. P.U. – 3mV correct to R.I.A.A. curve 20–25,000 Hz ± 1dB. Ceramic pick-up – 50mV. Radio – 50 to 150mV. Aux. adjustable between 3mV. and 3V.
Signal to noise ratio – Better than 70dB.
Distortion – better than 0.2% under all conditions.
Controls – Press buttons for on-off, P.U., radio and aux. Treble +15 to —15 dB at 10 kHz. Bass +15 to —15 dB at 100 Hz. Volume. Stereo Balance.
Channel matching within 1dB.
Front panel – brushed aluminium with black knobs.

Project 605 comprises Stereo 60 pre-amp/control unit, two Z-30 power amplifiers, PZ-5 power supply unit, the unique new Masterlink, leads and instructions manual complete in one pack. Post free

£29.95
Plus 10% V.A.T.

To SINCLAIR RADIONICS LTD., ST. IVES, HUNTINGDONSHIRE PE17 4HJ
Please send Project 605 post free ☐ Details and list of stockists ☐
Name .....
Address .....
.....
for which I enclose £29.95 cheque/money order/cash. EE6/73

SINCLAIR IC12 £2·00

Max supply Volts 28. Power 6 Watts rms. Complete with free printed circuit board and 44 page instruction booklet.

SWANLEY IC TOMORROW £2·50

The World's most powerful IC amplifier. Similar to the above but operates at 35 Volts max supply and gives 12 Watts rms output. Manufactured for us by a leading semiconductor company. Supplied with our Instructions and a 6 month guarantee, but no printed circuit.

SINCLAIR EQUIPMENT

Z30	£3·50	Z50	£4·25
PZ5	£3·97	PZ6	£6·40
PZ8	£6·60	Transformer	
AFU	£4·50	for PZ8	£2·95
Stereo 60	£7·80	Project 60 tuner	£16·80

EXECUTIVE CALCULATOR £55

PROJECT 60 KIT £2·50

Our extremely popular kit contains the extra capacitors, din plugs and sockets, cables and fuseholder needed to complete Project 60.

KITS FOR IC12 AND IC TOMORROW

Except for the power kits and speakers all items suit both integrated circuits

DELUXE KIT

Includes all parts for the printed circuit and volume, bass and treble controls needed to complete the mono version £1·45. Stereo version with balance control £3·30.

POWER KIT FOR IC12

A set of components to construct a 28V 0·5 Amp power supply £2·27. Also suitable Sinclair PZ5 £3·87.

POWER KIT FOR IC TOMORROW

A set of components to construct a 35V 1 Amp power supply £2·97.

LOUDSPEAKERS FOR THE IC12

8 ohm types. 5" £1·00. 5" x 8" £1·45.

PREAMPLIFIER KITS

Type 1 for magnetic pickups, mics and tuners with 3 position equalization switch. Mono model £1·20. Stereo model £2·20. Type 2 for ceramic or crystal pickups. Mono 60p. Stereo £1·20.

SEND S.A.E. FOR FREE LEAFLET ON KITS AND TBA651.

S-DECS AND T-DECS

S-Decs	£1·44
T-Decs	£2·88
μ-Decs A	£3·00
18 dil IC carriers	£1·20

IC RADIO CHIP TBA651 £2·10

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200μA	£1·95	1 amp.	£1·75
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1mA	£1·75	10 amp.	£1·75
1–0–1mA	£1·75	3V. D.C.	£1·75
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5mA	£1·75	15V. D.C.	£1·75
10mA	£1·75	20V. D.C.	£1·75
20mA	£1·75	50V. D.C.	£1·75
50mA	£1·75	150V. D.C.	£1·75
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150mA	£1·75	500V. D.C.	£1·75
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100–0–100μA	£2·05	50V. D.C.	£1·85
200μA	£2·05	300V. D.C.	£1·85
500μA	£1·95	15V. A.C.	£2·00
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1mA	£1·85	8 Meter 1mA	£2·05
5mA	£1·85	VU Meter	£2·60
10mA	£1·85	1 amp. A.C. *	£1·85
50mA	£1·85	5 amp. A.C. *	£1·85
100mA	£1·85	10 amp. A.C. *	£1·85
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100μA	£2·60	30 amp.	£2·15
100–0–100μA	£2·50	50 amp.	£2·15
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500–0–500μA	£2·15	10V. D.C.	£2·15
1mA	£2·15	20V. D.C.	£2·15
1–0–1mA	£2·15	50V. D.C.	£2·15
5mA	£2·15	150V. D.C.	£2·15
10mA	£2·15	300V. D.C.	£2·15
50mA	£2·15	60mV. D.C.	£2·40
100mA	£2·15	100mV. D.C.	£2·40
500mA	£2·15	30V. A.C. *	£2·20
		50V. A.C. *	£2·20
		150V. A.C. *	£2·20
		300V. A.C. *	£2·20
		500mA A.C. *	£2·15
		1 amp. A.C. *	£2·15
		5 amp. A.C. *	£2·15
		10 amp. A.C. *	£2·15
		20 amp. A.C. *	£2·15
		30 amp. A.C. *	£2·15
		50 amp. A.C. *	£2·15
		VU Meter	£3·40

Type S-80 80 mm. square fronts

50μA	£3·50	5 amp. D.C.	£2·85
50–0–50μA	£3·40	300V. A.C.	£2·85
100μA	£3·40	VU Meter	£3·70
100–0–100μA	£3·30		
500μA	£3·05		
1mA	£2·85		
20V. D.C.	£2·85		
50V. D.C.	£2·85		
300V. D.C.	£2·85		
1 amp. D.C.	£2·85		

"SEW" EDUCATIONAL METERS

Type ED.107. Size overall 100mm x 90mm x 108mm

A new range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The meter movement is easily accessible to demonstrate internal working. Available in the following ranges:

50μA	£5·50	20V. d.c.	£4·85
100μA	£5·10	50V. d.c.	£4·85
1mA	£4·85	300V. d.c.	£4·85
50–0–50μA	£5·10		
1–0–1mA	£4·85	Dual range	
1A d.c.	£4·85	500mA/5A d.c.	£5·10
5A d.c.	£4·85	5V/50V d.c.	£5·10
10V d.c.	£4·85		

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. 10/25/50/100/250/500/1000/2500 or 5000 ohms. 90p. P. & P. 10p.
50 WATT. 10/25/50/100/250/500/1000/2500 or 5000 ohms. £1·15 P. & P. 10p.
100 WATT. 1/5/10/25/50/100/250/500/1000 or 2500 ohms. £1·65 P. & P. 15p.

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Excellent quality · Low price · Immediate delivery

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2·5 Amp	£8·05
5 Amp	£11·75
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10 Amp	£22·50
12 Amp	£23·60
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ALL MODELS
INPUT 230 V 50/60 CYCLES
OUTPUT VARIABLE 0-260 VOLTS
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AUTO TRANSFORMERS

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

80 W	£2·10	P. & P. 18p
150 W	£2·70	P. & P. 18p
300 W	£3·60	P. & P. 23p
500 W	£5·25	P. & P. 33p
1000 W	£7·50	P. & P. 38p
1500 W	£10·20	P. & P. 43p
2250 W	£17·25	P. & P. 50p
5000 W	£35·00	P. & P. £1

230 VOLT A.C. 50 CYCLES RELAYS

Brand new. 3 sets of changeover contacts at 5 amp rating. 50p each. P. & P. 10p (100 lots £40) Quantities available.

MCA.220 AUTOMATIC VOLTAGE STABILISER

Input 88 125 VAC or 176 250VAC. Output 120V AC. or 240 VAC. 200 VA rating. £11·97, carr. 50p.

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Moving Coil. Ideal for language teaching, communications. Headphone imp. 16 ohms. Microphone imp. 200 ohms. £4·62. P. & P. 15p.

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P. & P. extra

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Solid state. Variable output 0–24V DC up to 1 amp. Dual scale meter to monitor voltage and current. Input 220/240V AC. Size 185 x 85 x 105mm. £8·97 P. & P. 25p.

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Solid state. Variable output 6-20 volt D.C. up to 2 amp. Independent meters to monitor voltage and current. Output 220/240 V. A.C. Size 7½" x 5½" x 3½". £19·95. P. & P. 25p.

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Solid state. Output 6, 9 or 12 volt DC up to 3 amps. Meter to monitor current. Input 220/240v AC. Size 4" x 3½" x 6½". £11·97. P. & P. 25p.

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Tests PNP or NPN transistors. Audio indication. Operates on two 1·5v batteries. Complete with all instructions, etc. £4·50. P. & P. 20 p.

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Tests ICO and B. PNP / NPN. Operates from 9v battery. Complete with all instructions, etc. £3·95. P. & P. 20p.

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MULTIMETERS *for EVERY purpose!*

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High-precision at low-cost. Ranges: D.C. 15V, 150V, 1,000V (10,000 opv). A.C. 15V, 150V, 300V (1,000 opv). D.C. Current 150mA. Resistance 100k ohms.
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0/3/15/150/300/1200 V. D.C. 0/6/30/300/600 V. A.C. 0/300μA/300 MA 0/10K/1 meg Ω
Decibels —10 to +16db
£2·75 each +15p P. & P.

HIOKI MODEL 720X
20,000 O.P.V.
Overload protection
5/25/100/500/1000 VDC. 10/50/250/1000 VAC.
50μA/250mA. 20K/2 meg ohm. —5 to +62db.
£4·97. P. & P. 15p.

HIOKI MODEL 730X
30,000 O.P.V. Overload protection. 6/30/60/300/600/1200 VDC. 12/60/120/600/1200 VAC. 50μA/30 mA/300 mA. 2K/200K/2 megohm. —10 to +63db.
£6·50. P. & P. 15p.

KAMODEN 72.200 MULTITESTER
High sensitivity tester. 200,000 o.p.v Overload protection. Mirror scale. Ranges:
0 / ·06 / ·3 / 3 / 30 / 120 / 600 / 1200V. D.C.
0 / 3 / 12 / 60 / 300 / 11, 200V. A.C.
0 / 6μA / 1·2mA / 120mA / 600mA / 12A. D.C.
0 / 12A. A.C.
— 20 to + 63dB.
0 / 2K / 200K / 2 meg / 200 meg ohms.
£18·95. Post 30p

MODEL TE-200
20,000 O.P.V. Mirror scale, overload protection. 0/5/25/125/1,000V. D.C. 0/10/50/250/1,000V. A.C. 0/50 μA/250 mA. 0/60K/6 meg Ω. —20 to +62db.
£3·95. P. & P. 15p.

MODEL 500
30,000 O.P.V. with overload protection mirror scale
0/·5/2·5/10/25/100/250/500/1,000v. D.C. 0/2·5/10/25/100/250/500/1,000V. A.C. 0/50μA/5/50/500mA. 12 amp. D.C. 0/60/K/6 Meg./60 Meg Ω
£8·87. Post paid.

HIOKI MODEL 750X
50,000 o.p.v. 43 ranges 0–0·3 to 1,200v D.C. 0–3 to 1,200v A.C. 0–30μA/300mA. 0–3K/30 meg ohms. — 10 to + 17dB.
£8·97. Post 20p.

HT100B4 MULTI-METER
Features A.C. current ranges. 100,000 o.p.v. Mirror Scale. Overload protection.
0/·5/2·5/10/50/250/500/1000 V D.C.
0/2·5/10/50/250/1000 V. A.C.
0/10/250μA/2·5/250 MA/10 Amp. D.C.
10 Amp A.C. 0/20K/200K/2 MEG/20 MEG. — 20 +62db.
£15·00. P. & P. 25p.

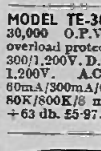
370 WTR MULTI-METER
Features A.C. current ranges. 20,000 o.p.v. 0/·5/2·5/10/50/250/500 1000 V. D.C.
0/2·5/10/50/250/500/1000V AC
0/50uA/1/10/100mA/1/10 Amp D.C.
0/100mA/1/10 Amp AC
0/5K/50K/500K/5 MEC/ 50 MEG.
—20 +62db.
£15. P. & P. 25p.

RUSSIAN 22 RANGE MULTIMETER
Model U437 10,000 o.p.v.
A first class versatile instrument manufactured in U.S.S.R. to the highest standards. Ranges: 2·5/10/50/250/500/1000v D.C. 2·5/10/50/250/500/1000v A.C. DC Current 100mA/1/10/100mA/1A. Resistance 300 ohms/3/30/300K/3m Ω. Complete with batteries, test leads, instructions and sturdy steel carrying case.
OUR PRICE £6·97. P. & P. 25p

ROUND SCALE TYPE PENCIL TESTER MODEL T.S.68
Completely portable, simple to use pocket sized tester. Ranges 0/3/30/300V AC and DC at 2,000 o.p.v. Resistance 0·20K ohms.
ONLY £1·97 P. & P. 13p.

LT601 MULTIMETER
New style 20,000 o.p.v. pocket multimeter. 5/25/50/250/500 / 2500 V. D.C. 10 / 50 / 100 / 500 / 1000V. A.C. 50μA / 250mA. 6K / 6 meg ohms. —20 to + 22 dB.
£3·75. Post 20p.

MODEL TH-12
20,000 o.p.v. Overload protection. Slide switch selector 0 / ·25 / 2·5 / 10 / 50 / 250 / 1000V. D.C. 0 / 10 / 50 / 250 / 1000V. A.C. 0 / 50μA / 25 / 250mA. D.C. 0 / 3K / 30K / 300K / 3 meg — 20 to + 50dB
£4·97. Post 15p.



MODEL TE-300
30,000 O.P.V. Mirror scale, overload protection 0/·6/3/15/60/300/1,200V. D.C. 0/6/30/120/600/1,200V. A.C. 0/30μA/6mA/60mA/300mA/600mA. 0/8K/60K/600K/8 meg. ohm —20 to +63 db. £5·97. P. & P. 15p.

MODEL PL436
20k Ω/Volt D.C. 8k Ω/Volt AC. Mirror scale. ·6/3/12/30/120/600 V D.C. 3/30/120/600 V A.C. 50/600μA/60/600 mA. 10/100K/1 Meg/10 Meg Ω — 20 to +46db.
£5·97. P. & P. 12p.

TMK MODEL TW-50K
46 ranges, mirror scale, 50K/Vol. D.C. 5K/Volt A.C. D.C.: Volts ·125, ·25, 1·25, 2·5, 5, 10, 25, 50, 125, 250, 500, 1000V, A.C. Volts: 1·5, 3, 5, 10, 25, 50, 125, 250, 500, 1000V. D.C. Current: 25, 60μA, 2·5, 5, 25, 50, 250, 500mA, 5, 10 amp. Resistance: 10K, 100K, 1 MEG, 10 MEG Ω. Decibels: —20 to +81·5db
£8·50. P. & P. 17p.

MODEL K228A
Taut band suspension. Overload protection. Polarity reversing switch. 30,000 o.p.v.
0 / ·5 / 2·5 / 15 / 50 / 250/ 500 / 1000 / 2500V. D.C. 0 / 15 / 50 / 150 / 500 / 1000V. A.C. 0 / 50μA / 5 / 50 / 150 / 500mA / 5A D.C. 0 / 3K / 300K / 3 meg.
£8·95. Post 20p.

HIOKO MODEL 700X
100,000 O.P.V. Overload protection. Mirror scale.
·3/·6/1·2/1·5/3/6/12/30/60/120/300/600/1200V DC
1·5/3/6/12/30/60/150/300/600/1200 V. A.C.
15/30μA/3/6/30/60/150/300mA 6/12 AMP. DC. 2K/200K/2 Meg/20 Meg ohm —20 to +63dB. £13·50. P. & P. 20p.

MODEL C-7080 EN
Giant 6" mirror scale. 20,000 o.p.v. 0 / ·25 / 1 / 2·5 / 10 / 50 / 250 / 1000 / 5000V. D.C. 0 / 2·5 / 10 / 50 / 250 / 1000 / 5000V. A.C. 0 / 50μA / 1 / 10 / 100 / 500mA / 10 amp. D.C. 0 / 2K / 200K / 20 meg — 20 to + 50 dB.
£18·95. Post 35p.

U431Z MULTIMETER
Extremely sturdy instrument for general electrical use. 667 o.p.v.
0/·3/1·5/7·5/30/60/150/300/600/900 VDC and 75mV.
0/·3/1·5/7·5/30/60/150/300 600/900 VAC.
0/300μA/1·5/6/15/60/150/600MA/1·5/6 AMP. D.C.
0/1·5/6/15/60/150/600MA/1·5/6 AMP. AC.
0/200 Ω/2K/30K Ω.
Accuracy DC 1%. AC 1·5%.
Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions. £8·50 plus P. & P. 25p.

Selected TEST EQUIPMENT

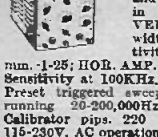
FTC-401 TRANSISTOR TESTER
Full capabilities for measuring A, B and ICO. NPN or PNP. Equally adaptable for checking diodes. Supplied complete with instructions, battery and leads.
£7·50. Post 20p.

Model S-100TR MULTIMETER/TRANSISTOR TESTER
100,000 o.p.v. mirror scale/overload protection. 0/·12/·6/3/12/30/120/600 V DC. 0/6/30/120/600. V AC. 0/12/600μA/ 12/300mA/12 AMP DC. 0/10 K/1 MEG/100MEG. —20 to +50db. 0·01—2 MFD. Transistor tester measures Alpha, beta and Ico. Complete with batteries, instructions and leads. £13·50. P/P 25p.

MODEL 449A IN CIRCUIT TRANSISTOR TESTER
Checks true A.C. beta in / out. Checks Icbo. Checks diodes in / out. Checks SCR, etc. Beta HI 10 — 500. LO 2 — 50. Icbo 0–5000μA. 220/240 V A.C. operation
£17·50. Post 25p.

KAMODEN HM. 720B F.E.T. V.O.M.
Input impedance 10 meg ohms.
Ranges:
0 / ·25 / 1 / 2·5 / 10 / 50/ 250 / 1000V. D.C.
0 / 2·5 / 10 / 50 / 250 / 1000V. A.C.
0 / 25μA / 2·5 / 25 / 250 MA D.C.
— 20 to + 62dB
0 / 5K / 50K / 500K / 5meg/ 500meg ohms.
£14·95. Post 30p

MODEL L-55 FET V.O.M.
Input impedance 10 meg ohms. 0 / ·3 / 1·2 / 6 / 30 / 120 / 600V. D.C. 0 / 3 / 12 / 60 / 120 / 600V. A.C. 0 / 120μA / 120mA D.C. 0 / 1K / 100K / 10 meg /100 meg ohms
£15·97. Post 15p.



CI-5 PULSE OSCILLOSCOPE
For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth 10MHz. Sensitivity at 100KHz VRMS/mm. ·1·25; HOR. AMP. Bandwidth 500KHz. Sensitivity at 100KHz. V RMS/mm. ·3·25; Preset triggered sweep 1–3,000usec.; free running 20–200,000Hz in nine ranges. Calibrator pips. 220 × 360 × 430mm. 115–230V. AC operation.
£39·00. Carr. paid.

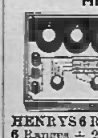
TO-3 PORTABLE OSCILLOSCOPE

3in. tube. Y amp. Sensitivity 0·1v p-p/CM. Bandwidth 1·5 cps–1·5 MHz. Input imp. 2 meg Ω 25pF X amp. sensitivity 0·9v. p-p/CM. Bandwidth 1·5cps–800kHz. Input imp. 2 meg Ω 20pF, Time base. 5 ranges 10 cps 300 kHz. Synchronization. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15½lb. 220/240V. A.C. Supplied brand new with handbook. £47·50. Carr. 50p.

RUSSIAN CI-16 DOUBLE BEAM OSCILLOSCOPE
5 mc/s Pass Band. Separate Y1 and Y2 amplifiers. Rectangular 5in. × 4in. C.R.T. Calibrated triggered sweep from ·2 u/sec. to 100 milli-sec. per cm. Free running time base 50 c/s–1 mc/s. Built-in time base calibrator and amplitude calibrator. Supplied complete with all accessories and instruction manual
£87. Carr. Paid.

TE-16A TRANSISTORISED SIGNAL GENERATOR
5 ranges 400kHz–30mHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide easy to read scale. 800kHz modulation. 5¾ × 5¼ × 3¾in. Complete with instructions and leads. £7·97. Post 25p.

TRANSISTORISED L.C.R. A.C MEASURING BRIDGE
A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω 11·2 meg Ω 6 Ranges ±1% L.1 μ H — 111 HENRYS 6 Ranges 2 — % C.10pF ±1110mFd 6 Ranges ± 2%. TURNS RATIO 1 : 1/1000-1 : 1/100. 6 Ranges ± 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. 25p.



MODEL TE-15 GRID DIP METER
Transistorised. Operates as Grid Dip, Oscillator, Absorption Wave Meter and Oscillating Detector. Frequency range 440Kc/s–280Mc/s in 6 coils. 500μA Meter. 9V battery operation. Size 180 × 80 × 40mm.
£15·00. Post 20p.

BELCO AF-5A SOLID STATE SINE SQUARE WAVE C.R. OSCILLATOR
Sine 18 × 200,000 Hz; Square 18 × 50,000 Hz
Output max. + 10 dB. (10 K ohms) Operation internal batteries Attractive 2-tone case 7¼" × 5" × 2". Price £17·50. Carr. 17½p.

MODEL MG-100 SINE SQUARE WAVE AUDIO GENERATOR
Range 19–220,000Hz Sine Wave 19–100,000 Hz Square Wave. Output Sine or Square wave 10v. P. to P. Size 180 × 90 × 90mm. Operation 220/240v. A.C.
£17·50 Post 37p.

MODEL AT201 DECADE ATTENUATOR
Frequency range 0–200KHz. Attenuator 0–111db, 0·1db step. Impedance 600 ohms. Max. input power 30dbm. Size 180 × 90 × 55mm.
£12·50 Post 37p.

TE-65 VALVE VOLTMETER
28 ranges. D.C. volts 1·5–1,500v. A.C. volts 1·5–1,500v. Resistance up to 1,000 megohms. 200/240v. A.C. operation Complete with probe and instructions.
£12·50. P. & P. 30p.
Additional probes available: R.F. £2·12½; H.V. £2·50.

MODEL U431I SUB-STANDARD MULTI-RANGE VOLT AMMETER
Sensitivity 330 ohms/Volt AC and DC. Accuracy 5% D.C. 1% AC. Scale length 165mm. 0/300/750μA/1·5/3/7·5/15/30/75/150/300/750mA/1·5/3/7·5AMP DC 0/3/7·5/15/30/75/150/300/750mA/1·5/3/7·5/15/30/75/150/300/750mV/1·5/3/7·5/15/30/75/150/300/750V DC 0/750mV/1·5/3/7·5/15/30/75/150/300/750V AC. Automatic cut out. Supplied complete with test leads, manual and test certificates. £49·00. Post 50p.

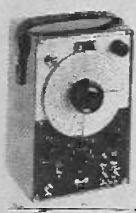
KAMODEN HM.350 TRANSISTOR TESTER

High quality instrument to test Reverse Leak current and DC current. Amplification factor of NPN, PNP, transistors, diodes, SCR's etc. 4" × 4½" clear scale meter. Operates from internal batteries. Complete with instructions, leads and carrying handle. £12·50. Post 30p.

KAMODEN HMG-500 INSULATION RESISTANCE TESTER

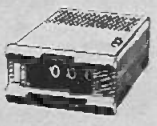
Range 0–1000 Megohms. 500 Volt. Battery operated. Wide range clear meter 4½" × 4". Complete with deluxe carrying case, batteries, instructions. £19·95. Post 30p

ARF-300 AF/RF SIGNAL GENERATOR



All transistorised, compact, fully portable. AF sine wave 18 Hz to 220 KHz. AF square wave 18 Hz to 100 KHz. Output sine / square 10v. P-P. RF 100 KHz to 200 MHz. Output 1v. maximum. Operation 220/240v. AC. Complete with instructions and leads. £29·95. Post 50p.

HONEYWELL DIGITAL VOLTMETER VT.100



Can be panel or bench mounted. Basic meter measures 1 volt D.C. but can be used to measure a wide range of AC and DC volt. current and ohms with optional plug in cards. Specification: Accuracy: ± 0·2, ±1 digit. Resolution: 1mV. Number of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1·999). Input impedance: 1000 Meg ohm. Measuring cycle: 1 per second. Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage. Overload: to 100v. D.C. Input: Fully floating (3 poles). Input power. 110–230v. A.C. 50/60 cycles. Overall size: 5¾in. × 2 13/16in. × 8 3/16in. AVAILABLE BRAND NEW AND FULLY GUARANTEED. £35·50. Carr. 50p.

HAND HELD 2-WAY WALKIE TALKIES

Industrial quality in robust metal cases. Battery operation. Volume and squelch controls. Call button and press to talk button. Telescopic aerial. Complete carrying cases.

2 channel 300 mW — **£52·50** — Pair. Post 50p.

3 channel 2 watt. — **£79·50** — Pair. Post 50p.

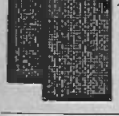
Licence required for operation in U.K.

EMI LOUDSPEAKERS

Model 350. 13" × 8" with single tweeter/crossover. 20–20,000 Hz. 15 watt RMS. Available 8 or 15 ohms. £7·25 each P. & P. 37p.

Model 450: 13" × 8" with twin tweeter/crossover. 55–13,000 Hz. 8 watt RMS. Available 8 or 15 ohms. £3·62 each. P. & P. 25p.

SPECIAL OFFER! STEREO SPEAKERS



Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size 14½" × 9" × 7½". 8 ohms. 8 watt RMS. 16 watt peak. Complete with DIN lead. £12·95 pr. Carr. 50p.

EA.41 REVERBERATION AMPLIFIER

Self contained, transistorised, battery operated. Simply plug in microphone, guitar, etc., and output into your amplifier. Volume control, depth of reverberation control. Beautiful walnut cabinet. 7½ × 3 × 4½in. £5·97. P. & P. 15p.

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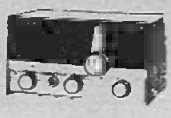

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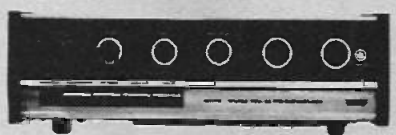

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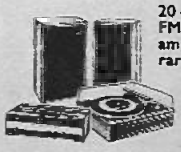

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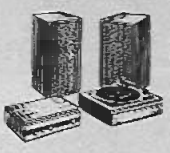

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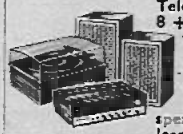

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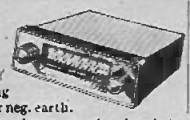

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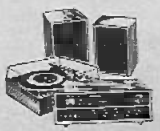

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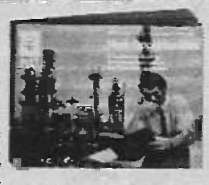

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¼W Iskra high stability carbon film—very low noise—capless construction. ¼W Mullard CR25 carbon film—very small body size 7·5 x 2·5mm. ¼W 2% Electrosil TR5.

Power watts	Tolerance	Range	Values available	Price 1–99	Price 100+
¼	5%	4·7Ω–2·2MΩ	E24	1·0p	0·8p
¼	10%	3·3MΩ–10MΩ	E12	1·0p	0·8p
¼	2%	10Ω–1M	E24	3·5p	3·0p
¼	10%	1Ω–3·9Ω	E12	1·0p	0·8p
¼	5%	4·7Ω–1MΩ	E12	1·0p	0·8p
¼	10%	1Ω–10Ω	E12	6p	5·5p

Quantity price applies for any selection. Ignore fractions on total order.

DEVELOPMENT PACK
0·5 watt 5% Iskra resistors 5 off each value 4·7Ω to 1MΩ.
E12 pack 325 resistors £2·40. E24 pack 650 resistors £4·70.

POTENTIOMETERS
Carbon track 5kΩ to 2MΩ, log or linear (log ¼W, lin ¼W).
Single, 12p. Dual gang (stereo), 40p. Single D.P. switch 24p.

SKELETON PRESET POTENTIOMETERS
Linear: 100, 250, 500Ω and decades to 5MΩ. Horizontal or vertical P.C. mounting (0·1 matrix).
Sub-miniature 0·1W, 5p each. Miniature 0·25W, 6p each.

TRANSISTORS

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AC126	12p	AF125	20p	BD132	75p	OC28	50p	2N3703	12p
AC127	12p	AF126	20p	BD133	75p	OC35	50p	2N3704	13p
AC128	12p	AF127	20p	BF115	25p	OC42	12p	2N3705	12p
AC131	12p	AF139	32p	BF173	20p	OC44	12p	2N3706	11p
AC132	12p	AF178	32p	BF177	28p	OC45	12p	2N3707	12p
AC176	12p	AF180	40p	BF178	32p	OC70	12p	2N3708	10p
AC187	22p	AF181	40p	BF179	32p	OC71	12p	2N3709	11p
AC188	22p	BC107	9p	BF180	32p	OC72	12p	2N3710	11p
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AF115	20p	BC157	14p	BFY50	20p	2N2926Y	9p	40408	40p
AF116	20p	BC158	14p	BFY51	20p	2N2926G	10p	ZTX302	15p
AF117	20p	BC159	14p	BFY52	20p	2N3054	58p	ZTX500	15p
AF117	38p	BC187	22p	BU105	225p	2N3055	60p	ZTX502	20p

ZENER DIODES
400mW 5% 3·3V to 30V, 12p.

WIRE WOUND POTS, 3W, 10, 25, 50 Ω and decades to 100kΩ, 35p.

DIODES

RECTIFIER				SIGNAL	
BY127	1250V	1A	12p	OA85	7p
BZY10	800V	6A	25p	OA90	5p
BZY13	200V	6A	20p	OA91	5p
IN4001	50V	1A	7p	OA202	7p
IN4004	400V	1A	8p	IN4148	5p
IN4007	1000V	1A	12p	BA114	8p

BRUSHED ALUMINIUM PANELS
12in x 6in–25p; 12in x 2½in–10p; 9in x 2in–7p.

SLIDER POTENTIOMETERS
86mm x 9mm x 16mm, length of track 59mm.
SINGLE 10K, 25K, 100K log. or lin. 40p.
DUAL GANG, 10K + 10K etc. log. or lin. 60p.
KNOB FOR ABOVE 12p.
FRONT PANEL 65p
18 Gauge panel 12" x 4" with slots cut for use with slider pots. Grey or matt black finish complete with fixings for 4 pots.

THERMISTORS

VA10555	15p
VA10665	15p
VA1077	15p
R53	£1·35

THYRISTORS

2N5060	50V	0·8A
30p, 2N5064	200V	
0·8A 47p, CRS1/40		
400V 1A 25p, 106F		
50V 4A 40p, 106D		
400V 4A 55p		

MULLARD POLYESTER CAPACITORS C296 SERIES
400V: 0·001μF, 0·0015μF, 0·0022μF, 0·0033μF, 0·0047μF, 2½p. 0·0068μF, 0·01μF, 0·015μF, 0·022μF, 0·033μF, 3p. 0·047μF, 0·068μF, 0·1μF, 4p. 0·15μF, 6p. 0·22μF, 7½p. 0·33μF, 11p. 0·47μF, 13p.
160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF, 3p. 0·1μF 3½p. 0·15μF 4½p. 0·22μF, 5p. 0·33μF, 6p. 0·47μF, 7½p. 0·68μF, 11p. 1·0μF, 13p.

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MYLAR FILM CAPACITORS 100V,
0·001μF, 0·002μF, 0·005μF, 0·01μF, 0·02μF 2½p. 0·04μF, 0·05μF, 0·068μF, 0·1μF, 3½p.

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100pF to 10,000pF. 2p each.

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REPLACES C426, C487 RANGES
(μF/V) 1·0/63, 1·5/63, 2·2/63, 3·3/63, 4·7/63, 6·8/40, 10/25, 10/63, 15/16, 15/40, 15/63, 22/10, 22/25, 22/63, 33/6·3, 33/40, 47/4, 47/10, 47/25, 47/40, 47/63, 68/6·3, 68/16, 100/4, 100/10, 100/25, 100/40, 150/6·3, 150/16, 150/25, 220/4, 220/10, 220/16, 330/4, 330/10, 470/6·3, 5p each. 68/63, 150/40, 220/25, 330/16, 470/10, 680/6·3, 1000/4 9p. 100/63, 150/63, 220/40, 470/25, 680/16, 1000/10, 1500/6·3 12p. 220/63, 470/40, 680/25, 1000/16, 1500/10, 2200/6·3, 15p. 330/63, 680/40, 1000/25, 1500/16, 2200/10, 3300/6·3, 4700/4, 18p.

SOLID TANTALUM BEAD CAPACITORS 12p

0·1μF	35V	2·2μF	35V	22μF	16V
0·22μF	35V	4·7μF	35V	33μF	10V
0·47μF	35V	6·8μF	25V	47μF	6·3V
1·0μF	35V	10μF	25V	100μF	3V

VEROBOARD

	0·1	0·15
2½ x 3½	22p	17p
2½ x 5	24p	21p
3½ x 3½	24p	21p
3½ x 5	28p	28p
17 x 2½	75p	57p
17 x 3½	100p	78p
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17 x 2½ (plain)	—	42p
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Pkt 50 pins	20p	20p

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Stereo screened	35p	3·5mm screened	13p
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Stereo socket	18p	3·5mm socket	8p

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6 way screened cable 22p/metre

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9V mains power supply. Same size as PP9 battery

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	p	p	p
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SN7403	0·20	0·18	0·16
SN7404	0·20	0·18	0·16
SN7405	0·20	0·18	0·16
SN7406	0·30	0·27	0·25
SN7407	0·30	0·27	0·25
SN7408	0·20	0·19	0·18
SN7409	0·45	0·42	0·35
SN7410	0·20	0·18	0·16
SN7411	0·23	0·22	0·20
SN7412	0·42	0·40	0·35
SN7413	0·30	0·27	0·25
SN7416	0·30	0·27	0·25
SN7417	0·30	0·27	0·25
SN7420	0·20	0·18	0·16
SN7422	0·48	0·44	0·40
SN7423	0·48	0·44	0·40
SN7425	0·48	0·40	0·35
SN7427	0·42	0·39	0·35
SN7428	0·50	0·45	0·42
SN7430	0·20	0·18	0·16
SN7432	0·42	0·39	0·35
SN7433	0·70	0·61	0·44
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SN7454	0·20	0·18	0·16
SN7460	0·20	0·18	0·16
SN7470	0·30	0·27	0·25
SN7472	0·30	0·27	0·25
SN7473	0·40	0·37	0·35
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SN7475	0·55	0·52	0·50
SN7476	0·45	0·42	0·39
SN7480	0·80	0·75	0·67
SN7481	1·25	1·15	1·10
SN7482	0·87	0·80	0·70
SN7483	1·60	0·90	0·85
SN7484	0·90	0·85	0·80
SN7486	0·45	0·41	0·38
SN7490	0·75	0·70	0·65
SN7491AN	1·00	0·95	0·90
SN7492	0·75	0·70	0·65
SN7493	0·75	0·70	0·65
SN7494	0·80	0·75	0·70
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SN74105	1·45	1·35	1·20
SN74107	0·50	0·45	0·40
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SN74118	1·00	0·95	0·90
SN74119	1·90	1·78	1·65
SN74121	0·60	0·55	0·50
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SN74150	3·35	2·95	2·15
SN74151	1·10	0·95	0·90
SN74153	1·35	1·27	1·20
SN74154	2·00	1·75	1·55
SN74155	1·55	1·47	1·35
SN74156	1·55	1·47	1·35
SN74157	1·80	1·70	1·50
SN74160	3·60	2·40	2·25
SN74161	2·60	2·40	2·25
SN74162	3·40	3·25	2·70
SN74163	3·40	3·25	2·70
SN74164	3·75	2·30	2·10
SN74165	4·00	3·50	3·00
SN74166	4·00	3·50	3·00
SN74167	6·25	5·60	5·10
SN74170	4·10	3·55	3·05
SN74174	3·00	1·75	1·30
SN74175	1·35	1·27	1·15
SN74176	1·60	1·35	1·20
SN74177	1·60	1·35	1·20
SN74180	1·55	1·50	1·20
SN74181	7·00	6·00	5·50
SN74182	3·00	1·80	1·60
SN74184	2·40	2·00	1·80
SN74185A	2·40	2·00	1·80
SN74190	1·95	1·85	1·75
SN74191	1·95	1·85	1·75
SN74192	2·00	1·90	1·80
SN74193	3·00	1·90	1·80
SN74194	2·50	2·25	1·90
SN74195	1·85	1·70	1·50
SN74196	1·50	1·40	1·30
SN74197	1·50	1·40	1·30
SN74198	4·60	3·70	3·35
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AC126	25p	BCY32	75p	BYZ13	35p	OC72	25p
AC127	25p	BCY34	35p	C106D	65p	OC77	45p
AC128	25p	BCY39	1·00	GET111	55p	OC81	25p
AC176	25p	BCY42	30p	GET115	55p	OC83	25p
AC187	25p	BCY43	25p	GET880	45p	OC140	55p
AC188	25p	BCY55	2·50	LM309K		OC170	25p
ACY17	30p	BCY70	15p	(TO3)	1·87	OC171	30p
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ACY21	20p	BCY72	15p	MJE340	50p	OC201	75p
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AD140	50p	BCZ11	50p	MJE520	75p	OC203	50p
AD149	50p	BD124	80p	MJE2955		OCP71	1·25
AD161	35p	BD131	75p		1·10	ORP12	50p
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BA115	7p	BFX13	25p	OA81	10p	TIP31A	60p
BA145	15p	BFX34	75p	OA91	7p	TIP33A	70p
BAX13	5p	BFX87	30p	OA200	7p	TIP33A	
BAX16	7p	BFX88	20p	OA202	10p		1·00
BC107	10p	BFY50	20p	OC16	75p	TIP34A	
BC108	10p	BFY51	20p	OC20	95p		1·50
BC109	10p	BFY52	20p	OC23	85p	TIP35A	
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						2N3525	75p
						2N3614	59p
						2N3615	75p
						2N3702	10p
						2N3704	10p
						2N3705	10p
						2N3714	1·80
						2N3771	1·75
						2N3773	2·00
						2N3790	2·25
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						2N5777	55p
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						28018	6·25
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SC50B	200	£1·35
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3 Amp T048


15 Amp T048

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B1/20	200	30p
B1/60	600	35p
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W005	50	30p
W01	100	35p
W02	200	40p
W06	600	45p
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B2/05	50	35p
B2/100	100	40p
B2/200	200	45p
B2/600	600	50p
B2/1000	1000	60p
FOUR AMPS ½H × ½L × ¼		
B4/100	100	60p
B4/200	200	65p
B4/400	400	70p
B4/600	600	75p
B4/800	800	£1·00
SIX AMPS ½H × ½L × ¼		
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CR8 1/40	400	25p
CR8 1/60	600	45p
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CR8 3/05	50	30p
CR8 3/10	100	30p
CR8 3/20	200	35p
CR8 3/40	400	45p
CR8 3/60	600	55p
FIVE AMP (TO66)		
CR8 5/400	400	60p
SEVEN AMP (TO48)		
CR8 7/100	100	60p
CR8 7/200	200	65p
CR8 7/400	400	70p
CR8 7/600	600	95p
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1 Amp T05


3 Amp T048

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P.W. Tricolor as per April/May June 1973. Parts list on request (52A).

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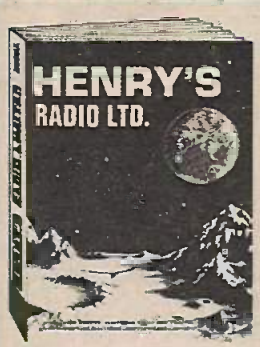

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